COCOA GROWERS' BULLETIN

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Contents

Cadbury Limited
Overseas Cocoa Department
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Editorial

Fertilisers and Cocoa

The "Cocoa Growers' Bulletin" has always stressed the need for higher yields and more intensive cultivation of cocoa. It is only in this way that cocoa growers can be assured of continued prosperity and that cocoa can remain competitive with other tropical crops. If cocoa is less profitable than other crops, then there can be no assurance that production will increase or indeed be maintained.

There are two positive approaches to higher yields. The long term approach lies in the planting of better planting material. The short term answer lies in increasing yields from existing farms. The use of fertilisers seems the obvious solution but, for a long time, the results of fertiliser trials on cocoa were disappointing. It was relatively recently that the relationship of shade and nutrition became understood and the reason for the earlier disappointing results can be seen to lie in the limiting factor being light rather than nutrients. This relationship first became clear in the shade and spacing trials in Trinidad; these were then reinforced by the spectacular results from the larger shade and fertiliser trial at Tafo. This trial showed that the removal of shade and the addition of fertilisers resulted individually in considerable increases in yield and, when combined, yields of 3,000 lb. per acre were obtained. Apart from clarifying the results of shade removal and fertiliser application, the trial showed that Amelonado cocoa was capable of far higher yields than had previously been thought possible. One inference from these trials is that those countries where cocoa is grown with little or no shade should obtain worthwhile responses from the application of fertilisers. Nigeria is such a country and Mr. Wessel's article shows that the application of fertilisers is profitable except at the lowest initial yields.

The results of the trial at Tafo apply to the particular conditions of soil and climate at Tafo and it must be stated that it would be most unwise to start removing shade and applying fertilisers on a wide scale either in Ghana or elsewhere. Many trials of this type are needed but, despite the fact that the Tafo results have been with us for several years, this has not been done. The exceptions have been Nigeria whose trials are described here, but the results have not been put into practice; and Brazil where sales of fertiliser to cocoa growers are increasing rapidly. It will be surprising if the application of fertilisers to cocoa is not a general practice by the end of another decade, but many trials and demonstrations are needed.

G. A. R. WOOD.

Review of Production and Consumption

June 1970

A. P. Williamson, Cadbury Schweppes Limited

Production

The early pessimistic reports on the West African main crops proved to be completely unfounded and production was the second highest total on record. All major producers showed substantial increases over last year and the production in the Ivory Coast was an all-time record. In Bahia there was an exceptionally good main crop and, with prospects of a good average Temperao crop, production there should be the second highest ever.

Among the smaller producers, production in the Dominican Republic recovered dramatically from the setback last year. In New Guinea it appears that the expected increase will not materialise and production will be a little down on last year and, because of political troubles, production from Equatorial Guinea will be sharply down.

The prospects for the forthcoming mid-crops appear promising, with good early purchases in Ghana and the Ivory Coast in particular.

Consumption

The forecast of world grindings in 1970 has been increased by 30,000 tons and is now expected to be only 2 per cent less than in 1969. The main fall is still expected to be in Western Europe and North America, with Eastern Europe increasing their requirements.

Although the recent fall in prices should encourage consumption during the second half of 1970, if the good summer in Western Europe continues it will cancel this out.

Stocks

The nominal production surplus in 1970 is now expected to be 65,000 tons. After allowing for the normal 1 per cent loss in weight this is equivalent to a true surplus of around 50,000 tons. If this forecast proves correct then there will be a modest increase in stocks during the year although in historical terms stock levels will still be low.

Prices

During December and January prices fell by over £100 from the £390 per ton level ruling at the end of November and then held steady at these new lower levels during February, March and April before falling a further £30/ton during May and June. Month-end prices for nearby shipment cocoa over the period under review have been:—

November	£390·0/ton	March	£292·5/ton
December	£350·0/ton	April	£290·0/ton
January	£330·0/ton	May	£275·0/ton
February	£292·5/ton	June (mid)	£260·0/ton

WORLD COCOA PRODUCTION AND GRINDING DATA

Reproduced from Gill and Duffus Market Report dated

12th June, 1970

(Thousand long tons)

	1967-68	1968-69	1969-70 (Forecast)
Africa	964	852	979
America	291	300	312
West Indies	49	37	53
Asia and Oceania	37	40	39
World Total	1,341	1,228	1,383
Principal Countries			
Ghana	415	334	395
Nigeria	235	187	220
Ivory Coast	144	142	175
Cameroon	90	103	107
Guinea (Spanish)	33	37	28
Brazil	141	163	185
Ecuador	68	52	48
Dominican Republic	30	21	37
Mexico	27	26	24
New Guinea	24	27	25

Grindings

	1968	1969	1970 (Forecast)
Western Europe	546	522	503
Eastern Europe and U.S.S.R. ..	186	188	193
North America	304	280	265
Australia and New Zealand ..	17	16	17
Central and South America ..	155	151	152
Asia	50	49	46
Africa	137	140	142
World Total	1,397	1,346	1,318
Principal Countries			
United States	286	264	250
Germany (Federal Republic) ..	137	122	120
Netherlands	110	109	105
United Kingdom	92	91	86
U.S.S.R.	95	106	112
France	49	42	40
NOMINAL BALANCE	—56	—118	+65

Cocoa in Grenada

A. M. Cruickshank, Department of Agriculture, Grenada

Geography

The territory of Grenada is located in the British West Indies and includes the islands of Carriacou and Petite Martinique about 20 miles to the north and all islets known as the Grenadines lying between. Grenada is the most southerly of the group. It lies 90 miles north of Trinidad and 68 miles south-west of St. Vincent. It is 21 miles long and 12 miles at its greatest breadth, covering an area of about 120 square miles (4).

Historical Background to the Industry

It is generally believed that serious attempts at cultivating cocoa in Grenada began around the year 1714. If this assumption is correct then the crop must have been introduced prior to that date. A census taken in 1700 showed that there were 150,000 cocoa trees in that year and a great impetus to the trade was given when vessels plying between Martinique and the Spanish Main began calling at Grenada for water (1). However there does not appear to be any accurate record as to when exports started. The earliest available data shows that in 1787 some 135 tons of cocoa were exported.

After emancipation in 1839 exports rose and reached 2,900 tons in 1881. Emancipation and the fall in sugar prices perhaps accelerated the decline in sugar production in Grenada. Many sugar estates were sold, abandoned or converted to cocoa, and this crop steadily replaced sugar. The crop was planted mainly by small proprietors through the "Garden" or "Contract system", whereby the "contractor"—usually a labourer—agreed to bring between one and three acres of land into bearing cocoa. After about five years, the estate took over, and paid the contractor at an agreed rate for every cocoa tree. With the lump sum so obtained, the contractor purchased lands from bankrupt sugar estates (6). In this way the cocoa industry expanded rapidly between 1870 and 1920. Following the financial crisis after the 1914-18 war, prices fell to 42/– per cwt. compared with 92/– for the previous four years. By the turn of the thirties they had declined to 23/–. In spite of this, peak production was reached in 1918 and 1927 when over 6,250 tons were exported in each of those years. There was, however, a general decline in production which was attributable to several causes, amongst them a hurricane in 1921, the prolonged period of depression and low prices resulting in neglect of cultivation, conversion to other crops such as nutmegs and bananas, and the age of the cocoa trees.

By 1938 the situation facing cocoa producers led to a petition to the Government urging assistance in maintaining the industry on a sound economic basis and from this was born the Grenada Cocoa Rehabilitation Scheme.

When the scheme started in 1940, it embraced separate concepts of research and rehabilitation. These were subsequently merged, and the revised scheme came into operation in 1946. However, between 1940-43, 79 clones were selected locally and the rehabilitation programme revolved around the propagation, testing and distribution of these clones.

Ecology and Soils

The crop is mainly confined to protected valleys and slopes on the western, eastern and northern parts of the island, where the mean annual rainfall is about 80 in. with two dry months. Although cocoa may be found growing from 200 ft.–1,200 ft. above sea level, the main belt is between 500 ft. and 1,000 ft.

The soils are volcanic in origin and are all derived from similar parent material though climate, both as total rainfall and duration of the dry season, has influenced the weathering processes. The more intense weathering in the wetter areas gave rise to the kaolinitic latosolic "Red Earths" with a moderate to low base status, and in the drier areas to the montmorillinitic dark grey "Shoal", a less weathered ash soil, with a moderate to high base status. The "Brown Earths" tend to be intermediate between these two groups and these three are the main cocoa soils of the island.

The "Red Earths" are the most extensive (about 25,500 acres) followed by the "Brown Earths" (about 17,000 acres) and the "Shoals" etc. (about 5,600 acres). The normal soils of the "Red Earths" and the "Brown Earths" are the Capital Clay Loam and the Belmont Clay Loam respectively. The former usually occurs over highly weathered basic igneous rocks and the latter usually over basic ash and agglomerate. They are both moderately well drained with good water retention and moderate erodibility. The latter however has higher natural fertility. The normal "Shoal" soils are the Perseverance and Concord Clay Loams, developed over ash and agglomerate; these occur at relatively low elevations and are moderate to poorly drained. The Perseverance Clay Loam is shallow and has low fertility, but the Concord Clay Loam is heavy with a fairly high fertility (7). Generally, all the cocoa soils are responsive to fertiliser treatment and there is a growing awareness of the beneficial effects of fertiliser.

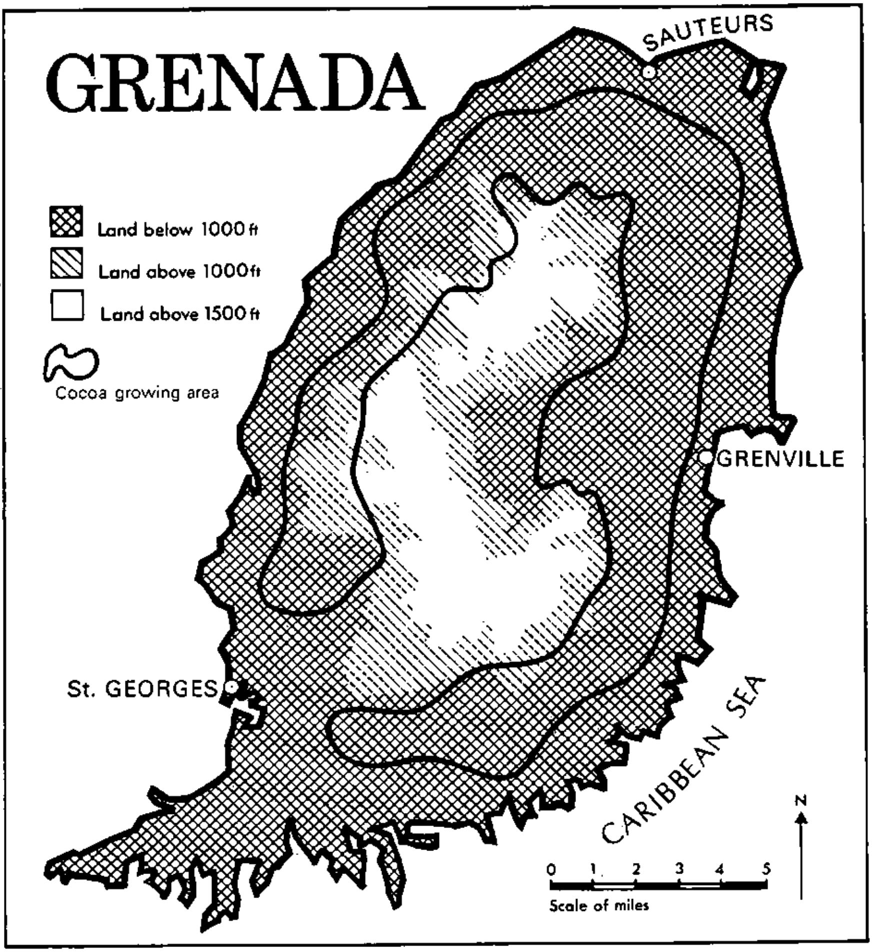
Organisation and Importance of the Industry

Cocoa has been produced in Grenada for over 200 years, perhaps longer than most present day producers and thus considerable expertise is available in all aspects of cocoa cultivation.

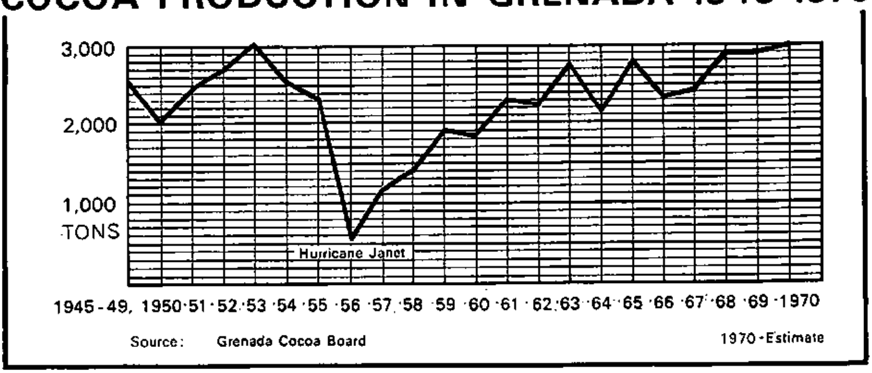
In 1958 there were about 8,400 cocoa farmers and 30 per cent of the crop was produced by farms under 50 acres. The total area of cocoa was in the region of 20,000 acres.

As previously stated, clones of the 79 Grenada selected (G.S.) clones have formed the basis of the rehabilitation of Grenada's cocoa industry. Distribution started in 1946 and increased steadily until 1955 when the industry received a setback by hurricane "Janet" in September of that year. Many fields were damaged and others rendered unsuitable for replanting, due to erosion. The demand for planting material increased, and in addition to rooted cuttings, budded cocoa seedlings were propagated to accelerate the rate of replanting. This phase lasted until around 1962, and although limited quantities of hybrid seedlings have been produced from time to time, clonal plants still predominate. Planting has not extended to new areas but over 10,000 acres have been replanted to date.

Farmers are invited to submit their application for plants one year in advance. Following this, the Extension Staff of the Ministry of Agriculture inspects the area to determine its suitability for growing cocoa. If suitable, the farmer is advised on such requirements as soil conservation, windbreaks, shade, planting distance and size of holes; regular visits are made to the farm to check on the



COCOA PRODUCTION IN GRENADA 1949-1970



progress of preparation. Plant distribution begins with the onset of the rains in June and ends in December before the dry season. If the Extension Officer is satisfied with the preparation, the plants are delivered to the farm at a cost of five cents each (2½d). This is a subsidised price as the true cost is in the region of seventy-five cents (3/1½d).

The cocoa industry is without doubt a most reliable source of the territory's income contributing indirectly through income tax, and directly through export duty levied at the rate of 6d per cwt. Additional export duty is also levied at the rate of 20 per cent of the amount by which the net price exceeds 11½d per lb., in addition to a cess of 1d on every pound of cocoa exported. The latter is used in assisting to finance the rehabilitation programme.

In terms of value, the industry is responsible for a gross revenue in the region of £0·9-£1·1 m. or over 37 per cent of the territory's revenue.

System of Cultivation

With the importance of bananas in the local economy, cocoa is established under temporary nurse shade of this crop; formerly *Gliricidia sp.* and Bluggoe (*Musa sp.*) were used.

Recommended Spacings:—

6 ft. × 6 ft.—1,200 plants/ac.	12 ft. × 12 ft.—300 plants/ac.
6 ft. × 7 ft.—1,000 „ „	12 ft. × 14 ft.—260 „ „
7 ft. × 7 ft.— 890 „ „	14 ft. × 14 ft.—220 „ „
7 ft. × 8 ft.— 770 „ „	14 ft. × 16 ft.—190 „ „
8 ft. × 8 ft.— 680 „ „	16 ft. × 16 ft.—170 „ „

Permanent windbreaks are established at right angles to the prevailing winds. The main windbreak consists of seedling mangoes. These are collected when they are about 12 in. tall and planted staggered in triple rows about 3 ft. apart in and between the rows. The middle row is allowed to grow unrestricted, whilst the two outer rows are occasionally topped to slow down their growth as long as possible in order to control "bottom winds". Frequent small doses of sulphate of ammonia during the first three years are helpful in the establishment of the windbreak. These take time to establish and quick-growing subsidiary hedges are planted around and through the fields in conjunction with contour drains. *Arabica* coffee is often used as a subsidiary hedge and is planted in staggered double rows, 3 ft. apart.

The bananas are planted at least one year in advance of the cocoa, and the revenue from that crop tides the farmer over until the cocoa comes into production at about the 3rd-4th year. In fact the banana shade is regulated so that by the time the cocoa is about four years old, the banana plants are completely eliminated from the field.

During this establishment phase fertiliser application is made for both crops. Between the 1st and the 4th years this increases from ½ lb. of a 12:8:24 or 11:11:33 NPK mixture to 1 lb. of the same mixture per plant per annum for cocoa, and 2 lb. per plant per annum for each banana stool. After the bananas have been removed, the cocoa receives 1 lb. of 12:8:24 NPK in the 5th year and 2 lb. from the 6th year onward. The fertilisers are applied in split doses in June and September/October.

The cocoa therefore develops without shade after the 4th year, but with proper lateral protection from windbreaks and hedges.

At the end of the rainy season, plants are usually mulched at the rate of 4-5 tons per acre giving a 4 in. thick protective mulch cover to the soil. The materials used consist of trimmings from windbreaks and hedges, old banana pseudo-stems, etc.

Plants are pruned regularly, beginning with formation pruning between one and three years followed by light maintenance pruning to keep the trees in good shape.

Because of the expense of hand weeding and the likelihood of spreading diseases, the use of herbicides is becoming more widespread. Promising results have been obtained with a mixture of Karmex*—2 lb./ac. and Gramoxone—1 pint/ac. against annual and perennial herbaceous broad-leaf weeds and grasses.

Processing and Marketing

Many of the small farmers are encouraged to harvest their cocoa and sell the wet beans to cocoa dealers located throughout the island. This cocoa is therefore fermented in bulk by those dealers who possess fermenting and drying facilities. The larger farmers process the beans themselves and sell their cocoa dry to these dealers or direct to exporters. Both the dealers and the exporters are agents of the Cocoa Industry Board, and operate under licence to that body. The Board is a statutory body created by Government to safeguard and promote the interest of the cocoa industry and in particular to market and regulate cocoa exports (2). The dealers and exporters are therefore remunerated by the Board for their services.

The Extension Staff and Produce Inspectors advise all farmers on fermenting and drying techniques. Any farmer selling wet cocoa is permitted to do so on a specific day every week, to ensure regularity in delivery and uniformity in fermentation. The beans are box-fermented for about 6-7 days, during which period they are turned two or three times. Following fermentation, the cocoa is put out to dry in the sun. Depending on weather conditions, drying may be completed in about six days. On the 5th day, however, the beans are polished or danced. They are put into a large iron cauldron and water added. The worker manipulates the beans under his feet so as not to crush them, and they develop a gloss or polish in less than an hour. The beans are then put back on the drying floor to preserve the polish and complete drying. More recently, the process of polishing is being done largely by the exporters who have mechanical polishers.

After polishing and drying, the cocoa is graded and bagged into 200 lb. bags in two grades, i.e. Grade I and Grade II, using international criteria. The cocoa may be rejected as unfit for export if on examination it is not thoroughly fermented or dried or if it contains foreign matter, evidence of adulteration or smoky beans, insect damage, germinated, flat or slaty beans (3).

Except for the small quantity of rejected and sub-grade cocoa consumed locally for drinking, all the cocoa is exported. The principal markets are the United Kingdom, Holland, Belgium and West Germany.

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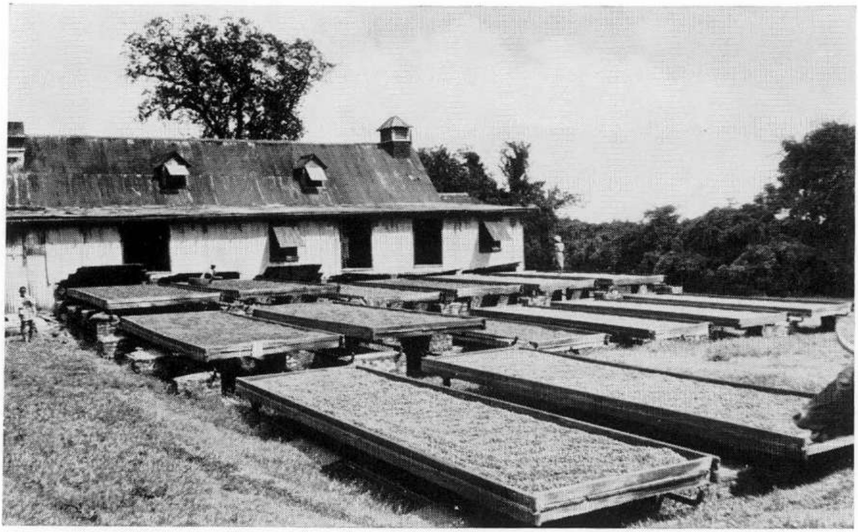
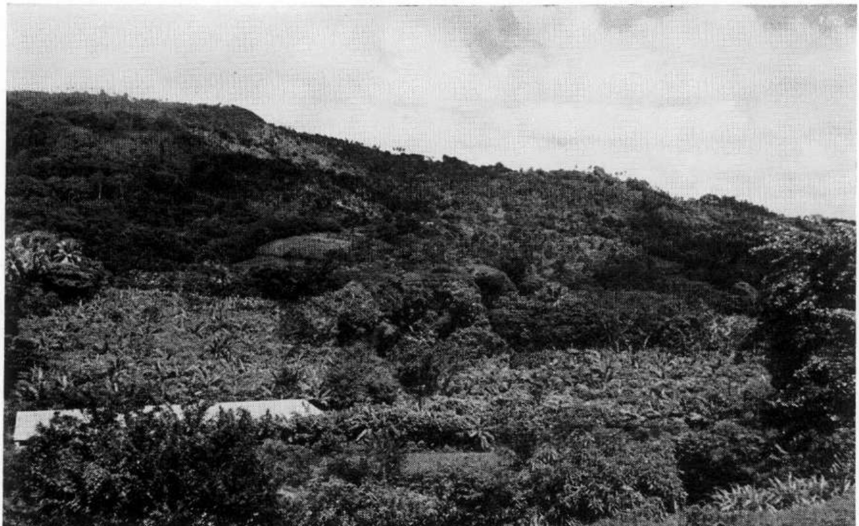
*There have been reports from Sabah of toxicity symptoms as described by Kasasian Cocoa Growers' Bulletin 5, 10–15. Young cocoa seedlings planted on alluvial soil in an area with 130″ annual rainfall showed these symptoms after $2 \times \frac{1}{2}$ lb. applications of Karmex.—Editor.



Sliding tray dryers at Boulogne Estate.

Typical cocoa fields in Grenada, showing cocoa under bananas with windbreaks.



Pests and Diseases

Pests:— There are two important pests of cocoa in Grenada; the cocoa beetle (*Steirastoma breve*) and cocoa thrips (*Selenothrips rubrocinctus*). For control of beetles hand collecting and trapping have given way to low-volume spraying with Dieldrin, Toxaphene or DDT. The same mixture is also used for thrips control. Aphids, mealy bugs and ants are of minor importance.

Diseases:— The major diseases are Witches' Broom (*Marasmius perniciosus*) and Black Pod (*Phytophthora palmivora*). Witches' Broom infects the shoots, flower cushions and pods. Control can be by removal and destruction of the brooms (green and dry) and other infected tissue, but as this method has not been found to be very effective, attempts have been made to establish tolerant hybrid seedlings in areas of high infection. This work is proceeding.

Black Pod causes on average an annual loss of about 2 per cent of the crop. Some control is achieved by removal and burying of the infected pods, regular harvesting, and field sanitation; low volume spraying of Perenox at the rate of 2 lb. in 4 gallons of water is resorted to in places where infection is high. Other fungicides being tried are Kocide and Cupravit.

Research

Clonal, manurial and cultural trials have been established on the main "cocoa soils" of the territory. These are relatively long term and have been going on for many years. All information obtained from these trials is disseminated to farmers through the Extension Staff. The clonal trials are designed to test the 79 locally selected clones. Emphasis is given to yields and quality, but simultaneous observations are being made for disease, pest resistance, vigour, etc. The manurial trials are designed to investigate the local manurial requirements of clonal cocoa, in order to advise farmers how best to correct the manurial deficiencies.

In addition to the above, there are simple clonal trials conducted on private estates to compare quantitatively under estate conditions, selected ICS (Trinidad (clones and G.S. (Grenada) clones, as well as controlled crosses of the following hybrid seedlings:

G.S. 29×SCA 6	ICS 1×SCA 6
G.S. 29×SCA 12	ICS 1×SCA 12
G.S. 36×SCA 6	ICS 6×SCA 6
G.S. 36×SCA 12	ICS 6×SCA 12

Future of the Industry

The instability and violent fluctuations in the world market price for cocoa over the last few years have been causing the local farmer a lot of concern. This has had an adverse effect on the rehabilitation programme. Some years ago when the market price fell to a very low level, many farmers started replacing cocoa with pure stands of bananas, which at the time appeared more lucrative, and for which there are excellent marketing arrangements.

Nevertheless, the present production can be increased significantly if farmers can be assured of an economic price and a guaranteed outlet. There is a certain amount of disenchantment with the continuing dialogue which has been taking place for so many years between producers and consumers on the question of an International Cocoa Agreement, with no significant gains. Unless there are some tangible results forthcoming, farmers will feel that this is only an academic exercise.

The trade recognises Grenada's cocoa in the fine flavour category and it enjoys a premium over bulk or ordinary cocoa. This premium has been narrowed considerably in spite of the continuing improvements in the quality of the local product.

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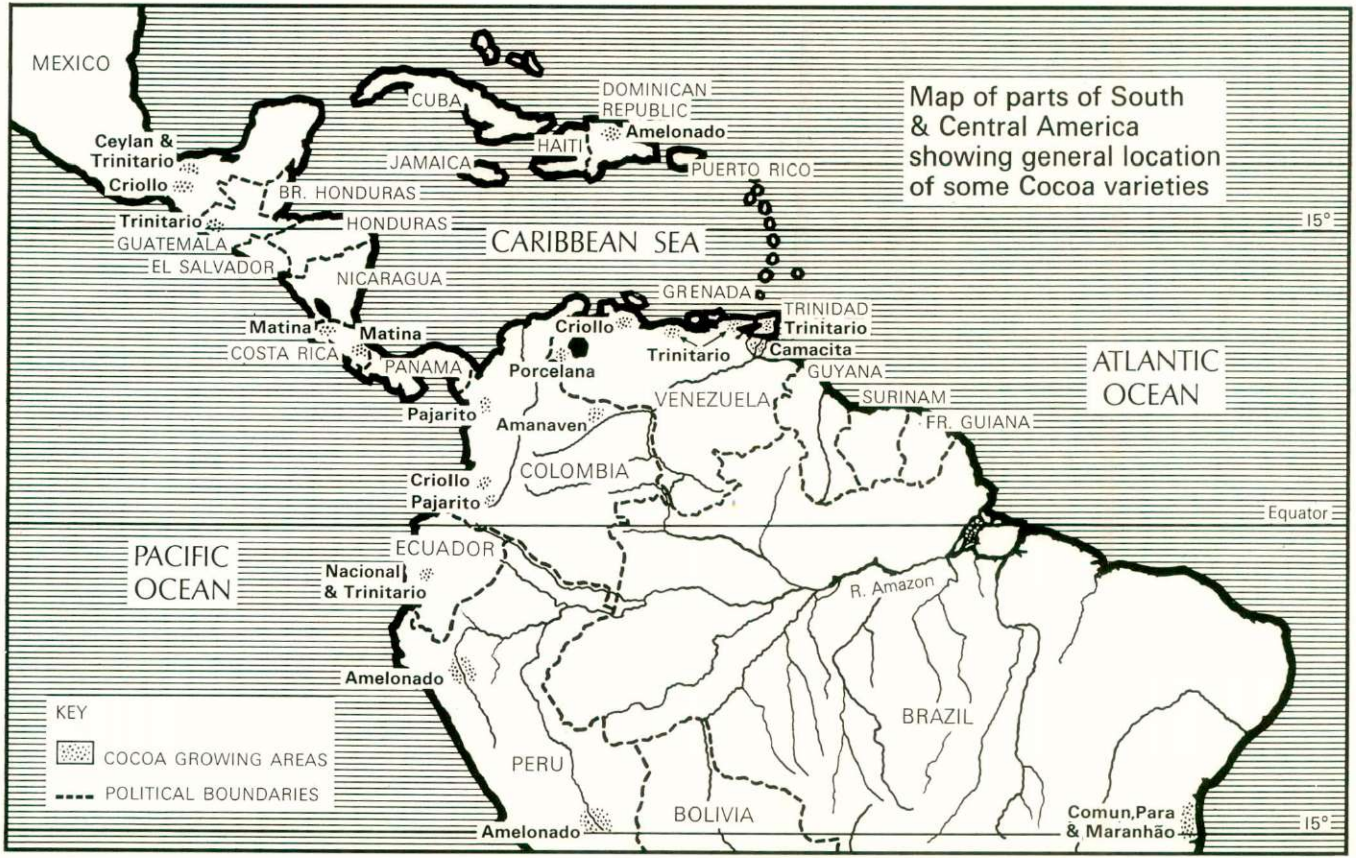


Map of parts of South & Central America showing general location of some Cocoa varieties
MEXICO
Ceylan & Trinitario
Criollo
Trinitario
GUATEMALA
EL SALVADOR
BR. HONDURAS
HONDURAS
NICARAGUA
Matina
Matina
COSTA RICA
PANAMA
CUBA
JAMAICA
HAITI
DOMINICAN REPUBLIC
Amelonado
PUERTO RICO
CARIBBEAN SEA
GRENADA
TRINIDAD
Trinitario
Camacita
Criollo
Porcelana
Trinitario
VENEZUELA
GUYANA
SURINAM
FR. GUIANA
ATLANTIC OCEAN
15°
Pajarito
Amanaven
COLOMBIA
Criollo
Pajarito
Equator
PACIFIC OCEAN
ECUADOR
Nacional & Trinitario
R. Amazon
Amelonado
BRAZIL
PERU
BOLIVIA
Amelonado
Comun,Para & Maranhão
15°
KEY
COCOA GROWING AREAS
POLITICAL BOUNDARIES

Principal Varieties of Cocoa Cultivated in Tropical America

Jorge Soria V., I.I.C.A. Turrialba, Costa Rica

Introduction

In accordance with the International Code of Nomenclature for cultivated plants, the term variety is the same as cultivar when it is applied to "a group of individuals which show genetic differences but which have one or more characteristics by which they may be differentiated from other cultivars (varieties)". Following this definition only the common names applied to populations of *Theobroma cacao* will be used for the varieties in each region. This paper is intended to describe only the principal varieties of the American continent.

It is necessary also to mention that botanical classifications will not be made to the species or subspecies level as has been proposed by other authors (3, 5). Hybridization work between the different groups has not encountered genetic barriers in production of F1 hybrids which would justify such divisions and, in fact, considerable hybrid vigour is obtained in many cases. It is true that there are notable differences in the shape and colour of pods, seeds and foliage, but these are at the gene rather than the chromosome level.

It is important also to define certain terms which are used in the text and which may vary in meaning from one location to another. The terms "Amelonado" (melon shaped), "Calabacillo" (gourd shaped), "Cundeamor" (elongated pod with bottle neck and pointed), and "Angoleta" (base broad and pointed) refer to the shape of the pods and not to the varieties or genetic complexes. The terms Criollo, Trinitario and Forastero refer to broad genetic complexes which correspond to varieties.

Criollo cocoas

The majority of authors (1, 3, 4, 5) give the following characters as typical of the Criollos: cylindrical pods with ten deep simple ridges or in five pairs, shell (pericarp) verrugose, thin or thick, with a light lignified layer in the centre of the pericarp, with or without a depression at the neck, pointed tips with five angles, straight or curved. The colour of the pod may vary from green to red; seeds white or slightly pigmented, cylindrical or oval.

The trees are relatively lower or less robust than those of other varieties; the canopy rounded; leaves small, oval shaped, thick, or a clear green colour and very susceptible to the majority of diseases.

Forastero cocoas

The Forasteros (3, 5) have been described as having oval shaped pods, Amelonado, with ten superficial or deep ridges. The shell smooth, thin or thick with a lignified layer in the centre of the pericarp, the two extremes rounded and at times with a small bottle neck at the base. The pods are green or slightly rose coloured. Seeds are purple, triangular when cut transversally, flattened and small. The trees are more vigorous, the foliage larger and more dense and the plants more tolerant to diseases than the Criollo types.

Trinitario cocoas

These constitute hybrid populations of Criollo and Forastero and have seed and pod characteristics which are almost intermediate between the two original groups.

MEXICAN AND CENTRAL AMERICAN VARIETIES

Criollo cocoa of Mexico

There now exist no pure plantations of Criollos in Mexico though there are a few trees located in the state of Chiapas. The author noted in 1961 the great variability in shape and size of pods and seeds, all with the white seeds showing that they were developed from an authentic population of Criollo. The pods always had a pointed tip, though colour varied from green to clear red.

"Lagarto"

Among the Criollo and Trinitario plantings of Mexico and Guatemala are found a few cocoa trees of the so-called "Lagarto" or "Pentagona" variety with five angular ridges. The seeds are similar to those of the Criollo and Trinitario types with varying shades of coloration and the shells are very thin, red or rarely green.

"Ceylan"

This is the most common name for a Forastero Amelonado variety which is cultivated in the main cocoa areas in the states of Tabasco and Chiapas. In some localities it is known by other names such as "Sanchez" or "Costa Rica". Although never pure due to being mixed with Trinitarios, it is characterised by pods of Amelonado shape of whitish green colour, with ten ridges, five deeper than the others, and a smooth surface. The older cocoa farmers indicate that this variety came from Costa Rica about 1900 and this name is applied to the variety in certain localities. In the author's opinion the variety is the common Forastero type called "Matina" in Costa Rica.

The Forastero varieties and hybrids of these with Criollo types have practically displaced the Criollos in all districts of Mexico.

"Criollo type"

This is the Mexican name for the hybrids (Trinitarios) or local Criollos and introduced Forasteros; they show all combinations of shape and colour seen in the parent populations. Hybrid vigour is very evident between these populations resulting in a number of trees of high production.

Criollo de Nicaragua or "Cacao Real"

The most outstanding characteristics of this variety is the high frequency of intense red coloration and the obvious bottle neck of the pods. Nevertheless, Angoleta shapes are also found, always exhibiting a curved or straight tip. This variety has almost disappeared from cultivation in Nicaragua (6) and has been replaced by Forasteros and Trinitarios. Only in areas such as

Chinandega, Valle Menier, and a few others are small plantations or isolated groups of this variety seen. Among these plantations of Criollo cocoa are found a few trees of "Pentagona", generally with green or pink colorations.

"Matina"

Along the Atlantic coast of Costa Rica the variety "Matina" is cultivated, the name being derived from the original site where this cocoa has been cultivated since the end of 1700. This variety is very similar to the one called "Comun" in Bahia, Brazil. It is highly uniform Forastero type with Amelonado pods of medium size, and potentially high yield generally appearing to be self-compatible. It is susceptible to the "dieback" complex and to some extent to *Phytophthora palmivora*. The origin of this variety is not known, but there are many reasons for believing that it was introduced from some part of South America, possibly from Brazil or Surinam.

COLOMBIA

"Criollo de Colombia"

This variety has been cultivated in some small or localised areas of the high valleys (600-1,200 m. above sea level) in the Cauca Valley, Caldas, Antioquia, and Huila Departments. These cocoas resemble the Mexican Criollos in their pod characteristics. According to Patino (6) there was no native cocoa in the high valleys of Colombia before colonisation of the areas by the Spanish who introduced it from Central America or Mexico. At present there are very few plantations of Criollos, most having been destroyed by disease (particularly *Ceratocystis fimbriata*) and age. They have been replaced by other more economic crops or by other varieties of cocoa which are more profitable or tolerant to pests and diseases.

"Pajarito"

In the Departments of Antioquia, Caldas, Santander, and Huila the variety called "Pajarito" is cultivated to a greater extent than the Criollo. This variety was introduced into Antioquia at the end of the last century, from one of the West Indian Islands. The pods are of Amelonado shape, small, smooth with superficial ridges, and the trees are high yielding, tolerant to insects and diseases. This new variety and Trinitario populations, from hybrids between Forastero and Criollo, account for the majority of the plantations of Colombia.

"Amanaven"

In the Department of Vichada, on the eastern Amazon plain, there is cultivated on a small scale an Amazon Forastero cocoa of possible local origin called "Amanaven". It is a green Amelonado, smooth-shelled, with ten ridges.

VENEZUELA

"Criollo de Venezuela", synonyms: "Criollo morado", "Criollo colorado"

This variety is cultivated at different degrees of purity in the valleys of the northern part of the state of Aragua, where it has been grown under irrigation since the 18th Century. The variety is similar to the Criollo from Nicaragua and is elongated with a curved tip and purple or blood red.

In the plantations in the valleys Cepe, Chuao, and Choroni most of the trees are of this type, but this variety is in the minority in the plantings of Aroa, Cuyagua, and Ocumare de la Costa (2).

The cocoa called "Criollo de Venezuela" is apparently not a native of Venezuela but was probably introduced from Central America (Nicaragua) when the Capuchine monks established the first cocoa plantations under irrigation in the 18th Century(6). Before this period cocoa was not cultivated in that region owing to the limiting effect of soil moisture and it is doubtful that wild cocoa could have grown there under such dry conditions.

Trinitario cocoa

The greater part of the cocoa zone of northern Aragua (87 per cent) consists of various hybrids between Criollo and Amelonado introduced before the Criollos. The variable shape and colour of pods and seed sizes may be due to their hybrid origin.

"Porcelana" or "Porcelano"

Contrary to the proposal of Ciferri (2), who maintains that it is a white mutant of a Calabacillo, this variety is a Criollo with small pods, of Angoleta or almost Amelonado shapes and very superficial ridges. The seeds are for the most part white or slightly rose coloured, thick, round or flattened. The trees are very similar to the Criollos, with small leaves and of slow growth. The dry beans are graded in the international market as being of extra fine quality, among the best Criollos.

This variety is located in a very confined area on the south-western edge of Lake Maracaibo, along the shores of the Catatumbo and Escalante rivers and in this area its production is judged as good with yields of 300 lb./acre. Plants from seeds of "Porcelana" sown outside this area have been grown with difficulty in localities such as Ocumare and Barlovento, Venezuela, and Turrialba, Costa Rica. At five years of age they have not yet flowered.

"Forastero de Barlovento"

The zone of Barlovento, in the northern part of the state of Miranda, is one of the major cocoa areas in Venezuela and produces for the most part a Forastero Amelonado of probable Amazon origin, with a green shell, ten superficial ridges, smooth or semi-rugose, seeds small and purple. The trees are more vigorous than the Criollos. In very few plantations of Barlovento, Trinitario types are observed.

"Camacita"

In the neighbouring areas of Tupucita, Delta Amacuro territory, in the estuary of the Orinoco river, a great proportion of the plantations consist of a Calabacillo variety called "Camacita". The farmers prefer it for its great productive capacity and its tolerance to Witches' Broom. This variety probably represents a step in the culture of wild cocoa from the tributaries of the Orinoco river.

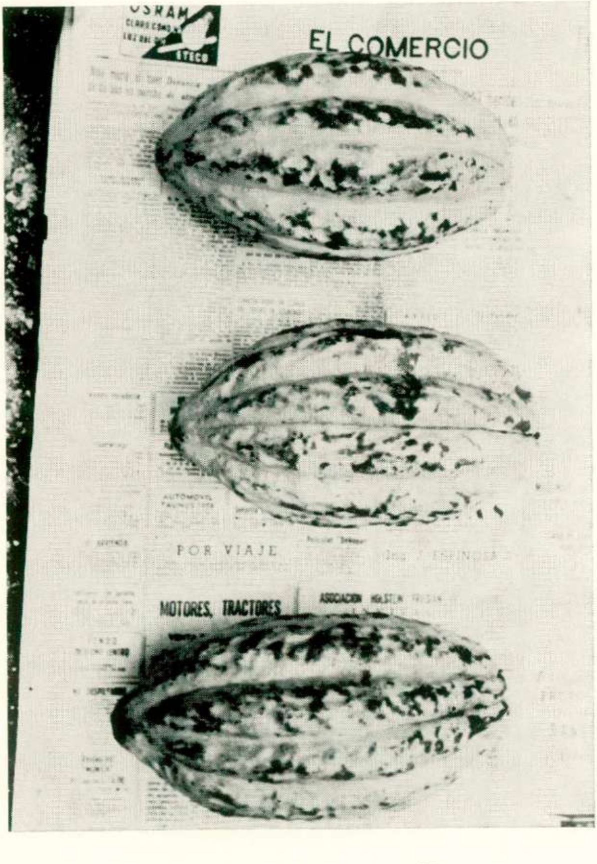
Trinitario cocoas

In the zone of Tupucita about 50 per cent of the plantations are hybrids between the native Forastero and Venezuelan Criollos, introduced in the 18th Century. All the possible segregations of seed and pod characteristics may be observed and great hybrid vigour is manifested by high production. In the zones that are highly infected with Witches' Broom, trees are observed with little or no infection. The most extensive cocoa zone of Venezuela, the peninsula of Paria in the state of Sucre, is almost entirely planted with Trinitario cocoa.

ECUADOR

"Nacional" or "Arriba"

There are very few plantations which retain this variety in a pure state and these are located in the provinces of Guayas and Los Rios. The majority of the cocoa presently graded as "Arriba" comes from plantations with hybrids between "Nacional" and Trinitarios.



Cocoa pods. Nacional variety from Ecuador.

The Nacional variety belongs to the Amazon Forastero type with Amelonado pods, large, almost oval-shaped with a slight strangulation at the neck. Seeds are of medium size to large and of a violet to purple colour. The trees are tall and robust with thick trunks and large leaves. This variety apparently comes from the western slopes of the Andes range in the Amazon basin of Ecuador. The author has observed the same types of pods and seeds in plants native to the Ecuadorian Amazon regions of Tena, Archidona, and Macas. "Cacao Nacional" was first cultivated on the western coast of Ecuador at the beginning of the 18th Century and it is quite likely that it was transported in the form of pods from one side of the Andes to the other and thereafter developed to a prominent position in the world market. Owing to its susceptibility to Witches' Broom the culture of this variety is no longer economic.

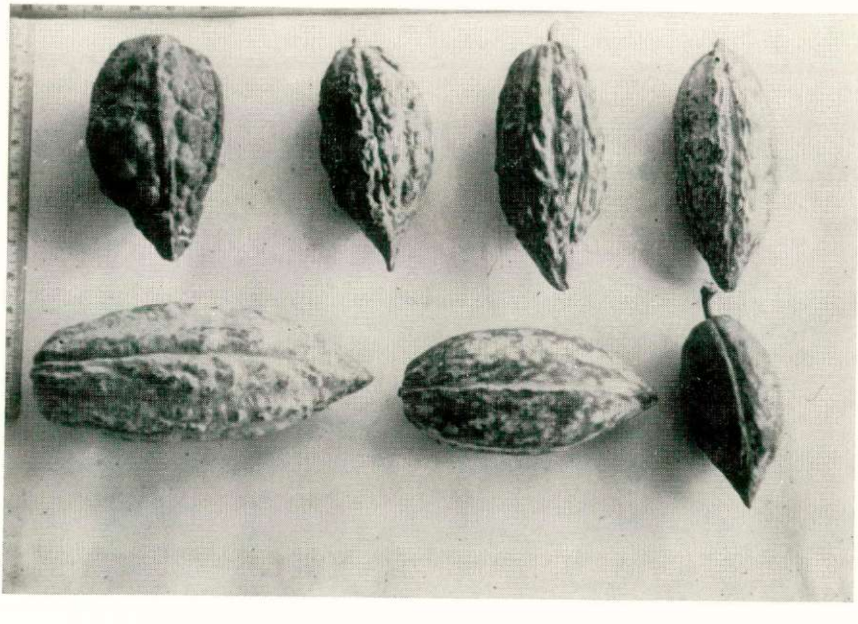
Trinitario cocoas

Almost 90 per cent of the production of Ecuador comes from Trinitario plantations known locally as Venezolano morado or "Venezolano verde". These were introduced from Venezuela from 1930 to 1940 and because of their tolerance to Witches' Broom replaced the "Nacional" variety. At present the new plantations of Ecuador are being augmented with hybrids of Forastero clones resistant to Witches' Broom and Trinitario clones of high production.

PERU

In Jaén and Bagua (Amazonas), and Saposoa and Juanjui (San Martín), a variety of Amazon Forastero cocoa is cultivated in limited areas. It is of

Three types of cocoa. "Pentagona" in upper row, with Trinitario and Criollo below.



Amelonado shape, elongated, with small and purple seeds. This variety possibly represents a cultural step from the wild cocoas of the neighbouring Amazon slope.

BRAZIL

Almost the entire production of Brazil comes from the state of Bahia where three varieties are cultivated (9).

"Para"

This is a Forastero variety with small pods of Calabacillo shape, green with a smooth surface with ten slightly perceptible ridges. This is a variety of high productive capacity, but it is not extensively grown. It is found mixed in the plantations with the "Comun" variety in certain areas. Its origin is unknown but its name seems to indicate that it comes from an area in the state of Para in the Amazon Delta.

"Maranhao"

This variety was introduced from the Amazon area at the end of the 18th Century. The pods are of elongated Amelonado type with a constriction at the neck and ten evident ridges. It is rarely found in pure stands in Bahia but is grown with "Comun" especially in certain areas near Itabuna.

"Comun"

This is the most extensively cultivated variety in Bahia, perhaps constituting

From Brazil, "Para" variety in top row, with "Comun" in bottom row.

90 per cent of the total cocoa of Brazil. It is an Amazon Forastero, with typical Amelonado pods and the plants have a considerable capacity to grow under a wide range of conditions with high yield. It is noted (7) that in other cocoa countries in this hemisphere the main varieties are similar to a great extent in their pod, seed, and tree characteristics to the variety "Comun" of Brazil. The variety "Matina" of Costa Rica, "Ceylan" or "Costa Rica" of Mexico and Guatemala also resemble the "Comun" from Brazil.

"Catongo"

At present in Bahia this cultivar is being planted to a considerable extent, having been obtained from a plant of the variety "Comun" in 1937. It is characterised by having white seeds with the normally pigmented parts of the flower and the young flushes also white in colour. For this reason it is known also as "Cacao Branco de Bahia". Under the conditions of Bahia it reveals resistance to *Phytophthora palmivora* and has been classified as having mild flavour and high production.

DOMINICAN REPUBLIC

"Calabacillo" or "Amelonado de Trinidad"

This is an Amazon Forastero type of typical Amelonado shape which constitutes between 85 per cent and 90 per cent of the cocoa population of the country. This variety is very similar to "Matina" of Costa Rica, "Costa Rica" of Mexico and to "Comun" of Bahia. Cheesman (1) suggests that this variety might have come from Brazil or Surinam and that the name "Amelonado de Trinidad" is inappropriate as this type of cocoa is not extensively grown in Trinidad. There are small areas with typical Trinitarios types introduced from Venezuela with red, rose or white coloured pods which are called "Trinitario de Venezuela" or "Carupano". Almost the entire production of this country is concentrated in the valley of Cibao.

TRINIDAD AND TOBAGO

Most of the plantations grow Trinitario types with varying degrees of introgression to Criollos or Forastero Amelonados mainly toward the Criollos. In the replanting programmes which have taken place since 1930 many areas have been planted with clones propagated by cuttings or with interclonal hybrids of the Trinitario complex.

The islands of Grenada, Jamaica, and Haiti are smaller producers of cocoa and the plantations for the most part consist of mixtures of Trinitarios and near Criollo types.

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Fertiliser Experiments on Farmers' Cocoa in South Western Nigeria

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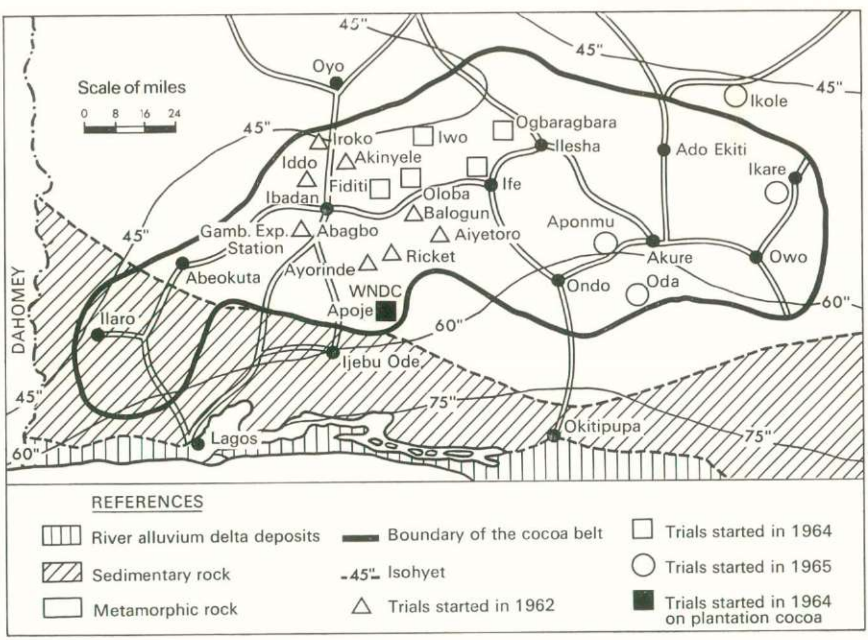
Introduction

Most of the Nigerian cocoa is grown in South-Western Nigeria in an area underlain by Pre-Cambrian metamorphic rock of the Basement Complex except for a small area (shaded in the map) which is underlain by Tertiary sediments. The mean annual rainfall varies from 45 inches in the northern part to 65 inches in the southern part of the cocoa belt. Rainfall is unevenly distributed over the year and the average dry season (in the months November to March inclusive) is less than 10 inches. Under these conditions cocoa grows best on clayey soils which are less drought-susceptible than sandy soils and which have, moreover, a higher chemical fertility. The clay-fraction is mainly kaolinitic and as a result the cation-exchange capacity is low, except in the top layer of the soil where organic matter is present. The soils are neutral to weakly acid which reflects the high percentage saturation of the cation exchange complex.

The cocoa in the main is randomly planted West African Amelonado and it is grown in smallholdings. Yields are low and estimates of the main crop yield per acre vary between 350 and 400 lb. dry beans. The light crop is produced



from April to June and the main crop from September to January, with a production peak in October or November. Mature cocoa is generally grown with little or no permanent shade.

Fertiliser experiments

When experiments in Ghana had proved that farmers' cocoa gave increased yield after application of fertilisers (4,5) a large programme of fertiliser trials was started jointly in Nigeria by the Ministry of Agriculture and Natural Resources and the Cocoa Research Institute of Nigeria. For these experiments 17 3-4 acre sites with 25-35-year-old cocoa trees were selected in various parts of the cocoa belt (see Figure I) on the basis of apparent homogeneity of cocoa and soil. By using these criteria it was inevitable that farms of above average yield were selected. There were three groups of experiments called Series I, II and III. They all had circular plots, approximately 1/24 acre in size. The trees in all plots were calibrated for pre-treatment yield.

The Series I trials had a $4^2 \times 2^3$ design with N and P at four, and K, Ca and Mg at two levels. It was replicated twice and comprised eight sites, each having 1/4 replicate of 32 plots. Fertiliser application was started in 1962 and discontinued in 1968 to study residual effects. The Series II trials were five 3^3 NP (KMg) factorials with one replicate of 27 plots per site. Fertilisers were applied from 1964 onwards. One year later the Series III trials were started at four sites. These are simple 2^3 NPK experiments with three replicates.

The fertiliser types and the rates of application are given in Table 1. Urea was given in a split dose: 2/3 in April/May at the beginning of the major rains, and 1/3 in August/September, while the other fertilisers were applied in one dose in April or May. All fertilisers were broadcast by hand onto the soil surface throughout the plots.

The results of these trials have been recorded in the Annual Reports of the Cocoa Research Institute of Nigeria and elsewhere (6, 7, 8) and they can be summarised as follows: Positive responses to phosphatic fertilisers are found

Table 1 Annual Fertiliser Rates in lb. per acre of the Series I, II and III Trials.

Experiment	Levels	N (as urea)	P_2O_5 (as triple super-phosphate)	K_2O (as sulphate of potash)	CaO (as calcium sulphate)	MgO (as magnesium sulphate)
Series I	0	—	—	—	—	—
	1	40	30	50	50	50
	2	80	60	—	—	—
	3	120	90	—	—	—
Series II	0	—	—	—	—	—
	1	(2) 80	(1)30	(1)50	—	(1) 50
	2	(4)160	(2)60	(2)100	—	(2)100
Series III	0	—	—	—	—	—
	1	120	30	50	—	—

Figures in parentheses refer to the levels of the Series I trials.

at 14 out of 17 sites and responses to nitrogen at 12 sites. The nitrogen responses were, however, more pronounced in the Series I trials than in the other experiments. The N and P effects are mainly linear and they usually started to appear in the second or third year after the first applications of fertiliser. Magnesium increased the yields initially at two sites and later on a third site, while the combined applications of KMg had a positive linear effect on two sites of the Series II trials. Application of potassium alone had no effect. Calcium increased the yield at one site but depressed yield at another. The N and P effects are illustrated in Table 2 where the mean five-yearly post treatment yields for all NP combinations of the Series I and II experiments are given. The figures in the body of Table 2A are means of 16 plots and those in Table 2B means of 15 plots. The date of the Series I trials indicate that the yield rises steadily with increasing amounts of nitrogen but the highest rate of nitrogen (N) has no effect without additional P. In the Series II trials there was greater response to phosphorus, and nitrogen was only effective in combination with phosphorus. The best NP combinations seem to be those which are high in N (120-160 lb. N per acre) and rather low in P (30-60 lb. P_2O_5 per acre). When the overall linear effects of N and P (shown in the margins of the tables) are expressed in lb. dry beans per lb. element supplied then it is found that in the Series I trials mean yield increments of 1·60 lb. dry beans per lb. N and 1·53 lb. dry beans per lb. P_2O_5 have been obtained. Figures for the Series II trials are: 0·75 lb. dry beans per lb. N and 3·60 lb. dry beans per lb. P_2O_5. Furthermore, the tables show that high yield can still be obtained from rather old Amelonado cocoa. These yields are, however, potential yields which have been obtained by converting the total number of fully-grown pods, including non-fermentable pods, to lb. dry beans per acre (6). On the experimental sites the percentage non-fermentable pods did not exceed 10 per cent.

Economical Returns of Fertiliser Applications

Having found that fertilisers can increase yields considerably the problem to be considered is whether the increases in yield cover the costs and whether the returns are high enough to induce farmers to use fertilisers. This question is considered in Table 3 in which net returns are given in relation to initial yield and losses of the additional crop produced. The figures are based on a price of £N150 per ton which is now being paid by the Cocoa Marketing Board. Furthermore it has been assumed that the farmer uses 3 cwt. of a NP compound fertiliser (with 20 per cent N and 20 per cent P_2O_5) which is now being sold at a subsidised price (half the cost price) of £N1 per cwt. and that this application increases the production of mature pods by 25 per cent. This particular NP compound has been chosen for our calculations because it is easily available to the farmers from the fertiliser distribution centres of the Ministry of Agriculture, while the 25 per cent increase in yield has been based on the linear responses to N and P as found in the Series II trials.

From Table 3 it can be seen that on the experimental sites where mean annual yields vary between 800 and 1,200 lb. dry beans and less than 10 per cent of the pods have to be discarded as unfermentable, net profits between £N10 and £N17 per acre can be obtained. The net returns drop, however, with decreasing initial yields and are further lowered by increases in the percentage loss. On farms with yields of 600 lb. dry beans per acre and no losses, net

Table 2 Mean Yields in lb. Dry Beans/acre over a Five-year Period For all NP Combinations in the Series I and II trials.

A. Series I Trials.

	P0	P1	P2	P3	Means
N0	832	957	911	1,041	935
N1	897	955	997	1,091	985
N2	1,031	1,164	985	1,103	1,071
N3	909	1,224	1,224	1,112	1,122
Means	917	1,075	1,034	1,086	1,028

S.E. 70·8* 35·4**

B. Series II Trials.

	P0	P1	P2	Means
N0	1,076	1,121	1,202	1,133
N1	1,013	1,185	1,240	1,146
N2	1,069	1,319	1,362	1,250
Means	1,053	1,208	1,268	1,176

S.E. 65·8* 37·9**

* S.E. for comparing two figures in the body of the table.

** S.E. for comparing two figures in the margins of the table.

Table 3 Net returns per acre (in £N) following fertiliser application for various levels of initial yield and of subsequent mature pod losses.

Yield in lb. per acre		Loss of additional pods produced					
Initial	Increase*	0%	10%	20%	30%	40%	50%
200	50	0 7 0	—	–0 6 6	–0 13 0	–0 19 6	–1 6 6
400	100	3 14 0	3 1 0	2 7 0	1 13 0	1 0 0	0 7 0
600	150	7 0 0	6 0 0	5 0 0	4 0 0	3 0 0	2 0 0
800	200	10 7 0	9 0 0	7 14 0	6 8 0	5 1 0	3 14 0
1,000	250	13 15 0	12 0 0	10 7 0	8 14 0	7 0 0	5 7 0
1,200	300	17 0 0	15 0 0	13 0 0	11 0 0	9 0 0	7 0 0

*This increase is assumed to be 25 per cent of initial yield caused by application of 3 cwts. of fertiliser at a total cost of £N3.

profits will be £N7 per acre which corresponds to a ratio of three of money value of extra crop to cost of fertilisers. When this value-cost ratio must be three or more to be acceptable to the farmer, then farms yielding less than 500-600 lb. dry beans should not be considered for fertiliser application.

When the Cocoa Marketing Board sells the cocoa at £N300 per ton and pays for half the costs of the fertilisers, the same value-cost ratio applies to both the farmer and the Marketing Board. This means that when fertilisers are applied to farms with yields exceeding 600 lb. dry beans per acre, the Cocoa Marketing Board receives at least £N3 in return for every £N1 spent in subsidising fertiliser prices.

From these calculations it may be concluded that the use of fertilisers in the peasant cocoa industry of Nigeria can be profitable. Annual net returns of £N6 to £N12 per acre can be obtained on medium high to high yielding farms when a 20:20 NP compound is used. Higher profits can, however, be expected when the types of fertiliser are chosen on the basis of the nutrient requirements of individual farms (8).

The Use of Soil and Leaf Analysis in Assessing the Nutrient Requirements of Cocoa

On the basis of the results so far obtained a general recommendation has been made advising the farmers to use 3-4 cwt. of an NP compound (preferably with 25 per cent N and 15 per cent P_2O_5) per acre. It can be expected that these applications will raise the total yield of all good farms by 25-35 per cent. It will also be true that N is wasted on some sites and P on others and that the N/P_2O_5 ratio is suboptimal for certain farms. Therefore the use of soil and leaf analysis in assessing fertiliser requirements of individual farms has been investigated. It was found that the N figures for soils give no indications of the nitrogen requirements of the crop and that the leaf data for N can only be used in detecting the fields which are very deficient in this element. This result is not surprising because responses to N depend on light conditions. Unshaded cocoa usually responds positively while shaded, and also closely spaced cocoa reacts negatively or does not respond to nitrogen applications (2). This shade and fertiliser interaction may well explain why N increases the yield of the lightly shaded cocoa in Nigeria, but fails to do so in the more heavily shaded farms in Ghana (4, 5).

In the case of phosphorus better results were found and clear relationships

Table 4 Relationship between the Phosphorus Content of Cocoa Leaves, Soil-Phosphorus and Response to Phosphatic Fertilisers.

Percentage P in Leaves		Soil P in ppm.[2]	Linear Yield Response in lb. Dry Beans per acre per lb. P_2O_5 applied
Young Leaves[1]	Older Leaves adjacent to Young Leaves		
<0·16	<0·11	<6	>3
0·17-0·20	0·11-0·13	6-10	1-3
>0·21	>0·13	>12	No Response

[1]Leaves developed in March, sampled April/May.
[2]Soil Layer 0-6 in.; P extracted with 0·03 N NH_4F in 0·025 N HCl.

between soil and leaf P and reactions to P fertilisers were established as summarised in Table 4. Soils with less than 12 ppm P in the 0-6 in. layer should be considered as phosphorus deficient. A survey of the P status of 50 cocoa farms in the Basement Complex area has revealed that 75 per cent of the soils fall into this category.

The figures for exchangeable K usually vary between 0·2-0·6 m. eq. per 100 grams of soil and in the 0-2 in. layer they are well above the 0·2 m. eq. limit below which K deficiency was found in Amazon cocoa in Ghana (1). On the sedimentary soils of the cocoa belt figures of 0·1 m. eq. are found and here widespread K deficiency in cocoa would be established by leaf analysis. The lack of response to K on the metamorphic rock soils is thus not unexpected in view of the soil figures.

Conclusions and Summary

Long-term fertiliser trials have shown that cocoa on the Basement Complex soils of South-Western Nigeria mainly responds to applications of nitrogen and phosphorus. Calculations have demonstrated that with the use of fertilisers an additional annual net income of £N6-12 per acre or more can be obtained.

The fact that the lightly shaded and unshaded cocoa of Nigeria responds to nitrogen is in line with the general hypothesis that unshaded cocoa requires nitrogen for high yields (3). The positive reaction to phosphorus can be explained from the phosphorus status of most cocoa soils.

Soil and leaf analyses are of limited value for assessing N requirements but can fairly accurately determine the P requirements of the crop.

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A Note on an Attack of Periodical Cicada

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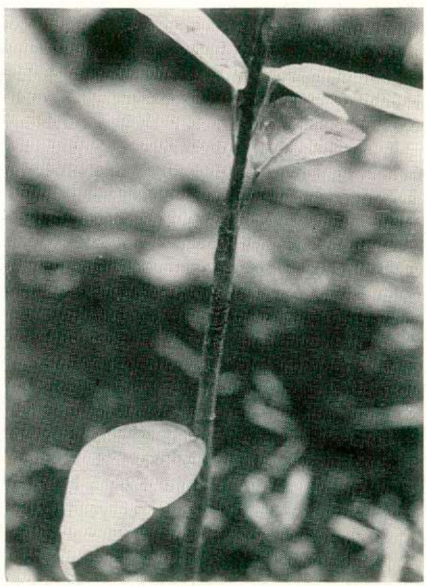
An unexpected problem arose on BAL cocoa estates between March and early May 1969 when, after an unusually dry spell of more than two months, cocoa recently planted in light abaca was subjected during rainy weather to severe attacks by a species of periodical cicada, later determined as *Dundubia rufivena.* Walk. (Plate I). Young shoots of many varieties of plants were severely damaged and often destroyed by mutilation caused by egg-laying (Plate II), and in addition, avocadoes, rambutans, bauhinias and hibiscus suffered severe dieback.

In the field most of the eggs were laid on the mid-ribs of abaca leaves, but the abaca was unaffected. Abaca had evidently been able to support over the years a very large population of cicada larvae, which had fed on the root system and had hitherto been undetected as the abaca had not suffered any apparent setback. Because the stand of abaca was reduced when cocoa was planted, gravid females laid their eggs in vast quantities on young gliricidia shade trees and cocoa. Inevitably oviposition led to shoot dieback and by early May dieback had occurred on 49 per cent of the cocoa planted up to the end of March,

Adult Dundubia rufivena. Walk.

Damage caused by egg-laying on young cocoa.



and ultimately 26 per cent of the total population succumbed. However, some of these vacancies were caused by sun-scorch through inadequate shade at planting time.

In an attempt to reduce the population as the pupae emerged from the ground, the soil in two plots, each of 300 cocoa trees, was sprayed with dieldrin and endrin respectively: in a third plot the upper parts of the cocoa plants were smeared with petroleum jelly, of the type used as a wound dressing, in an attempt to prevent oviposition. A fourth plot was used as control. Two light traps were installed in each plot and the number of cicadas collected over a period of seven nights was recorded. The results indicated a reduction in the number of cicadas in the sprayed areas, but the use of petroleum jelly did not inhibit oviposition on the cocoa and in fact damage was caused to the unhardened tissues of the plants by this treatment, perhaps due to interference with transpiration.

The eggs take five to eight weeks to hatch and the larvae then fall to the ground. By the first week in July larvae from the first eggs to be laid had attained the size of white ants and had penetrated to a depth of about two inches into the ground. There were still many eggs to emerge, particularly from the mid-ribs of abaca leaves. Damaged cocoa shoots were pruned, collected and burnt, but it was unfortunately not possible to do the same with abaca leaves and gliricidia shoots. Dieldrin was therefore sprayed over all old abaca mats with the object of reducing the population of young larvae. A large number of late instars, which could pupate within the next twelve months, was also found and a further attack could be expected whenever the conditions are favourable. A lesser emergence of adults did occur in August/September and a number of half emerged and dead imagos were found thus proving that dieldrin had in fact helped to reduce the population.

Summary

An attack by a periodical cicada, seriously affecting half the young cocoa in the field, is reported. Light traps were used to reduce the adult population and ground sprays of dieldrin helped to reduce the numbers of the emerging pupae and the young larvae as they hatched.

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Cocoa Abstracts

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January, 1970

Ventocilla, J. A. Inseticidas e suas implicaçóes sôbre as mosquinhas polinizadoras do cacaueiro. (Insecticides and their influence on the small flies pollinating cocoa). Cacau Atualidades, 4, 4, p. 50-1 (1967; received 1969).
The principal insects responsible for the pollination of cocoa in the State of Bahia, Brazil, are minute flies of the family of the *Ceratopogonidae*, which belong to the genus of *Forcipomyia*. Trials with application of BHC 1 per cent during flowering time (which is not a normal practice) showed that the activity of the pollinating flies was not affected, indicating that this insecticide may be used without risks of a reduced yield of cocoa.

Cabala Rosand, F. P., et al. Normas para adubação da cacaueiro. (Norms of cocoa fertilizing). Cacau Atualidades 4, 4, p. 52-7 (1967; received 1969).
Recommendations are given for the fertilising of cocoa in the State of Bahia, Brazil. Quantities of 65-100 g. of a mixture of 50 per cent of ammonium sulphate, 30 per cent triple phosphate and 20 per cent KMg sulphate are applied to the plant holes, 130-200 g. is given after one year, and 195-300 g. after the second year, corresponding to 20 per cent, 40 per cent and 60 per cent of the quantities given to an adult tree, respectively. The fertiliser is broadcast within a circle around the trunk of the tree, the first year within a circle of 50 cm. diameter, the second year within 80 cm. and, finally, from the seventh year onwards, the whole soil surface is fertilised. For the correction of the soil pH, agricultural lime at a maximum rate of 1,200 kg./ha./year should be applied when the shade trees are pruned. Tables. Figs.

Reyes, E. H. Las malezas en el cacaotero y su control. (Weeds in cocoa plantings and their control). Cacao Bol. Inform. 5, 1-2, p. 1-16 (1968).
In Venezuela, cocoa is cultivated under humid conditions, and therefore weed growth is exuberant. Weeding is done two to seven times per year, depending on the weed infestation of the crop, at a cost of Bs. 50-60/ha. (US$1 = Bs. 4·50) per weeding. The noxious effects of weeds are briefly discussed. The occurrence of different types of weeds at different light intensities in the plantings is mentioned. The chemical control of the weeds is discussed, and costs of chemical control and manual weeding in crops of different ages are compared. Generally, chemical control methods are cheaper. The toxicity of herbicides to cocoa is discussed. A list of Venezuelan weeds is presented. Tables. 16 refs.

Jimenez Saenz, E. Relación entre el ataque de nemátodos y la muerte súbita del cacao (Theobroma cacao L.) en Bahia, Brasil. (Relation between nematode attack and the sudden death disease of cocoa in Bahia, Brazil). Turrialba, Rev. Interam. Ciencias Agr. 19, 2, p. 255-60 (1969).

Laboratory experiments with cocoa seedlings planted in pots with nematode (*Meloidogyne* sp.) infected soil showed that the symptoms of the sudden death disease were less severe in soil treated with a nematicide. No definite conclusions can be drawn yet from the data obtained, but there are strong indications that this cocoa disease is closely associated with the attack of plant parasitic nematodes, which destroy the feeding roots and eventually kill the plant. English summary. Tables. Photos. 13 refs.

February, 1970

Normas de classificação do cacau. (Methods classifying cocoa). Comun. Técn., CEPLAC 27, p. 1-8 (1969).
The new classification methods for the grading and supervising of export cocoa in Brazil are described. These specifications have taken effect in April 1969, except the restrictions on the contamination by smoke that will fully take effect in April 1970. Depending on the quality the export cocoa will be graded as "superior" or "good". Cocoa "below standard" may be exported only with a special authorisation, whereas the fourth group, "refuse", may never be exported. The qualifications of each group are presented. The methods of sampling and grading are discussed. Tables.

Alvim, P. Tarso de Fatôres responsáveis pela queda de produção de cacau na Bahia em 1968. (Factors responsible for the decrease in the cocoa production of Bahia in 1968). Comun. Técn., CEPLAC 20, p. 1-8 (1968).
An analysis is made of the climatical conditions, and the related physiological factors affecting the cocoa tree, to explain the production decrease of cocoa in Bahia, Brazil, in 1968. It is concluded that excessive rains occurring from September 1967 to March 1968 inhibited the root growth of the cocoa and the process of foliar renovation. Temperatures were lower than normal during the flowering season, and contributed to reduced flowering, and, consequently, to lower production. Graphs.

Silva, L. Ferreira da, et al. Solos dos vales dos rios Pardo e Jequitinhonha da Bahia. (Soils of the valleys of the Pardo and Jequitinhonha rivers in Bahia). Comun. Técn., CEPLAC 16, p. 1-30 (1968).
This paper presents a part of the detailed soils study of the cocoa zone in the State of Bahia, Brazil. Geology, topography, basic material, climate and vegetation are briefly discussed. Special attention is given to the alluvial soils, which have been classified for their suitability of growing cocoa. The clayish soils are considered to be suitable for cocoa, the loamy sands for annual crops, and the sandy soils for pastures. Tables. Maps. 9 refs.

Vello, F., and Silva, L. Ferreira da. Relatório de viagem à região Amazônica. (Report on a voyage to the Amazon region). Comun. Técn., CEPLAC 22, p. 1-19 (1968).
In search of new cocoa plant material a trip was made to the Jari river at the border between the Territory of Amapa and the State of Para, Brazil. The spontaneous growing cocoa trees showed little variation in regard to shape and size of fruits and plants, indicating that they originated from only a few plants. The plants did not appear to be high yielding but ecological conditions may be responsible for this feature as well as genetic characteristics. Some of the trees

are described separately. Furthermore, the soil types around Manaus are briefly discussed in relation with plans to establish a new cocoa experimental station in this area. Because of the high incidence of Witches' Broom disease in this region, work must be conducted on selection of resistant varieties. Tables. Map.

March, 1970

Die Kakaowirtschaft zwischen den Erntejahren. (The cocoa economy between the harvest years). Rev. Int. Sucre Confiserie 22, 9, p. 513-4, 517-8 (1969).
The uncertain situation of world cocoa trade prior to the 1969-70 harvest is reviewed. Prospects of world cocoa production, consumption and trade are discussed. Tables present figures on cocoa harvests of the producing countries from 1964-65 to 1967-68, and on cocoa consumption in the different countries from 1965 to 1968. World harvest 1969/70 is now estimated at 1,230,000 tons, world consumption in 1969 at 1,345,000 tons (F.A.O.), and world cocoa stocks at the end of 1969 at 191,000 tons. Average monthly New York Spot Ghana prices increased in 1969 from 98·7 US cents/kg. in January to 105·3 US cents/kg. in July.

Ali, F. M. Effects of rainfall on yield of cocoa in Ghana. Exp. Agr. 5, 3, p. 209-13 (1969).
Field trials with cocoa conducted in the Eastern and Ashanti regions of Ghana, showed a positive regression of rainfall on yield during the drier periods and a negative regression in the wetter part of the year, irrespective of areas. In the Eastern region this effect was highly significant, and some 8-31·5 per cent of it could be attributed to the direct influence of rainfall. In Ashanti, regression was not significant with values amounting to 0·1-7·4 per cent. When capsids and mealy bugs were low in number, yield and rainfall were positively associated, and vice versa. The author suggests that the crop, at least partly, benefits from rainfall when relatively much NO_3 is present in the soil, and when insect populations are low. Tables. Graph. 9 refs.

Trojer, H. El clima y el desarrollo de la producción de cacao en la finca "La Lola". (Climate and the cocoa production at the "La Lola" estate). Cacao; Inst. Interam. Ciencias Agr. 13, 4, p. 1-9 (1968).
On the basis of average monthly figures, seasonal and daily climatic conditions prevailing at "La Lola" estate, Costa Rica, are analysed. Attention is given to the agro-climatic calendar related to the cocoa production cycle; and comparisons are made with the situations in other tropical cocoa producing regions, with particular emphasis on Colombia. Tables. Graphs. 17 refs.

Zevallos, A. Cadima. Influência do solo sôbre o desenvolvimento das raízes do cacaueiro. (Influence of the soil on the development of the roots of cocoa). Cacau Atualidades 5, Jan.-Dec., p. 2-5 (1968).
The root development of cocoa in 4 different soil types in the State of Bahia, Brazil, was studied. Special attention was paid to the roots and the aerial part of the young seedlings. It was found that during 4 months after germination the lengths of the taproot and of the stem remain the same. After that, the stem grows more rapidly than the taproot. Figs.

Charrier, A. Contribution à l'étude de la morphogenèse et de la multiplication végétative du cacaoyer (Theobroma cacao L.). (Contribution to the study of the morphogenesis and the vegetative propagation of cocoa. (*Theobroma cacao*). Café Cacao Thé 13, 2, p. 97-115 (1969).
The general morphological characteristics of aerial parts and the root system of cocoa seedling trees, the effect of environmental factors, and the role of the relationships between the internal phenomena, are reviewed in relation to the morphology of cocoa trees raised from cuttings. The existence of a differentiation gradient in the orthotropic axillary primordia along the orthotropic axes is demonstrated. This supports the hypothesis that production and habitus of cuttings vary with the position on the mother plant from which they were taken. English, German, and Spanish summaries. Tables. Figs. Photos. 44 refs.

Rocha, H. M., and Medeiros, A. G. Bases para a selecão de cultivares de cacau resistentes a Phytophthora palmivora (Butl.) Butl. (Principles for the breeding and selection of cocoa cultivars resistant to *Phytophthora palmivora*). Cacao; Inst. Interam. Ciencias Agr. 13, 4, p. 10-17 (1968).
Present research on the development of cocoa cultivars resistant to *Phytophthora palmivora* is reviewed. The practical value of replacement of old unproductive susceptible cultivars by improved planting material is emphasized. To achieve this a standard method for testing rather large plant populations is proposed. Advanced ideas explaining the mechanism of resistance, and the importance in any selection programme of knowledge of the relation between host plant, the pathogen and the surrounding environment, are discussed. From authors' English summary. Tables. Graphs. 34 refs.

Ventocilla, J. A., et al. Consideraçôes em tôrno das pesquisas relacionadas com o polvilhamento aéreo de cacauais na Bahia. (Considerations about the aerial dusting of cocoa groves in Bahia, Brazil). Comun. Técn., CEPLAC 24, p. 1-9 (1969).
The objectives, results and interpretations of preliminary studies on the new technique of aerial dusting with BHC 1 per cent of cocoa in the State of Bahia, Brazil, are presented in a series of summaries. From these studies conclusions are drawn. Aerial dusting was less effective than manual or mechanized dusting until 8 days after treatment. Total damage by insects was reduced more and for a longer period in aerial dusted plots, whereas the reduction of the damage to the foliage was the same in aerial and manual or mechanized dusted plots. 28 refs.

Marchart, H., and Lodos, N. The biology and insecticidal control of the cocoa pod pentatomid Bathycoelia thalassina (Herrich-Schaeffer) (Hemiptera, Pentatomidae). Ghana J. Agr. Sci. 2, p. 31-7 (1969).
The biology, damage, annual population fluctuation, and mass rearing for experimental purposes of the cocoa pod pentatomid *Bathycoelia thalassina* are described. In Ghana, treatment of caged insects under field conditions with azodrin or dicrotophos at a rate of 140 g./ha. or with 2- (1,3-dioxolan-2-yl.)-phenyl-N-methyl-carbamate at a rate of 560 g./ha. gave 97 per cent or complete control. French summary. Tables. Graph. 14 refs.

Kenten, R. H., and Asante, E. A. T. Plant breeding and selection. Growth of different types of cocoa in an exposed site. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 100, 102-3 (1969).
There is accumulating evidence in Ghana that, provided insect pests are controlled, mature cocoa gives the highest yields when grown without shade. To overcome the need of temporary shade for very young seedlings for good initial growth and establishment, a number of cocoa types were tested for their light tolerance at the seedling stage. Although even the most tolerant type performed generally badly, the highly significant differences found justified further work, including work on the reaction to light of intercrosses between the types. Table.

Opeke, L. K., and Jacob, V. J. Studies on methods of overcoming self-incompatibility in Theobroma cacao Linn. Cacao; Inst. Interam. Ciencias Agr. 13, 4, p. 17-19 (1968).
To overcome the obstacle of self-incompatibility of high yielding Upper Amazon cocoa clones for the production of inbred lines for breeding purposes, 6 self-pollination methods were tested in Nigeria on 8 clones regarded as self-incompatible. The clones C65 and C85 appeared to be self-compatible when artificially self-pollinated. In the other 6 clones more than 10 per cent of the flowers, which had been self-pollinated by 1 or more of the methods tested, set pods. The best method to induce self-pollination was to apply 4 hrs. after selfing compatible pollen grains from the clone C24, carrying a marker gene for purple axil spot in the seedlings: seedlings without this characteristic can be considered as derived from self-pollination. Tables. 8 refs.

Reyes, E. H., et al. Observaciones sobre el marchitamiento de los chireles del cacao. (Observations on cherelle wilt of cocoa). Agron. Trop., Venezuela 19, 1, p. 19-28 (1969).
The production of healthy and affected pods of 12 cuttings from 13-year-old cocoa plants was recorded in Venezuela during 5 years. The results showed that annual pod production and percentage of prematurely wilted fruits largely varied. Physiological changes due to water and nutrient competition are considered to be the primary causes of the fruit losses. English and French summaries. Tables. Graphs. 18 refs.

Legg, J. T., and Lovi, N. K. Virus research. The movement of CSSV in cocoa seedlings. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 27-8 (1969).
In Ghana, virus sensitive Amelonado and tolerant Amazon cocoa seedlings of approx. 1·20 m. in length were graft-infected with swollen shoot virus (New Juaben strain) half way up the stem. Virus movement, as determined by removing vertical strips of bark in line with and opposite to the donor patch and grafting on to Amelonado indicator plants was most rapid in downward direction, in particular in Amelonado cocoa. Upward movement also was more rapid in Amelonado than in Amazon cocoa. On the opposite side of the stems, infection rates in downward and upward direction were equal. The tests indicated that in the early stages of infection, Amelonado tissues appear to be a better host for swollen shoot virus than Amazon tissues.

Kenten, R. H., and Legg, J. T. Virus research. Effect of water stress on virus infected Amelonado seedlings. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 28 (1969).
In Ghana, 2 pot experiments were conducted to study the effect of water stress on the growth of Amelonado cocoa seedlings infected with swollen shoot virus (New Juaben strain). Healthy plants were more affected by drought than the virus infected seedlings. At the lowest water level, the healthy plants wilted and died, or became moribund earlier than the virus infected ones. Further work is necessary to determine why virus infected plants can be kept alive in the greenhouse, but normally die in the field.

Kenten, R. H., et al. Virus research. Resistance and tolerance. The screening of seedlings. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 29-32 (1969).
In Ghana, results are presented of continued screening of cocoa seedlings progenies. These progenies were derived from 27 crosses between parents which earlier had shown resistance to the swollen shoot virus (New Juaben strain). The Trinitario T9/21 appeared to be a good parent. The most resistant progeny to virus infection was Nanay 33 × Nanay 34. Table. Fig. 3 refs.

Owusu, G. K. Virus research. Vector investigations. Effect of treating seedlings with mineral oil on virus transmission. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 40-1 (1969).
Experiments in Ghana showed that mealybugs (*Planococcoides njalensis*) fed on P_{32} pre-treated Amelonado cocoa seedlings, which were infected with swollen shoot virus (New Juaben strain) and sprayed with paraffin oil, had very low radio-activities. This indicates that the vector was unable to feed properly on oil-sprayed plants: the bugs had a considerably higher mortality rate and survivors were much weaker than those on unsprayed seedlings. Moreover, virus transmission, as measured with the use of test beans, was very much reduced. Table. 6 refs.

Naylor, A. G. Cacao black pod disease control in Jamaica. Farmer, Jamaica 74, 4, p. 124-5, 127-8 (1969).
The results of preliminary field trials in Jamaica indicate that cocoa black pod (*Phytophthora palmivora*) can be controlled adequately with copper fungicides, as well as with some other fungicides, such as fentin hydroxyde in copper fungicide, and maneb. Spraying costs are estimated at 50/– (US $ 7.00) per ha. per cycle, including chemicals and labour. Tables.

Gibbs, D. G. Report of the International Capsid Research team. Capsid population studies. Pyrethrum knockdown on selected sites. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 53-5 (1969).
In Ghana, the relationship between numbers of capsids and canopy of a mature cocoa planting was studied at fortnightly intervals. The results indicated that whereas *Sahlbergella singularis* occurred in equal numbers on cocoa with canopy of different types, *Distantiella theobroma* was consistently more abundant on cocoa with broken canopy. Table. Graphs.

Marchart, H., and Pickett, A. D. Insecticides. Cage spraying tests. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 72 (1969).
In Ghana, a method of insecticide screening has been developed as an intermediate stage between laboratory topical applications, and full-scale field trials regarding the control of capsids in cocoa plantings. Capsids are placed with chupons in wire cages which are suspended in the canopy of mature cocoa trees. The area is then sprayed in the usual way and the capsid mortality in the cages is recorded 24 hrs. thereafter. The advantages of this method over normal field testing are: (1) the number of test insects can be kept constant; (2) successive tests can be repeated in the same area, i.e. the spraying geometry can be kept constant; and (3) the results reflect the spraying efficiency in the canopy. Table.

Marchart, H. Insecticides. Field trials with baygon. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 74 (1969).
Field trials conducted in Ghana showed that arprocarb, mistblown at a rate of 210 g. a.i./ha. reduced capsid population (BHC-resistant *Distantiella theobroma* and *Sahlbergella singularis*) in cocoa plantings with 95 per cent. On moderately attacked plots 1 to 2 applications were sufficient. Where reinfestation was heavy, 5 to 6 sprays during the season were sometimes necessary. Table. 1 ref.

Marchart, H. Insecticides Fumigant effect of baygon. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 75-6 (1969).
In Ghana, the fumigant effect of arprocarb on *Distantiella theobroma* capsids in cocoa plots was investigated. The insecticide was applied by mistblowing at a rate of 280 g. a.i./ha. in 56 l. water. Wire cages containing *Distantiella* larvae were suspended in trees of the sprayed areas at various intervals after spraying. An extremely powerful fumigant effect with almost complete kill up to 1 hr. after treatment was recorded. The fumigant effect declines to a low level after 24 hrs. which reflects the short persistence of the insecticide. Graph.

Collingwood, C. A. Assessment methods for cocoa mirid trials. Café Cacao Thé 13, 3, p. 206-7 (1969).
In Ghana, different methods of assessing efficiency of insecticidal treatment of capsid-infested cocoa plantings were compared. A strong correlation was found to exist between the method of counting surviving capsids up to head height and the method by which pyrethrum knock-down capsids collected on ground sheets were counted. Pod count was found to be another interesting method for indicating the treatment efficiency; there was a correlation between the number of pods and the capsid density which existed 2 or 3 months earlier. French, German, and Spanish summaries. Table. Graph.

Marchart, H. Insecticide work at C.R.I.G., Tafo. Café Cacao Thé 13, 3, p. 213-5 (1969).
Methods to screen insecticides for cocoa capsid control and to study residual effects of selected insecticides, developed at the Cocoa Research Institute in Ghana, are briefly outlined. Recently conducted work on the ovicidal action of insecticides and ultra-low-volume spraying is discussed. Cage spray tests in

the field precede laboratory testing by topical application. Residual effects are studied, using radio-active tracers. A standard method for the preparation of cocoa bean samples for taint and residue determination is described. French, German, and Spanish summaries. Tables.

Bruneau de Miré, Ph. Une fourmi utilisée au Cameroun dans la lutte contre les mirides du cacaoyer Wasmannia auropuncta Roger. (An ant used in the Cameroon Rep. for the control of cocoa capsids: *Wasmannia auropuncta*). Café Cacao Thé 13, 3, p. 209-12 (1969).
Cocoa farmers of the coastal area around Kribi in the Cameroon Rep. use the ant *Wasmannia auropuncta* for capsid control. Knock-down counts in cocoa plantings showed that the ant had driven off capsids and *Crematogaster* ants, and had reduced insect population in general. The *Wasmannia* ants trapped in baskets made of bundles of raphia-leaflets and containing sugar-cane or coconut waste as bait, are carried from one cocoa planting to another. A trial showed that these traps contained both larvae and immature adults within 10 days after placement. English, German, and Spanish summaries. Table. Figs. Photos.

Lotodé, R. Etude statistique de l'évolution d'une population de mirides. (Statistical study of the development of a capsid population) Café Cacao Thé 13, 3, p. 216-20 (1969).
A statistical study was made of the spatial distribution of capsids (*Sahlbergella singularis* and *Distantiella theobroma*) in cocoa in the Cameroon Rep. The distribution could be expressed by 1 simple equation in which the logarithm of the variance of the counts per tree is a linear function of the logarithm of the mean of these counts. This relationship was confirmed by data collected weekly in 1966, 1967 and 1968; the linear correlation coefficient was very highly significant. The relationship was particularly useful when classical statistical methods were used for comparing the averages of the numbers of insects per tree with the purpose to illustrate differences in attraction exerted by various cocoa clones. English, German, and Spanish summaries. Table. Graphs.

May, 1970

Pickett, A. D., et al. Insecticides. Effects of systematic insecticides on cocoa fauna and tree growth. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 82-3 (1969).
In Ghana, a block of unshaded degraded mature cocoa was coppiced, and part of it was treated with Azodrin and dicrotophos. The 1st spray of each chemical was applied at a concentration of 0·25 per cent a.i. After that, 5 applications were made at weekly intervals which were followed by monthly applications; for each application a concentration of 0·15 per cent was used. Seven months after spraying terminal bud damage by pests, including psyllids and capsids, was almost absent. Compared to untreated plots, foliage weights and leaf numbers of the treated plots were doubled, while number of shoots was lower and shoots were taller. Poor growth of the untreated plots was considered to be almost entirely due to pest damage and not to partial drought under full insolation. Tables.

Owusu, G. K. Viruses research. Mechanical transmission studies. Rep. Cocoa Res. Inst. (Ghana Acad Sci.) 1967-68, p. 25-7 (1969).
In Ghana, 98 young Amelonado cocoa seedlings were leaf-inoculated with swollen shoot virus (New Juaben strain) preparation at different ages, and only 1 was infected. Ungerminated beans were readily infected, but after germination susceptibility rapidly decreased. In another trial, CCL_4 was added to a standard preparation of the same strain, and the infectivity did not decline until after 123 days, whereas without addition of CCL_4 the infectivity decreased after 65 days. Tables. 2 refs.

Legg, J. T., and Agbodjan, F. X. Virus research. Field trials. Maintenance of virus experiments. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 35-9 (1969).
Preliminary field tests in Ghana on chemical control of weeds in cocoa showed that the use of paraquat (0·5 per cent commercial product) was safe provided the cocoa seedlings were protected from spray drift (by using a 024-floodjet). Most of the weeds were killed by a spray of 560 L./ha. followed after 3 weeks by a spray of 540 L./ha. (3·37 and 3·20 L. paraquat/ha. respectively). A 3rd spray after 5 weeks of 475 L./ha. (2·8 L. paraquat/ha.), using a 024-floodjet, was required to kill *Paspalum conjugatum* and *Centrosema pubescens*. Tables. 2 refs.

Leston, D. Report of the International Capsid Research Team. Ant-capsid ecology. Conditions required for encouragement of Oecophylla. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 68 (1969).
In Ghana, the relationship of *Distantiella theobroma* in cocoa with its predator, the ant *Oecophylla longinoda*, was investigated. Among others, it was concluded that large ant populations can be established only in fields where cocoa has formed a closed canopy. For colony development the ants require some sunshine; to meet this need, a limited number of breaks in the superior canopy (forest shade) is sufficient. When treating cocoa plots with insecticides, spraying of *Oecophylla*-colonized trees should be avoided, because recolonization after nest destruction takes more than 12 months, and old large colonies contain more potential predators per nest and per unit of canopy volume. 1 ref.

Marchart, H. Insecticides. Laboratory screening. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 71-2 (1969).
In Ghana, the effects of topical applications of 5 N. methyl carbamates on 4th and 5th instar larvae of the cocoa capsid *Distantiella theobroma* were determined. The test showed that arprocarb was the most effective compound, being almost twice as toxic as sevin. This laboratory method can be used to compare the insecticide susceptibility of capsids from different areas of cocoa and provides a means for detecting the development of resistance at an early stage. Table.

Marchart, H. Insecticides. Spraying techniques. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1967-68, p. 73-4 (1969).
In Ghana, 2 methods of mistblower spraying for capsid control in cocoa plantings were compared. The 1st method consisted of spraying directed upwards and uniformly into the canopy; and following the 2nd method a directed

spray was applied to individual trees from base to crown. The deposits of the fluorescent tracer containing sprays on leaf and pod samples were classified. Among others, the results showed: (1) by both methods penetration into the canopy was relatively poor; and (2) most of the insecticides was deposited on the upper surfaces of leaves and on the ground, where capsids are absent. The 2nd method appeared to be more effective than the 1st method; more deposits were found on the capsids' feeding and resting sites. Table.

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