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Contents

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Editorial

The Editor wishes to apologise to the readers of the *Cocoa Growers' Bulletin* for the lateness of this issue, a year having passed since the last issue. This does not indicate a change of policy but was due to pressure of other work. We will try to maintain the normal two issues a year in future.

The Cocoa Research Association Limited

In issue No. 12, February 1969, mention was made of the Ghana Cocoa Growing Research Association Limited, a company formed by Mr. John Cadbury after his retirement. This company supports cocoa research at the University of Ghana and at the present time a large project to investigate the economics of improved practices and social and economic factors limiting production is being undertaken.

In 1973 a second company, The Cocoa Research Association Limited, was incorporated following a further bequest by Mr. John Cadbury. The purpose of this company is to support research on cocoa in any part of the world. Its funds are small in relation to the costs of cocoa research generally but it expects to support one or two projects every year. It is expected that requests for assistance will be received.

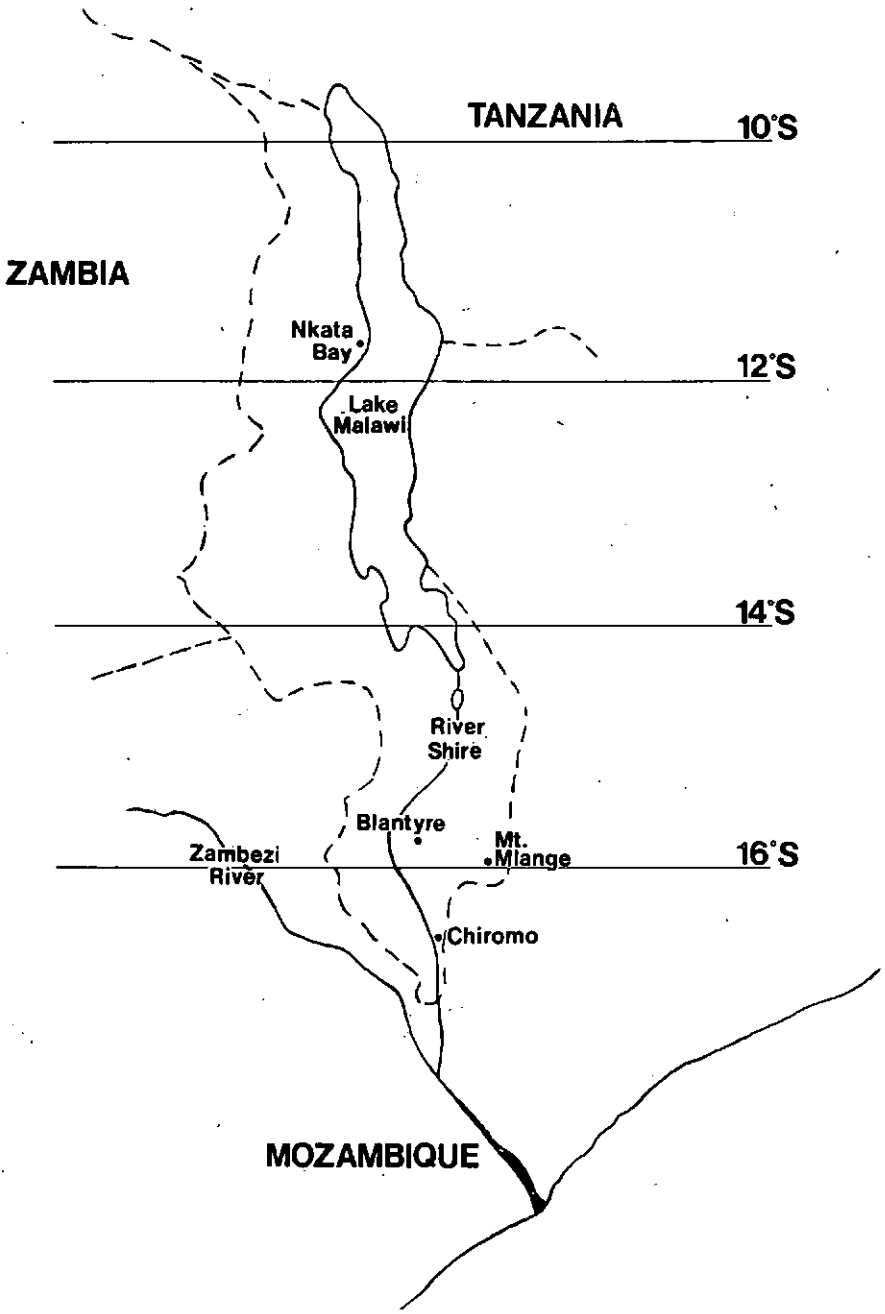
Research on Black Pod Disease

In the same issue – number 12 – we wrote about the survey of research on black pod disease that was being undertaken by Dr. P. H. Gregory, F.R.S., on behalf of the Cocoa Chocolate and Confectionery Alliance. His report, published later in 1969, made a number of recommendations, one of which was that the epidemiology of the disease should be studied by a team of two pathologists. This proposal was taken up by the International Office of Cocoa and Chocolate and two pathologists started work at the Cocoa Research Institute of Nigeria early in 1973, the cost being borne by manufacturers' associations in America and Europe. The two pathologists, Drs. Griffin and Maddison, have embarked on an extensive set of experiments designed to find out which of the many possible sources of disease are important during the course of an outbreak.

The results of this work are expected to be twofold: First, by showing the most important sources of disease and the means by which it spreads, more effective methods of control can be formulated. These results will apply to Nigeria but not necessarily to other countries where black pod is important. The second result, therefore, is to provide guidance as to an experimental method which could be applied elsewhere. We shall look forward to the results which could be of great value to cocoa growers in many countries.

G. A. R. WOOD

MALAWI


TANZANIA
10°S
ZAMBIA
Nkata Bay
12°S
Lake Malawi
14°S
River Shire
Blantyre
Mt. Mlange
Zambezi River
16°S
Chiromo
MOZAMBIQUE

Cocoa in Malawi

G. R. Lee, Agronomist, Ministry of Agriculture, Malawi

Malawi, formerly Nyasaland, lies well south of the equator stretching from about 9°S in the north to 17°S. Most of the country lies above 1,500 feet, the altitude of Lake Malawi, but the altitude is much lower in the southern part of the country where the Shire river drains the lake and descends to join the Zambezi. Cocoa has only been grown in Malawi on a trial basis but recent trials described in this article have indicated certain possibilities for the future.

A report in 1957 (1) suggested that cocoa be tried in three areas of Malawi. These areas were:—

(1) Nkata Bay on Lake Malawi in the Northern Region.
(2) Southern slopes of Mount Mlanje, in the Southern Region.
(3) The Lower Shire Valley which forms the southernmost tip of the country, at an altitude of only 200 feet.

At Nkata Bay where the rainfall is 90 inches, a few cocoa trees from Sri Lanka had already been established in 1957; further plantings were made there in 1971. The plantings at Mlanje failed due to exposure. The greatest success with cocoa was achieved on experiments in the Lower Shire Valley, and it is this area which will now be considered in detail.

Climate and Soils

The Lower Shire Valley of Malawi lies at latitude 16° south and is thus in the same latitude as the cocoa zone of Bahia, Brazil which is further from the equator than the bulk of the world's cocoa. The climate is therefore rather different from that of places where cocoa is normally grown. In Table 1 weather data from Tafo, Ghana and Makanga Experimental Station in the Lower Shire Valley are compared. It will be seen that total rainfall is only half that of Tafo and that there are seven dry months. Irrigation is clearly essential. During the long dry season the humidity is very low in the Lower Shire and causes tip die back and leaf fall, this problem has been overcome by the creation of a more humid micro-climate with wind breaks and light shade.

Temperatures at Makanga and Tafo differ in that the diurnal variation is considerably greater at Makanga. This variation ranges from 11 to 20°F at Tafo and from 19 to 28°F at Makanga. This may have some effect on the growth of the cocoa trees. Minimum temperatures fall beow 50°F occasionally at Makanga which reduces yields as will be shown later.

All cocoa has been planted under flood irrigation because of the poor rainfall. Reasonably large areas of highly fertile deep alluvial soils are found in the valley, and it is these which have been used for the cocoa experiments. The experimental plantings so far made have been irrigated by water from a small perennial stream, utilizing gravity flow. Additionally, two pump stations extract water from the rivers Ruo and Shire. There is only a limited number of small perennial streams suitable for gravity flow development, and as these are associated with highly populated areas, land reorganisation would be difficult. The Shire river, mentioned above, has an average discharge of about 40,000 cusecs. and is the most reliable source of irrigation water. It is already being used to provide irrigation for a sugar cane estate.

Table 1

Comparison of Meteorological Data for Tafo Ghana and Makanga Lower Shire Valley of Malawi, 25 and 26 years means respectively

	Rainfall in Inches		Afternoon Relative Humidity		Temperatures (Shade) °F			
					Tafo		Makanga	
	Tafo	Makanga	Tafo	Makanga	Max.	Min.	Max.	Min.
January	1·48	7·17	56	63	87·9	67·6	91·0	72·4
February	3·37	5·37	53	59	90·2	69·2	90·5	72·2
March	5·99	4·14	58	57	90·0	70·5	88·9	70·6
April	6·06	1·45	63	51	89·9	70·7	88·6	67·3
May	7·18	0·65	68	46	87·9	70·9	85·2	61·0
June	9·52	0·61	74	47	84·6	70·8	81·5	55·8
July	5·70	0·55	74	39	81·9	70·5	82·0	55·5
August	2·45	0·34	72	40	81·2	69·4	86·1	57·9
September	5·93	0·21	71	39	83·6	70·7	91·8	63·6
October	8·55	0·68	71	38	85·6	70·6	97·1	70·2
November	4·32	3·25	66	44	87·7	69·8	96·0	72·5
December	2·53	6·49	62	58	88·0	69·2	92·8	72·5
Total	63·08	30·91	Means 65·7	48·4	86·6	70·0	89·3	66·0

Establishment

The first experimental plantings at Makanga were made in 1957 with seed from Ghana. Approximately half an acre of land was divided into nine small plots, and nine different varieties of Amazon, Trinitario and Amelonado types were planted in them. Half the seed was planted at stake, and half in small baskets. Bananas and pigeon pea were established as shade after planting. There was no permanent overhead shade, but wind breaks were planted using *Gmelina arborea*, a large tree. All the cocoa was established on a 10 ft. × 10 ft. spacing. In 1960 a five acre plot was planted at Massenjere, some 17 miles north of Makanga. Here temporary shade was provided by bananas and pigeon pea, and wind breaks were of *Cassia* and mango trees planted close together to form a hedge. Once established, the mango hedge proved to be a very effective wind break, and also provided food and a source of revenue. *Glyricidia maculata* and *Albizzia lebbec* seedlings were planted in 1961 as permanent shade, and since their growth was rapid, the bananas were soon removed. In 1967 two and half acres of Amazon cocoa were established at Makanga to enable an investigation to be carried out into responses to fertilizer, water and spacing. The seedlings were produced in plastic planting sleeves and were transplanted under banana shade. *Gmelina arborea* formed wind breaks. Light overhead shade was established using *Terminalia ivorensis* spaced at 60 ft. × 60 ft. In the initial stages, covers of banana leaves were kept over the plants.

Cultivation

Initial weeding was necessary in all cases, but after two years the plants had produced full cover and weeding was not required. Fallen leaves formed an excellent mulch. No pruning was carried out in the early years. Few chupons were produced, and as a result, the trees tended to be rather flat with spreading branches, making harvesting difficult. Closer spacing tends to force the plants upwards.

Fertilizer and Irrigation

The fertilizer trial which is being carried out on Amazon cocoa has not shown any response to the main effects of N, P or K but when N alone is added, it significantly depresses yield. A combined NK treatment has given non-significant increases in yield. The trial is being carried out in approximately 75 per cent of full light.

The irrigation trial has indicated a factor of 0·8 × the evaporation from the open pan to be the most suitable. This gives a total water requirement of 70 inches per year, 40 inches of which is supplied by irrigation. Irrigating at 2 inches and 4 inches accumulated deficits have been studied and the 2 inch deficit has significantly outyielded the 4 inch deficit. At Makanga all cocoa is planted in level irrigation basins of only 10 yards × 15 yards which are surrounded by bunds. The larger plantings at Massenjere have been made on contoured bunds the centres of which are 10 feet apart and the height is approximately 18 inches. Water flows down between the bunds, runs of up to 100 yards being used.

Table 4

Relationship between distribution of cold days in June for the seasons 1965/66 to 1972/73 and mean yields of dry beans in lb/acre over all varieties at Makanga

Season	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73
Days 50°F or below	9	—	—	13	4	—	—	12
Consecutive days at 50°F or below	7	—	—	11	2	—	—	11
Yield dry beans	1759	1513	1651	788	1661	1694	1628	719
Lowest temperatures recorded ...	44·9	51·0	55·1	36·1	46·0	51·1	50·9	43·9

Pests and Diseases

Wool aphids (*Eriosoma lanigerum*) have occasionally built up on both young and mature trees but they have been easily controlled. The mango weevil (*Systates pollithosus*) does, on occasions, cause some damage, but not enough to warrant control. Evidence of the cocoa stem borer (*Mallodon downesi*) was found on one occasion but was removed. The burning of all dead wood seems to have prevented the spread of the pest.

At the Massenjere plot some trees showed a sickle leaf condition and chlorosis, normally associated with zinc deficiency. However, they quickly outgrew the condition. A more serious disease was first noted in 1962 at Massenjere when apparently healthy trees started to wilt in one branch. The condition quickly spread, and caused the complete death of the tree within three weeks. About two per cent of the population is lost in this way each year but without a marked depression in yield and all varieties have been affected. Removal of the wilting branch soon after the symptom is noticed often saves the trees: this suggests that the disease enters from the air and not from the soil. If a seedling is planted in soil where a tree has been killed it grows quite normally. It has not been possible to identify any organism as the definite cause of the disease, but the fungus *Botryodiplodia theobromae* is regularly isolated from the diseased tissue. There are no other serious diseases, and no regular spraying programme is carried out.

Yields

Right from the start the Amazon types have grown the most vigorously and the Amelonado type has been the least vigorous. Flowering usually starts one and a half years after planting in the case of Amazon varieties. Germination in the pod was initially a problem since some pods did not exhibit symptoms of maturity. This has now been largely overcome by regular harvesting by experienced workers.

The yields at Makanga and Massenjere are shown in Tables 2 and 3 respectively. Although cropping is continuous throughout the year, there are normally two peak periods of harvest. The position of these peaks varies from year to year but generally occurs during the May to July and January to March periods.

Table 2

Yields in Trial at Makanga

Means for 11 years 1962-1973

(lb/acre)

Amazon	T 79	2131
	T 73	1662
	T 17	1765
	Na x Pa	1557
Trinitario	T 9	1216
	SC 4	1028
	R 15	1265
Amelonado	A 196	1060
	S 84	1110

Table 3

Yields at Massenjere

Mean yields for 11 years

(lb./acre)

Amazon	11 varieties	1440
Trinitario	4 varieties	1012
Amelonado		961

As was mentioned earlier, temperatures do sometimes fall below 50°F and if this occurs for any length of time yields are reduced to a marked degree. These low temperatures usually occur in June. During the 1968/69 and 1972/73 seasons there was a marked depression in yield at Makanga and Massenjere. The relationship between cold days in June and yield is presented in Table 4 and in both years it can be seen that the yield drop is associated with the low temperatures. In the case of the 1965/66 seasons, however, temperatures were low for June but not quite as low, nor did they last so long, as in the other two seasons when yields were depressed. This would suggest a critical length and level of low temperatures which results in a dramatic drop in yield.

Quality

All the cocoa produced has been sold to Cadbury Schweppes (South Africa) Limited as a mixture of the three types. Their reports on the beans have been generally good as far as fermentation and flavour is concerned, although the flavour of the chocolate made from the beans is more aromatic than chocolate made from West African beans. Bean weights are low and shell percentage consequently rather high. The average weight of 200 beans of the Amazon and Trinitario types is 180–190 gm as compared with an average of 210–220 gm for West African beans while Amelonado beans have given even lower weights. Shell percentage ranges from 13–16 per cent.

The Future

A World Bank development project in the Lower Shire Valley is making funds available to develop up to a maximum of 500 acres of cocoa on a research basis. An experimental plot was established recently on a large irrigation pilot project on the banks of the Shire River and, should the crop yield well, development there should not be too difficult.

REFERENCES

1. Urquhart, D. H. (1958). Report on the possibilities of growing cocoa in the Protectorate of Nyasaland (now Malawi). Cadbury Brothers Limited, Bournville.

Young cocoa on a trial plot in Malawi.

Review of Production and Consumption

February 1974

A. B. Cook, Cadbury Schweppes Limited, Bournville, Birmingham

Production

The latest Gill & Duffus forecast of 1973/74 production predicts a world total of 1,437,000 long tons, an increase of 73,000 tons over the estimated final 1972/73 figure of 1,365,000 long tons, but still 125,000 tons below the 1971/72 total of 1,562,000 long tons.

The principal increase over last season is expected in Brazil where the main crop is confidently expected to exceed 2 million bags, with some estimates as high as 2·5 million bags, compared with last year's record total of just under 1·8 million bags. It is too early to make anything other than an arbitary estimate for the coming Temperao crop, but the average of recent years of 1,450,000 bags would show a substantial increase on last year's disastrous outturn of 700,000 bags. Over the whole year the increase could be 1·3–1·5 million bags or 80–90,000 tons, bringing the total to 4·1 million bags or 245,000 tons.

Production in Ivory Coast and Cameroon is expected to be up on last year, although still below the record 1971/72 levels. Estimates put Nigerian production at around last year's level, although purchase figures to date are running considerably behind last year. Ghana is expected to show a considerable shortfall against last season although the tail of the crop has been good and the final outturn may well be rather higher than originally predicted.

Purchases in the West African countries to the end of January compared with the figures at the corresponding dates last year were:—

		1973/74	**1972/73**
Ghana	31st January	309,361 tons	376,419 tons
Nigeria (West)	24th January	151,826 tons	196,189 tons
Ivory Coast	25th January	166,543 tons	155,827 tons
Cameroon (East)	21st January	64,136 tons	62,861 tons

Although it is generally hoped that the West African summer crops will show a substantial improvement on the exceptionally low levels of last season, reports of another severe Harmattan suggest that they will be no better than average.

Consumption

World consumption in 1974 is forecast by Gill & Duffus at 1,466,000 tons, a decrease of 71,000 tons from the revised total for 1973 of 1,537,000 tons. This reflects that the past year of very high prices is expected to have a considerable effect on consumption, although the size of the effect is largely a matter of conjecture.

WORLD COCOA PRODUCTION AND GRINDING DATA

Reproduced from Gill & Duffus Market Report

Dated 19th February 1974

(Thousand long tons)

Production

	1971/72	1972/73 (Estimate)	1973/74 (Forecast)
Africa	1,145	1,006	975
America	318	280	363
West Indies	54	41	47
Asia and Oceania	45	38	52
World Total	1,562	1,365	1,437
Principal Countries			
Ghana	457	411	360
Nigeria	251	237	220
Ivory Coast	221	178	212
Cameroon	121	97	105
Equatorial Guinea	22	10	14
Brazil	164	159	239
Ecuador	66	42	50
Dominican Republic	40	28	33
Venezuela	19	16	14
Colombia	22	23	25
Mexico	35	30	23
New Guinea	30	22	30

Grindings

	1972	1973 (Estimate)	1974 (Forecast)
Western Europe	561	580	544
Eastern Europe and U.S.S.R.	244	242	234
North America	306	292	258
Australia and New Zealand	19	19	18
Central and South America	198	196	201
Asia	63	68	60
Africa	157	140	151
World Total	1,548	1,537	1,466
Principal Countries			
United States	287	275	242
Germany (Federal Republic)	137	150	145
Netherlands	122	121	115
United Kingdom	96	105	95
U.S.S.R.	130	130	128
France	47	47	43
NOMINAL BALANCE (after allowing for 1% loss in weight)	—2	—186	—43

Stocks

The net deficit in 1973 was finally 186,000 tons. The deterioration from the February 1973 Gill & Duffus estimate of 61,000 tons was principally due to the failure of the Brazilian Temperao and the West African summer crops.

Gill & Duffus are predicting a net deficit in 1974 of 43,000 tons. This would leave the end of season stocks at 295,000 tons (2·4 months usage) compared with the end of 1973 season stocks of 342,000 tons (2·6 months usage). This predicted level would be the lowest, in usage terms, since the war.

Prices

Month end prices for nearby Ghana shipment cocoa have been:—

1973	February	£347·0/metric ton
	March	£418·0/metric ton
	April	£481·0/metric ton
	May	£575·0/metric ton
	June	£643·0/metric ton
	July	£919·0/metric ton
	August	£693·0/metric ton
	September	£706·0/metric ton
	October	£595·0/metric ton
	November	£535·0/metric ton
	December	£601·0/metric ton
1974	January	£602·0/metric ton

The very rapid rise in prices up to July reflected the growing realisation that, as the news of the summer crops worsened, the deficit in 1973 was far bigger than originally expected. The acute shortage of nearby cocoa produced panic buying, which caused very inflated prices through July. The price for later shipment positions never rose significantly above £700/metric ton.

Once the market had returned to a more orderly state, prices settled back to between £500 and £700/metric ton, with a premium for nearby and afloat cocoa. The continuing high prices reflect the lack of any sign of a significant improvement to the low world stock position.

Hybrid Cocoa Varieties in the Eastern Region of Ghana, Present and Future

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In a previous issue of *Cocoa Growers' Bulletin*, Glendenning (5) gave an account of the development and early performance of the new hybrids or Series II varieties which are being issued to farmers in Ghana. The present article describes experience with these hybrids and indicates how it is hoped to improve on them.

The hybrid cocoa varieties stemmed from a group of exploratory crosses which were made by Knight and Rogers and planted in trials at Tafo in 1952 and 1954. The purpose of the trials was not that the new crosses should be considered as 'varieties' but rather to assess the breeding potential of the then new Upper Amazon material which had shown great vigour and precocity when introduced to Ghana. However, such was the early promise of the hybrids that nine of them (excluding reciprocals) were tested for commercial use. In 1956, four trials were planted, three in Eastern Region and one in Central Region, and in 1957 four further trials in the other cocoa growing areas. From this point the development of them as varieties proceeded rapidly. When some were chosen for farmers' use the choice was based largely on the early yield figures from the Tafo trials, supplemented by data on early vegetative growth in the other trials. One variety was discarded because of high losses due to disease and another following adverse quality reports, the remainder were later approved for release. At the outset none of the pure Amazon varieties were considered for large scale use as it was thought they showed reduced hybrid vigour (1).

Propagation for the planting of biclonal seed gardens for mass production of these varieties was well under way in 1958 and the first plantings were made in 1959. At that time the varieties had not been approved for release and it was accepted that should a variety subsequently prove unsatisfactory the seed gardens producing it would be cut out. The original plans provided for 15 seed gardens totalling 735 acres but in 1973 less than 500 acres had reached maturity. This is an over estimate of the productive acreage because of guard trees and pollinator trees which do not provide useable seed pods. It was intended that seed pods from different seed gardens should be assembled at central points and distributed as mixtures and the gardens were allocated to sites to facilitate this. In recent years some gardens have been extended with new plantings but it is likely to be several years before these new areas come into bearing.

*On Secondment from the United Kingdom Overseas Development Administration on Technical Assistance.

Table 1

Hybrid Seed Gardens in Ghana

Amazon Parent	Hybrid	Cocoa Station	Acreage Planned	Approximate Productive Acreage 1973
T16/613	D	Foso	28	8
	D	Akumadan	90	None
T63/967	B	Bunso	190	116
	K/L	Fumso	40	40
		Buaku	35	35
T63/971	A	Pankese	60	60
		Foso	20	None
		Bechem	40	40
	C	Biene	23	23
		Buaku	35	35
T79/467	M	Bunso	45	45
		Asikuma	22	22
T85/799	J	Apedwa	32	23
		Kwadaso	50	32
		Goaso	25	None
			735	479

The design of the seed gardens was found to be unsatisfactory (2) because, while one parent was always a vigorous Upper Amazon clone, the other was a weaker local selection. Imbalances developed at the propagation stage as well as in the field and, when the Amazon clones were ready to commence bearing, the local clones, the pollinator parents, were too small to provide enough pollen. (In part this was because they were sometimes incompletely planted, due to a shortage of material because of difficulties in propagating them; in part poor field establishment; in part poor growth and in part because they were shy flowering compared to the Amazons). In 1969 yields from the seed gardens were found to be poor, even as low as the equivalent of 100 lb. dry cocoa per acre. In order to compensate for the lack of pollen for the Amazon clones, hand pollination of seed gardens was adopted; the practical aspects of this were discussed by Edwards (6). Hand pollination also allows a seed garden to produce different crosses and this advantage will be discussed later.

Recording of the Tafo trials and the four planted in 1956 continued and in 1970 a detailed examination of the results from them was made (2). The main conclusion was that the hybrids with an Amelonado parent are to be preferred to those with a local Trinitario parent. This is illustrated in Table 2 with data from the 8th Progeny Trial where the Amelonado hybrids were higher yielding than those with a Local Trinitario parent, mainly because of lower proportions of diseased pods (these were usually blackpods). The cropping data from this trial is also given in figure 1, which shows that from the 8th year after planting the Amelonado hybrids outyielded the Local Trinitario hybrids. In the other Tafo trial and in the four planted in 1956 the Amelonado hybrids were superior to the Local Trinitario hybrids in yield and in lower disease losses. Studies also

Table 2

Results from the 8th Progeny Trial, 1952-1973

	Series II Code	% Diseased Pods	% Rodent Damaged Pods	% Apparently Good Discarded at Breaking	% Discards Overall	Aggregate Actual Yield kg/Hect.
[1]Unselected Amelonado		16·0	1·0	7·4	24·8	16215
[1]Con D44/4 Selfed		15·4	0·8	7·5	24·3	15817
[2]P4/9 : J11/4/5 x T12/113		20·8	8·2	5·1	36·5	15384
[2]S72 : J11/4/49 x T60/887		16·8	3·3	6·0	27·9	21718
[2]S72 : J11/4/47 x T86/982		17·8	1·4	7·9	29·6	24529
[2]P4/9 : J11/4/5 x T63/971	A	16·2	1·0	7·3	25·6	25609
[3]E1 : C4/3/291 x T63/967	B	23·2	3·1	4·9	31·7	18398
[3]E1 : C4/3/270 x T63/971	C	23·2	1·5	6·7	32·8	19626
[4]E1 : C4/3/291 x T16/613	D	21·5	2·2	7·8	32·4	19818
[5]T12/26 x T12/27		19·2	10·6	8·6	40·2	11382
[5]T12/150 x T12/151		11·1	8·5	10·6	30·9	15437
[6]T60/887 x T60/888	G	16·8	5·7	8·5	32·3	14391
[7]E1 : C4/3/270 Selfed		16·9	0·5	8·2	26·7	14269
[7]K5 : C4/4/353 Selfed		19·7	0·8	7·4	29·6	8633

[1] Amelonado, 4 replicates of 36 tree plots.
[2] Amelonado x Amazon hybrid, only 1 replicate.
[3] Local Trinitario x Amazon hybrid, only 2 replicates.
[4] Local Trinitario x Amazon hybrid, 4 replicates.
[5] Sibbed Amazon, 2 replicates.
[6] Sibbed Amazon, 4 replicates.
[7] Local Trinitario Selfed, 4 replicates.

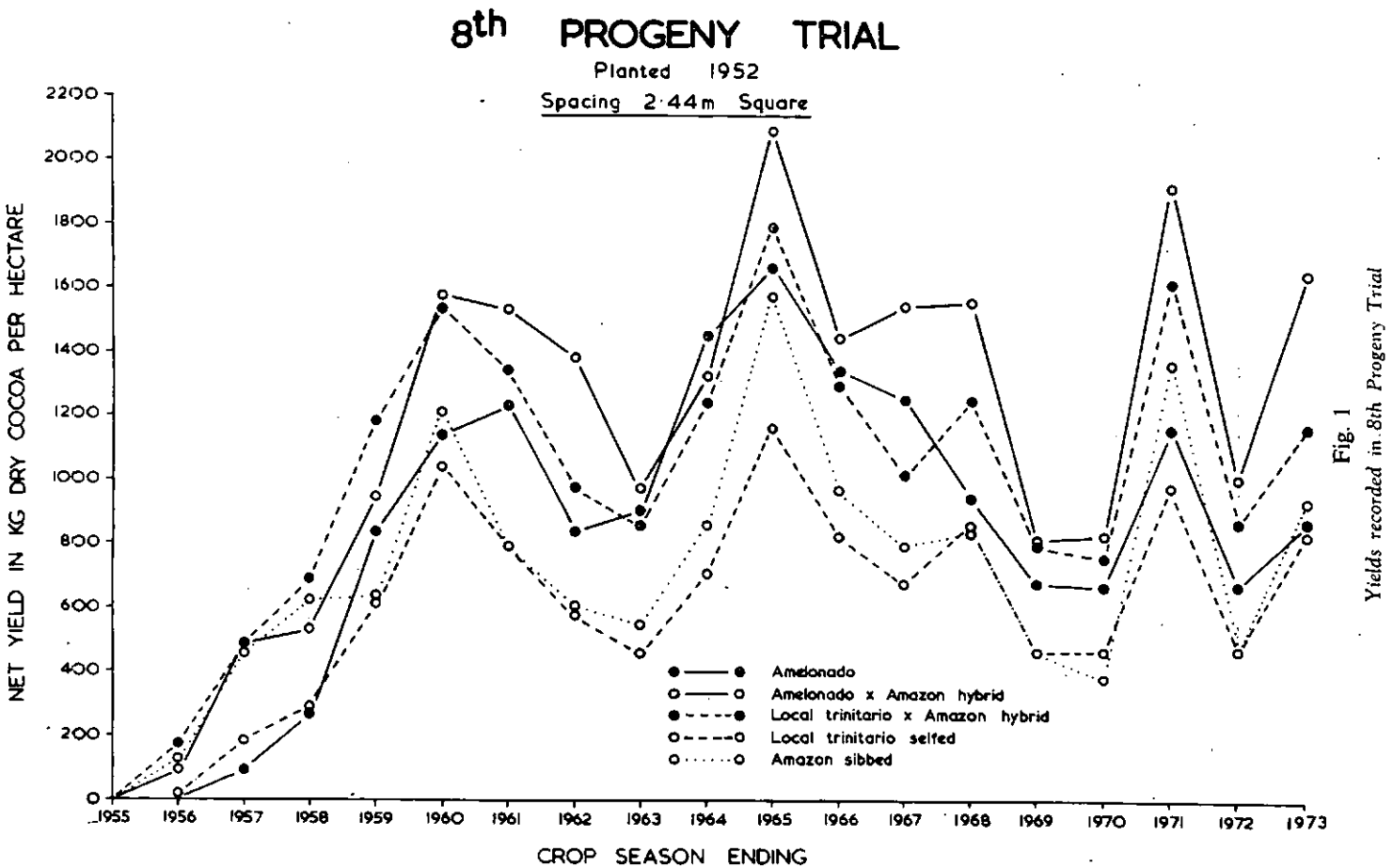

Fig. 1 *Yields recorded in 8th Progeny Trial*

indicated that the Amelonado hybrid trees were often smaller and more uniform in size than the Local Trinitario hybrids and it is believed that these characteristics are a further advantage when the varieties are used by local farmers. On the basis of these results it was decided that production of the local Trinitario hybrids should stop. Accordingly, only Amelonado flowers are used for hand pollination of the Amazon clones in the seed gardens, even in gardens which had been designed to produce Local Trinitario crosses.

It is generally accepted that the agronomic characteristics of the new varieties differ from those of Amelonado, and, to achieve the best results from them, growing techniques must be adapted to their needs. For many farmers, this would involve changes such as growing at wider spacings with more careful shade management than is normal, and harvesting more often. But the important question is whether or not the new varieties are likely to lead to a better economic return than can be expected from Amelonado, at a given level of management. To the farmer this means that the annual yield of dry cocoa must be great enough over long periods to compensate for any higher production costs.

Amelonado can be compared to the new varieties in only one mature trial, the 8th Progeny Trial Area. Some results from this trial are given in Table 2 and Figure 1 and it can be seen that the hybrids came into crop earlier than the Amelonado. This is shown even more clearly by dividing up the aggregate net yields into the first eight and second ten years:—

	1955/63	1963/73
Amelonado	5 288 kg	10 729 kg
Amelonado hybrids	7 503 kg	14 307 kg
Local Trinitario hybrids ..	7 411 kg	11 869 kg

This earliness of bearing is valuable in giving an early economic return from a young plantation. The results also indicate that higher early yields were not at the expense of the yields in later years and, although yields from the hybrids fluctuated between wide limits, yields from the Amelonado mirrored this variation.

During 21 years of the 8th Progeny Trial disease losses on Amelonado were lower on the hybrids; in the last 10 years losses were:—

Amelonado	15·9%
Amelonado hybrids	18·2%
Local Trinitario hybrids ..	21·6%

This was with harvesting every three to four weeks, more often than farmers normally practice, and it is known that regular harvesting reduces losses due to blackpod. For this reason it is likely that under farmers' conditions the difference between the hybrids and Amelonado would be accentuated.

A common criticism of the hybrid varieties (and any Amazon variety) is that they produce their crop continuously through the year, rather than in clearly defined peaks which are thought to be more typical of Amelonado. The crop from the 8th Progeny Trial taken month-by-month and averaged over five years is shown in Figure 2 and it was only during the April-June period that there was a marked difference in cropping pattern between the hybrids and Amelonado. However, these early ripening pods provide an all season food base for both pests and diseases. Marchart and Lodos (9) thought that the more even spread of cropping through the year on hybrids led to higher losses from *Bathycoelia thallasina* than are seen on Amelonado. These early ripening pods, which are often left unharvested by farmers, provide a basis for the build up of black pod

8TH PROGENY TRIAL 1964-69

CROPPING PATTERNS

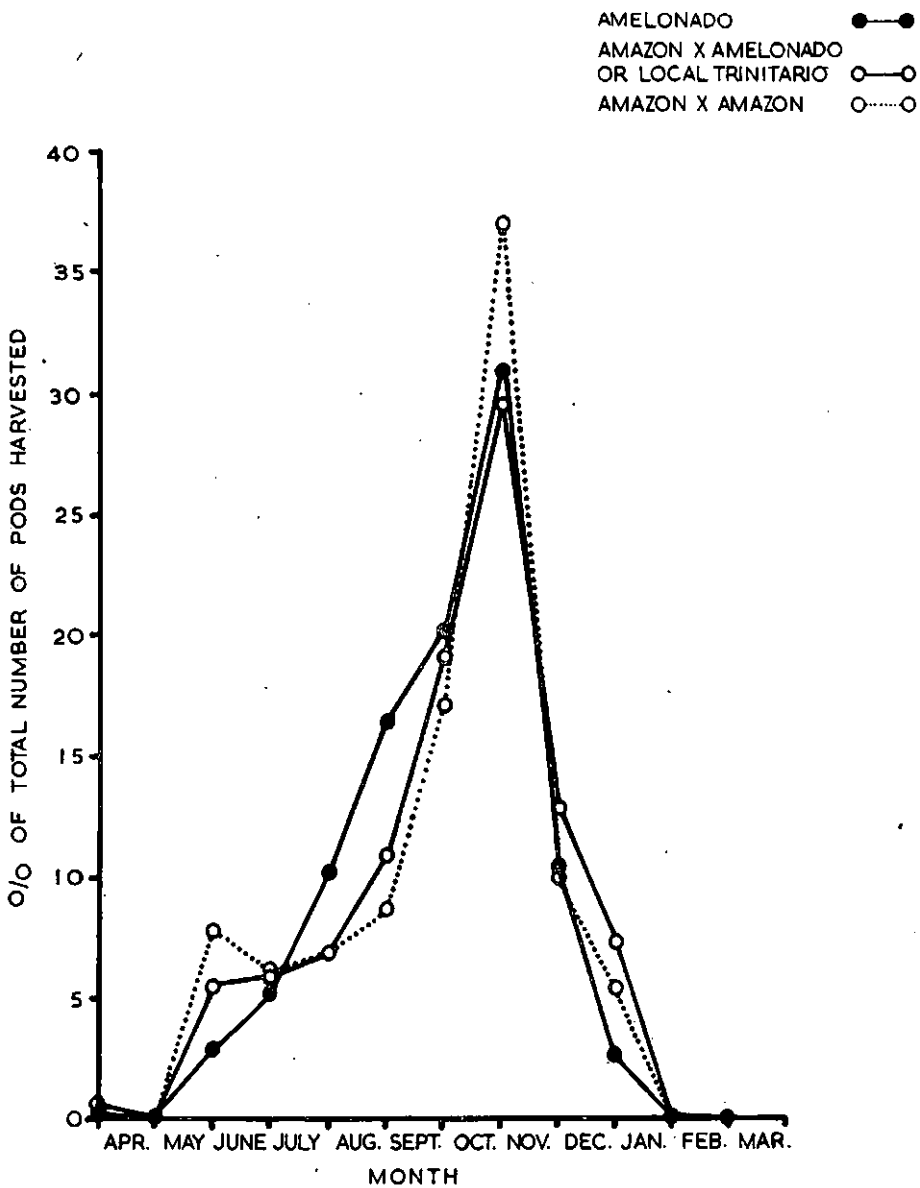

Fig. 2

Monthly cropping patterns in 8th Progeny Trial

epidemics, which may be why under wetter conditions black pod losses on hybrids can be great and so the importance of regular harvesting cannot be over-emphasised.

On the evidence of the 8th Progeny Trial alone it is not possible to say if the better hybrids yield more than Amelonado because when assessing the results several points must be borne in mind. It must always be said that conditions in formal trials are so different from those on farmers' farms that extrapolation from trial results is dangerous; so far experience with hybrids on farms is restricted to young trees and no comparison with yields from Amelonado can be made. The spacing (8 feet square) may have been greater than the optimum for Amelonado under the trial conditions, but for the hybrids it was more nearly right. The likelihood that under normal farmers' management the hybrids would suffer heavier blackpod losses has already been discussed. These two factors might suggest that the trial under-estimates the relative performance of Amelonado. On the other hand, this trial was established under good climatic conditions on a good soil which had not been degraded by excessive removal of forest shade trees and food farming. Experience in the Eastern Region of Ghana indicates that in poorer conditions the superiority in establishment ability and early yield of hybrids over Amelonado is much greater than the 8th Progeny Trial would suggest. Confirmation of this comes from a new shade and spacing experiment which include hybrids and Amelonado (4). On farms which have been devastated by swollen-shoot disease, ease of establishment and early yield is particularly valuable so that the economic loss to the farmer is minimised. Under such conditions the hybrids have a marked advantage over Amelonado and ease of establishment and early bearing may be their most important attribute.

In the Eastern Region the hybrids are now being used to replant farms which have been destroyed by swollen-shoot disease. In the discussion that follows, the term resistance is used to indicate the ease with which a variety can be infected with the disease; the highest level of resistance would be immunity – trees which could not be infected. Tolerance is used to describe infected trees and the best level of tolerance is when infected trees are symptomless, and yield is not reduced. If trees are badly affected they are described as sensitive of infection. When the hybrids were originally selected no attempt was made to breed for resistance to or tolerance of swollen-shoot disease. In later laboratory tests the hybrids were shown to be both susceptible and sensitive to swollen-shoot infection, while field experience with them has been restricted to trees infected by chance in variety trials. It appears that symptom expression is not as clear as is typical of Amelonado and this will hinder cutting out in farmers' plantings, as is already the situation with the mixed Amazons (3).

Development of hand pollination for large scale seed production allows the possibility of changing the pollen parents of the existing Series II seed gardens (at present Amelonado) and producing a new range of hybrids. It is known that certain Upper-Amazon parents, particularly from the Nanay and Iquitos populations, will give progenies with a significant level of field resistance to infection with swollen-shoot disease. The incorporation into varieties of a practical level of resistance is desirable, and the need for field resistance to the virus is underlined by the likelihood that control by cutting out in mixed Amazons and hybrids will be less successful than in Amelonado (8). The British Research Team at Tafo is evaluating a range of inter-Amazon crosses involving the four major seed garden parents – T63/967, T63/971, T79/467 and T85/799.

The first field experiments were established in 1971 and planting should be completed in 1974. The new types are being assessed for field resistance to the spread of the disease in trials where they are compared to the existing seed garden cross with Amelonado. At the same time they are being evaluated in formal variety trials and any crosses which are substantially inferior to the Amelonado equivalent will be eliminated. It is hoped that by 1980 there will be sufficient evidence to recommend some of these new types for farmers' use and it should be possible to commence large scale production of them immediately by use of hand pollination. Should further results justify it some varieties could be discarded and others substituted, simply by changing the male parents used for hand pollination.

In the trials the main characters under consideration, other than swollen-shoot disease resistance, are vigour (particularly establishment ability), blackpod disease losses, yield and quality. Swollen-shoot disease resistance is considered so important that varieties with resistance might be planted even if in trials they did not yield as well as the best susceptible types. At present it is thought that the main problem will be blackpod disease and it is likely that this will be the main selection criterion among virus resistant varieties. In this respect it is encouraging that the only outcrossed inter-Amazon among the Series II hybrids (WE6, hybrid F,T85/799 × T79/501) had the lowest pod disease losses. In the 9th Progeny trial over 14 years, losses were:—

Amazon × Amelonado hybrids	17·6%
Amazon × Local Trinitario Hybrids	24·0%
Inter-Amazon Hybrid (WE6)	11·7%

It would be wrong to assume that successful development and exploitation of known levels of resistance to swollen-shoot virus disease would immediately solve the virus problem. Firstly, for many years after the new varieties become available, they will only represent a small proportion of the total acreage and the bulk of the cocoa will be Amelonado. Secondly, the new varieties will not be immune to the disease so they will become infected; their advantage would be slower initial infection and a reduced rate of spread of virus through the farm once it became infected. This means that swollen-shoot disease must be contained by cutting out for many more years.

All new hybrids which include known Amazon parents are likely to have agronomic characters nearer to those of the Series II hybrids and mixed Upper Amazons than to Amelonado. There is sufficient experience with varieties derived from Upper Amazons to show that the growing methods which suit Amelonado are not all applicable. If the new varieties, including hybrids, are to be successful then extension work is required to assist farmers in adopting the necessary new growing techniques.

Acknowledgements

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The author is indebted to D. F. Edwards and J. T. Legg for much useful advice and discussion. This paper is published with the permission of the Director, Cocoa Research Institute of Ghana.

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Conferences on Cocoa

1. COCOA AND COCONUTS IN MALAYSIA

The Incorporated Society of Planters was founded in 1919 to represent the planters of Malaysia and its primary object is 'to promote the general interests of the planting profession'. It has organised technical education schemes for many years and recently has promoted conferences on oil palms, cocoa, coconuts and other subjects which have become as important in their field as the series of conferences on rubber organised by the Rubber Research Institute. The first of the I.S.P. conferences was held in 1967 and concerned cocoa and coconuts, a second conference on this subject was held in November 1971. The proceedings of this conference have been published under the title – 'Cocoa and Coconuts in Malaysia'.*

There were a number of sessions to the conference and a brief summary of the sessions concerned with cocoa follows.

Breeding and Improvement of Cocoa

H. Toxopeus	Cocoa breeding: a consequence of mating system, heterosis and population structure.
D. F. Edwards	Some notes on the development and management of hybrid cocoa varieties.
Chee Yau Fah	A review of some cocoa hybrids at the Cocoa Research Station, Sabah.
N. T. Arasu and C. I. Phang	Cocoa improvement in West Malaysia.

These papers are complementary to each other and present a full picture of breeding work generally, results in Malaysia and the management of new varieties. Toxopeus describes the history and distribution of Criollo, Amelonado, Upper Amazon and Trinitario populations and outlines the principles of a breeding scheme utilizing hybrid vigour. The last two papers present the results of trials in East and West Malaysia respectively; Dr. Chee's paper details the selection criteria used and makes recommendations for planting in Sabah.

Edwards enlarges on the management problems which result from large scale planting of hybrids. Hybrids tend to have an extended cropping season but it is suggested that this difficulty might be overcome by hand pollination, which would be more effective if applied to clones specially selected for this purpose. This would allow harvesting of individual fields to be compressed into a relatively short time.

*Proceedings of the Conference held in Kuala Lumpur 25-27th November 1971. Ed. R. L. Wastie and D. A. Earp. Available from The Incorporated Society of Planters, P.O. Box 262, Kuala Lumpur, Malaysia. Price $25.

Coconuts interplanted with cocoa, Bagan Datoh area of West Malaysia.

Pests and Diseases of Cocoa

T. C. Pang and R. A. Syed	Some important pests of cocoa in Sabah.
P. J. Keane and P. D. Turner	Vascular-streak dieback of cocoa in West Malaysia.
Dj. Purba and Ch. Hutauruk	Preliminary observations on the effect of zinc fungicide against pod rot disease (Phytophthora spp.) of cocoa plants and its relation to pod production.
D. Friend	Black pod disease and canker of cocoa in the British Solomon Islands Protectorate.

Pang and Syed outline the economic status of cocoa pests, which in general cause only small degree of damage in cocoa plantations in Sabah but the indiscriminate use of insecticides has upset the balance occasionally and this led to severe outbreaks. Friend's paper shows that losses of 20 per cent are caused by black pod and that control is difficult. The incidence of canker due to Phytophthora varies considerably according to the planting material, losses to Amelonado are low but on a Trinitario plantation 35 per cent of cocoa trees had died from canker infection. Keane and Turner present an important paper on vascular streak dieback which has recently been shown to be caused by *Oncobasidium theobromae*. The pathogen is a most destructive disease in Papua–New Guinea and has been found to be widespread in West Malaysia. No fungicide has yet been shown to control the disease and pruning of diseased branches to delay disease build-up is recommended. Varying degrees of resistance to vascular-streak dieback have been noted and selection work is in hand in Papua–New Guinea.

Age at Planting, Covers and Shade for Cocoa

Teoh Cheng Hai and R. Shepherd	Age at planting of cocoa seedlings in relation to month of planting.
J. W. Blencowe and F. T. P. Hubbard	Thinning and shaping of densely-planted cocoa.
B. J. Mainstone	A background to Dunlop work with covers and shade for cocoa.
Lee Aik Kien and A. Garot	Cocoa planting without shade in Pahang, West Malaysia.
K. Shama Bhat and K. V. Ahamed Bavappa	Cocoa under palms.

Teoh and Shepherd describe results of planting trials. Seed at stake suffered heavier losses than seedlings. Seedlings of various ages were planted at various times of year; in wet months older seedlings survived better and 4 month old seedlings gave the highest initial yield.

Blencowe and Hubbard describe a simple device for measuring the growth of trees and the way in which it can be used in thinning a field. Trials of thinning and pruning are also described – this is an area in which any new trial is welcome and where new ideas are welcome.

The paper on 'cocoa under palms' concerns experience in India where arecanuts and coconuts are interplanted with cocoa.

Soils and Manuring of Cocoa

I. F. T. Wong	Suitable cocoa soils in West Malaysia.
E. A. Wyrley-Birch	Manuring of cocoa.

Wong's paper presents the results of a reconnaisance survey of West Malaysian soils. This reveals that there are some 225,000 acres of coconuts and over 450,000 acres of forest on soils suitable for cocoa. This shows that there is much room for extension of cocoa growing.

Wyrley-Birch describes factorial fertilizer trials on lightly shaded mature Amelonado cocoa in Sabah from which it is recommended that an application of 600 lb/acre of 5,5:14:18:4 compound be made.

Weed Control, Herbicides and Harvesting of Cocoa

D. A. Ll. Brown and B. D. Boateng	Weed control for young cocoa: current work at the Cocoa Research Institute of Ghana.
K. S. Tan, B. J. Mainstone and J. M. Fua	The effects of selected herbicides on cocoa shade plants, cover and cocoa seedlings on inland sandy loam soils.
J. B. Owen Jones	Harvesting of cocoa as an intercrop.

Brown and Boateng describe some preliminary studies conducted in Ghana of a number of herbicides (Alachlor, amitrole, 2,–4–D, dalapon, diuron, M.S.M.A., paraquat, simazine and sodium chlorate), all are recommended for further field trial. It is felt, however, that herbicides are unlikely to have widespread application in Ghanaian conditions.

Tan, Mainstone and Fua describe detailed trials of both pre- and post-emergence herbicides during early stages of cocoa establishment in Malaya. A helpful schedule of herbicide spraying is presented for the period from shade establishment until the canopy closes. The choice of herbicides must depend on the weeds to be controlled, but experimental data is presented for chemicals available in Malaysia on flora typical of Malaysia.

Owen-Jones discusses factors influencing harvesting and collection systems and describes a method which has been evolved.

Quality and Drying of Cocoa

A. G. Salz	Cocoa processing – a practical approach to fermenting and drying.
G. A. R. Wood	Manufacturers' quality requirements.

Salz presents numerous factory layouts for fermenting and drying systems for both large and small producers. Much of this detailed information would be helpful to those preparing such systems as some of their advantages and disadvantages are described with comparative costs obtained from plantations in New Guinea.

Wood emphasises that flavour is the main criterion for quality but that flavour is 'essentially a subjective judgment'; physical examination by the cut test is objective but is a limited guide to flavour.

The relative price of different types of cocoa depends on fat content, flavour and consistency, but a new producer like Malaysia must be content to receive a discount until the quality of his cocoa is well known. International cocoa standards have been agreed by F.A.O. and the International Standards Organisation and these are appended to the paper.

Outlook for Cocoa

Sugar, Beverages and Horticultural Crops Service, F.A.O. Rome	Developments in the world cocoa economy.
D. H. Recter, J. R. Leach and Lim Kian Peng	Cost of production and expected return from cocoa planted under coconuts.
J. M. Bulder	Some annotations in relation to intercropping policies.

The F.A.O. paper gives projections of world consumption of cocoa beans at various prices. At 25c (US) per lb consumption is estimated to reach 1·7 m tons in 1975 and 1·95 m tons in 1980.

Recter, Leach and Lim present production costs and potential profits of mixed planting of cocoa and coconuts over a 25 year period. Using average spot cocoa price for past 17 years the paper shows inter-plating to be a rewarding agricultural investment. Detailed costings are presented.

2. TRAINING SEMINAR ON COCOA GRADING

The Food and Agricultural Organisation of the United Nations has been concerned with grading standards and quality improvements of cocoa since the Cocoa Study Group was created in 1956. Its early studies of grading practice in producing countries and of manufacturers' requirements led to the formation of a Working Party on Grading whose aim was to develop a Model Ordinance for cocoa grading. This Working Party started in 1961 and at its third meeting in 1969 agreement was reached on grade standards and a code of practice. The grade standards have been adopted by several producing countries, but have not yet been incorporated into commercial contracts.

At the third meeting, Nigeria proposed that training seminars should be arranged for members of the inspection staff and the first such seminar was held in Lagos in October 1972. A report on this seminar has been published by F.A.O.†

This seminar, attended by 34 produce inspectors from West Africa together with a representative from Brazil, was organised into several sessions dealing with the importance of quality and grading to producers and manufacturers, the factors affecting quality and its assessment, the standards applied in producing countries and the organisations applying them. The following papers were presented:

Dr. C. del Boca	The importance of quality grading for cocoa producers and manufacturers.
G. A. R. Wood	The importance of quality and grading from the producers' point of view.
G. A. R. Wood	The needs of manufacturers with respect to quality.
J. Braudeau	Factors influencing cocoa quality.
J. Braudeau	Methods and difficulties of assessing cocoa quality.
T. M. Bannerman-Martin	Standards of cocoa quality applied in Ghana.
A. Okusaga	Review of developments in cocoa quality standards in Nigeria over the last twenty years and national legislation defining standards.
T. M. Bannerman-Martin	Organisation of national quality control service in Ghana.
A. Okusaga	Organisation of services concerned with quality control and legislation in connection with the implementation of this control in Nigeria.
J. Riley	Insect infestation of stored cocoa.
J. O. Oyeniran	Internal mouldiness of cocoa: causes and control.

The report contains the text of these papers together with a summary of discussions, a history of the work of F.A.O. in relation to cocoa grading, the text of the Model Ordinance and Code of Practice, a comparison of that text with the grading regulations in force in Ghana and Nigeria and also the regulations applied in Brazil.

Apart from being a useful report on the Seminar, this publication gives a comprehensive review of the current position regarding cocoa grading.

†Report of the Training Seminar on Cocoa Grading, Lagos, Nigeria, 2nd-6th October 1972. F.A.O. No. TA 3195.

3. COCOA ECONOMICS RESEARCH CONFERENCE

The Institute of Statistical, Social and Economic Research at the University of Ghana, Legon organised a Cocoa Economics Research Conference at the University in April 1973. This was the first conference on this subject and it attracted a large number of delegates, several of whom came from Europe and the United States. During four days, 35 papers were presented to the conference in seven sessions covering different aspects of the subject. This large number of papers revealed the considerable extent to which this subject – neglected in the past – is now being studied.

The sessions are grouped under the major subjects of production prospects, production problems, production policy and marketing policy.

Production Prospects

The sessions on prospects were concerned with current costs of production on farms and plantations and the relative profitability of other crops together with the implication of research findings on future production costs. The costs of production on plantations are generally higher than the price paid to farmers in West Africa so that the Marketing Board arrangement has to be modified for plantations if they are to survive. Studies in Ghana and Nigeria of the relative profitability of cocoa and other crops suggest that cocoa is at least as profitable for the small holder as other crops.

On farm practices one paper reviews the various new practices that farmers might employ but does not come to any very positive conclusion, while another paper seeks to prove that routine spraying against capsids is harmful and uneconomic. The results of widespread fertilizer trials in Nigeria have shown that fertilizer application is profitable, but as usual more studies are needed.

Production Problems

The two sessions under this title were concerned with land tenure, labour and other social problems.

One paper described a survey of land use in Ashanti which indicated that competition for land between cocoa and food crops has not yet reached a critical point, but will do so as population increases.

The various papers on land tenure failed to examine this question in depth. The present systems in Ghana and Nigeria which virtually prevent a market in land from developing, show signs of being a limiting factor on cocoa production and require investigation.

A paper on labour conditions in Ghana concluded that labour was short, wages were low and farmers' incomes inadequate 'to employ the necessary labour'. Other papers reiterate the theme that the famers' price should be raised for the general health of the cocoa-growing industry.

Production Policy

Some papers presented in this session pursued the question of producer price and expressed the view that farmers' prices have been too low. Production has been discouraged and other crops favoured. A detailed analysis of Ghana's cocoa supply by Merrill Bateman indicates that production has reached a peak and will decline unless there are technical changes which the farmers adopt.

Marketing Policy

The two sessions under this title dealt with internal and external marketing respectively.

The internal marketing session received papers describing various aspects of marketing within Ghana: the pros and cons of monopoly versus competition, the work of the co-operatives and the United Ghana Farmers Co-operative. These papers led to very lively discussion of a subject to which there is probably no final answer.

There was equally spirited discussion of the papers on the world cocoa market and the policies of producing countries towards it. There is not enough space here to summarise these papers.

The conference papers and a resume of discussion will be published by the Institute in March 1974. This volume will be a valuable one on a subject to which greater attention is bound to be paid in future.

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Born: Bedford, 1945. Received B.Sc. (Horticulture) from Wye College, London University in 1967 and M.Sc. also from Wye, in 1968. Joined the Overseas Development Administration on graduating in 1967 and has been a cocoa breeder with the British Research Team at C.R.I.G. since April 1969.

Cocoa Abstracts

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

December 1972

Goreux, L. M. Price stabilisation policies in world markets for primary commodities: an application to cocoa. In: Policies, planning and management for agricultural development, p. 486-501 (1971).
A linear as well as a non-linear model for the determination of world cocoa prices is presented. Policy objectives chosen are: increased export earnings, reduced fluctuations in price and earnings. Policy simulation is conducted in the field of production policies, surplus disposal measures, export and import levies, and international buffer stocks. Among the conclusions are that more use should be made of progressive export taxes, and that buffer stock agencies should not aim at pegging prices between pre-determined levels. Table. Graphs.

Sajoso. Korelasi antara hasil tjoklat dan tjurah hudjan. (Correlation between yield and rainfall). Madjalah Univ. Tpenderawasih 8, 14, p. 36-43 (1971).
A study conducted in W. Irian, Indonesia, showed the existence of a highly significant correlation between the yield of Amelonado cocoa and the amount of rainfall during a 4-week period recorded 7 months before harvest, or around 1 month before flowering. English summary. Tables. Graph. 14 refs.

Couprie, F. Etude de certains aspects de l'écophysiologie du cacaoyer liés à sa productivité en Ouganda. (Study of some aspects of the ecophysiology of cocoa connected with its productivity in Uganda). Café Cacao Thé 16, 1 p. 31-43 (1972).
The influence of meteorological factors on flushing, flowering, fruit setting, cherelle wilt, and yield of cocoa was studied for over two years in Uganda on the basis of daily observations of 55 trees situated in the vicinity of a meteorological station. The results explained why, in the climate of Uganda, cocoa grows vigorously and yields well at an alt. around 1,200 m which in most countries is too high for satisfactory crop development. English, German, and Spanish summaries. Tables. Graphs. 14 refs.

Roth, I., and Lindorf, H. Desarrollo y anatomía del fruto y de la semilla de Theobroma cacao L. (Development and anatomy of the fruit and seed of *Theobroma cacao*). Acta Bot. Venezuelica 6, 1-4, p. 261-95 (1971).
The anatomy of the cocoa fruit and seed in successive stages of their development is described in detail from material collected in Grenada and Venezuela. Figs. 6 refs.

Reynolds, S. G. (S. Pac. Regional College Trop. Agr., Alafua, W. Samoa). **Nutrition of cacao (*Theobroma cacao L.*) in the nursery in Western Samoa.** Café Cacao Thé 16, 1 p. 19-30 (1972).
In 4 trials comprising 39 treatments, conducted in Western Samoa, various fertilizers were added to the soil of plastic containers in which cocoa cuttings were raised from rooting until delivery. Of the several growth parameters determined, the number of new leaves and mortality were the most important. Some treatments resulted in a considerable improvement of growth; in general the slow-acting fertilizers used, viz. Magamp (a granular NPKMg formulation) and a blood and bone meal mixture, gave better results than soluble NPK fertilizer and urea. Addition of some coral sand to raise the pH is recommended. French, German, and Spanish summaries. Tables. Graphs. 21 refs.

January 1973

Berbert, P. R. Fontes, and Alvim, P. de T. (Div. Fisiol., Centro Pesquisas Cacau, C.P. 7, 45.600 Itabuna, Bahia, Brazil). **Fatores que afetam o índice de iodo da manteiga de cacau do Brasil.** (Factors affecting the iodine number of Brazilian cocoa butter). Rev. Theobroma 2, 1, p. 3-16 (1972).
The iodine number of cocoa butter from the Comum cocoa cv. in Brazil was found to be inversely related to the mean temperature during the development period of the pod; this means that a high temperature increases the degree of saturation of the fatty acids. The length of the fermentation period, the time interval between harvesting and pod breaking, the degree of maturity of the pod, the age of the tree, shade, and fertilizer applications appeared to have no effect on the iodine number. No differences in the mean iodine number were detected between beans of the Comum, Pará, Maranhao, and Catongo cv. grown in the same locality and harvested simultaneously. English summary. Tables. Graphs. 15 refs.

Adenikinju, S. A. (Dep. Agr., Univ. Reading, Reading, U.K.). **Effects of pod maturity on bean development, viability, mucilage content and seedling vigour in cacao.** Exp. Agr., 8, 2, p. 123-9 (1972).
Studies with hand-pollinated pods of the cocoa progeny C 77 × C 23, conducted in Nigeria showed that pod maturity based on pod-age significantly affected bean viability as well as leaf area and leaf number, height and girth of the seedlings produced. Beans taken from immature pods 15 weeks after hand pollination were 44–64 per cent viable, producing seedlings ready for transplanting after 20 weeks in the nursery. Beans obtained from 21 to 27-week-old mature pods showed a viability of 96–100 per cent, whereas beans from 13-week-old pods did not germinate. These data suggest that seed loss by black pod disease can be prevented by early harvesting prior to infection of immature pods at an age of at least 15 weeks. Tables. 9 refs.

Vello, F., et al. (Div. Genética, Centro Pesquisas Cacau, C.P. 7, 45.600 Itabuna, Bahia, Brazil). **Método simplificado para produzir sementes híbridas de cacau por polinização manual controlada.** (A simplified method of producing hybrid cocoa seeds by controlled manual pollination.) Rev. Theobroma 2, 1, p. 35-44 (1972).

In Bahia, Brazil, flowers of the white-seeded Catongo cocoa cv. were hand-pollinated with pollen from 13 purple-seeded clones. The Catongo flowers were not emasculated or protected against insects, but part of the staminodes was removed. The mean percentages of white seeds produced, indicating the incidence of natural pollination, were 10.1 in 1968, 14.9 in 1969 and 12.0 in 1970; monthly means fluctuated between 6 and 20 per cent. These low percentages suggest that protection against natural pollination is unnecessary when large numbers of hybrid seeds have to be produced for commercial purposes. English summary. Tables. 10 refs.

Rocha, H. Maia, and Machado, A. Dantas. (Div. Fitopatol., Centro Pesquisas Cacau, C.P. 7, 45.600 Itabuna, Bahia, Brazil). **Fatores ambientais associados com a "podridão parda" do cacaueiro.** (Environmental factors associated with black pod disease of cocoa). Rev. Theobroma 2, 1, p. 26-34 (1972).
Observations made in Bahia, Brazil, demonstrated that *Phytophthora* pod-rot of cocoa causes appreciable damage only from May to November, with a peak in July-August. The percentage of diseased pods was not closely correlated with the amount of rainfall, the temperature, or the relative humidity as isolated factors. It was, however, closely correlated with the number of rainy days or hours and with the moisture deficit of the air, a deficit below 3.5 mm Hg resulting in a high incidence of the disease. Removal of all shade trees reduced the percentage of diseased pods by about 40 per cent. English summary. Table. Graphs. 14 refs.

Egbe, N. E., and Owolabi, C. A. (Cocoa Res. Inst. Nigeria, Ibadan, Nigeria). **Quality of Nigerian commercial cocoa beans.** Turrialba, Rev. Interamer. Ciencias Agr. 22, 2, p. 150-5 (1972).
Results are reported of a cocoa bean quality survey conducted in Nigeria. During three consecutive seasons (October-May), samples of commercial beans monthly collected at different grading stations were analysed. Bean weight, shell percentage and fat content varied with the time of the year, although remaining within the limits set by manufacturers. The highest and lowest levels for bean weight, shell percentage and fat content occurred in the main and light crops, respectively. Spanish summary. Tables. Graphs. Map. 1 1refs.

February 1973

Tarjot, M. Etude anatomique de la cabosse de cacaoyer en relation avec l'attaque du Phytophthora palmivora. (Anatomical study of the cocoa pod in relation with attack by *Phytophthora palmivora*). Café Cacao Thé 16, 2, p. 123-34 (1972).
Studies conducted in the Ivory Coast showed that the structure of the epidermis, the stomatal density, and the anatomy of the pericarp of the cocoa fruit do not differ between trees resistant or susceptible to *Phytophthora* pod rot. The mycelium can always penetrate through the epidermis into the small-celled parenchyma beneath, causing cell necrosis. However, in resistant trees necrosis of parenchymatous cells occurs less rapidly and the further extension of the mycelium is retarded especially in the lateral direction. No such retarding effect is observed in places where the pod surface has been damaged be it ever so slightly. English, German, and Spanish summaries. Tables. Figs. Photos. 1 ref.

Lobo, M. J. de Sousa, et al. Aspectos da defesa fitossanitária do cacau armazenado em S. Tomé. III parte. (Aspects of the protection of stored cocoa beans against moulds and insects in Sao Tomé. Part III). Garcia de Orta 19, 1-4, p. 107-69 (1971).
Results are presented of a comprehensive study of cocoa bean storage, conducted in Sao Tomé by a team of investigators. The six chapters, written by different authors, discuss, respectively: methods to determine the moisture content of the beans, changes in the moisture content dependent on the relative humidity of the air, protection against such changes offered by jute and plastic bags, infection with the fungus *Monascus ruber*, the rate at which methyl bromide residues disappear after fumigation, and a design for a fumigation room. French and English summaries. Tables. Graphs. Figs. 3 p. coloured photos between p. 169 and 171. 38 refs.

Gouveia, A. J. Soares de, et al. (Brigada Estud. Def. Fitossanitária Prod. Ultramarinos Junta Invest. Ultramar, Lisboa, Portugal). **Aspectos da defesa fitossanitária do cacau armazenado em S. Tomé. IV parte.** (Aspects of the protection of stored cocoa beans against moulds and insects in Sao Tomé. Part IV). Garcia de Orta, 19, 1-4, p. 171-205 (1971).
Three chapters written by different authors present further results of studies on the storage of cocoa beans, conducted in Sao Tomé. They are concerned with: (1) improvement of storage facilities on plantations and proposals for legislation on the storage of various products: (2) the relation between the moisture content of the beans and the development of various fungal species; (3) the relative humidity of the air in warehouses and its effect on attack of cocoa beans by insects. Tables. French and English summaries. Graphs. Figs. 5 p. coloured photos between p. 189 and 191, 195 and 197. 20 refs.

Borges, J. Marcondes, and Pereira, V. de Paula. (Dep. Tecnol. Alimentos, Univ. Fed. Viçosa, Viçosa, Minas Gerais, Brazil). **Estudo preliminar sobre a conservação do mel de cacau.** (Preliminary study on the preservation of cocoa pulp). Rev. Ceres 19, 103, p. 195-9 (1972).
A limitation to the industrial processing of a jelly from the pulp surrounding the cocoa seeds is that the pulp loses its jelling power within 10 hours after pod breaking. It was found at Itabuna, Brazil, that sterilization of the pulp by boiling for 90 seconds will preserve its jelling power for 6-12 months. English summary. Table. 1 ref. See also ibid. p. 200-10; Borges, J. Marcondes. Novo tipo de caixa para quebra de cacau, com dispositivo para coleta de mel (A new type of cocoa pod breaking box allowing the collection of pulp). English summary. Photos.

Esenam, E. U. (Dep. Biol. Sci., Univ. Ife, Ibadan, Nigeria). **Banana as an important host for the black-pod disease pathogen.** J. W. Afr. Sci. Assoc. 16, 1, p. 13-6 (1971).
Investigations conducted in Nigeria, revealed that a local banana variety (*Musa paradisiaca* var. *sapientum*) commonly planted in cocoa plantations for shade and as a catch-crop may play a major role in harbouring black pod fungus (*Phytophthora palmivora*), in particular during dry seasons. Banana fruits only exhibited infection symptoms when they were overripe. It was also found that

banana flowers turned black and wilted after treatment with fungus culture spray; some flowers set but produced small fruits which appeared to be infected when overripe. It will be difficult to convince the farmers of the utility of removing banana from their cocoa plantings. 13 refs.

Youdeowei, A. (Dep. Agr. Biol., Univ. Ibadan, Nigeria). **Studies on the pattern of distribution of the cacao capsid, Sahlbergella singularis Hagl. in relation to light intensity in an isolated plot of cacao, Theobroma cacao L.** J. W. Afr. Sci. Assoc. 16, 1, p. 5-12 (1971).
Observations conducted weekly during 13 months at Gambari, Nigeria, on the distribution of the capsid *Sahlbergella singularis* within a cocoa plot and on cocoa trees showed that the degree of capsid infestation was significantly positively correlated with the light intensity in the plot measured at 1.35 m above the ground. The drastic reduction in capsid numbers observed during July-August may be due to rainwashing of nymphs from the trunks. It is also suggested that capsid build-up can be controlled by insecticidal spraying of trees surrounding light gaps in the canopy and by regular removal of chupons. Table. Graph. Figs. 11 refs.

March 1973

Muttscheller, R. W. (343 Witzenhausen, Steinstr. 19, W. Germany). **Selektion von Anpassungsformen von Theobroma cacao L., dargestellt an einem Versuch am K.A.T.R.IN., Ifakara, Tansania.** (Selection of adapted types of cocoa through a field trial at the K.A.T.R.IN., Ifakara, Tanzania). Tropenlandwirt 73, Apr., p. 31-58 (1972).
Information is presented on environmental conditions, cocoa production history, and cocoa types occurring in Tanzania. A field trial was established at the Kilombero Agricultural Training, Water Development and Research Institute to find cocoa types adapted to the relatively dry local conditions. The results obtained during a three-year period suggest that 4 out of the 24 cocoa types selected for this trial appear to be adapted and, hence, can serve as rootstocks for budgrafting fine-grade cocoa types under the prevailing climatic conditions. English summary. Tables. Photos. 17 refs.

Cabala-Rosand, F. P., and Santana, B. M. (Setor Fertilidade, Div. Solos, Centro Pesquisas Cacau, Itabuna, Bahia, Brazil). **Comparação de extratores químicos de fosforo em solos do sul da Bahia.** (Comparison of chemical extractors of phosphorus in soils from southern Bahia). Turrialba. Rev. Interamer. Ciencias Agr. 22, 1, 19-26 (1972).
Available P in 10 cocoa soils of southern Bahia, Brazil, was determined by five methods. Cocoa seedlings grown in two soils relatively rich in available P and in two soils with low contents did not respond to P fertilizer; marked responses were shown by plants grown in four other soils. On the whole, the quantity of P extracted decreased in the order: Truog, modified Olsen, normal Olsen, Egner-Riehem, and Mehlich method; critical values for these methods in the same order were estimated at 10, 8, 8, 6, and 5 ppm. The dry-matter production of the aerial parts showed a high correlation with P extracted for each method; the dry-matter production of the root system showed no such correlation. English summary. Tables. Graphs. 25 refs.

Santana, Ch. J. L. de, and Igue, K. (Sector Fertilidade Div. Solos, Centro Pesquisas Cacau, Itabuna, Bahia, Brazil). **Formas de micronutrientes em solos da região cacaueira da Bahia.** (Forms of micronutrients in soils of the Bahia cocoa belt.) Turrialba, Rev. Interamer. Ciencias Agr. 22, 1, p. 73-80 (1972).
In each horizon of eight cocoa soils from southern Bahia, Brazil, the total concentrations of five micronutrients were determined by two methods and the available concentrations by four methods. In general, concentrations decreased in the order Fe, Mn, Zn, Cu and Mo. Only traces of available Mo were detected. Concentrations of Zn, Cu, and Mn decreased and those of Fe and Mo increased with increasing depth. Concentrations of Zn, Cu, Mn and Fe within some soils were positively correlated with organic matter contents. Positive correlations with clay content were found in some soils for Cu, total Mn, and total Mo, negative correlations for Fe and available Mn. English summary. Tables. 25 refs.

Atanda, O. A. (Gambari Exp. Stat., Cocoa Res. Inst. Nigeria, P.M.B. 5244, Ibadan, Nigeria). **Correlation studies in Theobroma cacao L.** Turrialba, Rev. Interamer. Ciencias Agr. 22, 1, p. 81-9 (1972).
Correlations between growth measurements of cocoa seedlings, between growth and yield, between yields at various ages, and between seed characters and climatic factors were computed from experimental data obtained in Nigeria, in order to establish methods of early selection for yield and selection criteria. It was found, *inter alia*, that the girth of young seedlings is a good indication of their future performance, and that the potential yield of a tree can be fairly accurately predicted from its yield over the first five years of general fruiting. The results need not be valid for all cocoa types under all conditions. Spanish summary. Tables. 43 refs.

Dominguez R., P. F. (Fac. Agron., Univ. Central Venezuela, Maracay, Venezuela). **Avance del trabajo sobre seleccion de plantas de cacao (Theobroma cacao L.) por resistencia al hongo Ceratocystis fimbriata.** (Progress of work on the selection of cocoa plants for resistance to the fungus *Ceratocystis fimbriata*). Rev. Fac. Agron., Venezuela 6, 2, p. 5-29 (1971).
Selfed progenies of five Criollo cocoa clones selected in Venezuela for their yield were found to contain very few plants resistant to *Ceratocystis fimbriata*; in reciprocal crosses of two of these clones with the resistant clone Pa 12, over 40 per cent of the plants were resistant. Susceptibility to the fungus was assessed by inoculating bark strips from the stems of six-month-old seedlings and incubating them for 72 hours. A programme of breeding and selection for high yield and quality combined with resistance to *C. fimbriata* is outlined. English summary. Tables. Graphs. Fig. Photos. 23 refs.

Atanda, O. A. (Cocoa Res. Inst. Nigeria, Ibadan, Nigeria). **Growth analysis of F3 Amazon and West African Amelonado seedlings under nursery conditions.** Nigerian J. Sci. 5, 1, p. 45-59 (1971).
In Nigeria, the growth of F3 cocoa seedlings over a period of 50 weeks was analysed, comparing Amazon and Amelonado seedlings. The main conclusion was that the superior growth of F3 Amazon over Amelonado seedlings is due to the more rapid increase and bigger size of their photosynthetic system, viz. the leaf area, rather than to the photosynthetic efficiency of their leaves; dry matter production rate, at least in cocoa seedlings, can be best improved by increasing the rate of leaf area development. Tables. Graphs. 24 refs.

Asomaning, E. J. A., and Hutcheon, W. V. Boron deficiency in cocoa. Ann. Rep. Cocoa Res. Inst., Counc. Scient. and Industr. Res. 1969-70, p. 160-4 (1972).
Results of a small-scale pot experiment recently conducted in Ghana, confirmed the earlier obtained finding that formation of distorted pods in cocoa trees is at least partly caused by B deficiency. Reasons for lack of response to regular B application to the soil as experienced at Tafo are not yet quite clear. Another small field experiment was discontinued after it became clear that recordings could not explain the phenomenon observed that particular trees produce excessive numbers of distorted pods. Tables.

April 1973

Vernon, A. J. (Res. Div., Dep. Agr., Suva, Fiji). **The estimation of annual yield of experimental plots of cocoa from sample picks.** Fiji Agr. J. 33, 2, p. 41-6 (1971).
In Fiji, the possibility ofestimating annual yields of cocoa experiment plots from the records of sample picks (every other, every 3rd, or every 4th pick) was studied by simulating such sampling on four sets of annual yield records of cocoa experiments. The sampling errors (particularly of alternate-pick sampling) were small compared with experimental error, suggesting that in appropriate circumstances (eg. extensive manurial trials on small-holdings) a substantial reduction in recording costs, or increase in precision, may be achieved at the expense of a modest increase in replication. Author's summary. Tables. Graph. 3 refs.

Collingwood, C. A. Cocoa in West Africa: the economics of pest control. Span 15, 2, p. 74-7 (1972).
Five years ago overall losses for the African cocoa crop were estimated at 15 per cent attributable to insect pests and 20 per cent originating from fungal and virus diseases. In this article losses are considered in some detail, with particular reference to Ghana. Costs of practicable control measures (where they exist) for some of the more important pests and diseases are discussed. French, Spanish and German summaries, on p. 98, 100, 102-3. Table. Graph. Photo. 20 refs.

June 1973

García B., J. and Montoya Maquin, J. M. (Inst. Interamer. Ciencias Agr. OEA, Turrialba, Costa Rica). **Relacion entre la magnitud de excesos hídricos y la produccion de cacao (Theobroma cacao) en Turrialba, Costa Rica.** (The relation between excess of soil water and cocoa yields in Turrialba, Costa Rica). Agron. Trop., Venezuela 22, 1, p. 57-66 (1972).
Yields of a cocoa field near Turrialba, Costa Rica, over 1963-70 were closely correlated with annual soil moisture excesses, a maximum yield corresponding to a moisture excess of 1,855 mm. Average monthly soil moisture excesses and excesses in the critical months of August and December (the main flowering periods) over 1944-70 were computed by a modification of Thornthwaite's method and adjusted by harmonic analysis. The August excess has a greater effect on the yield than the December excess. At Turrialba, all months show soil moisture excesses, from 40 mm in March to 276 mm in December. English summary. Table. Graphs. 10 refs.

Arévalo, R., A., et al. (Univ. Amazonia Peruana, Iquitos, Perú). **Determinacion de los genotipos de incompatibilidad o compatibilidad en varios clones de cacao.** (Determination of the incompatibility or compatibility genotypes in various cocoa clones). Rev. Theobroma 2, 2, p. 33-8 (1972).
At Turrialba, Costa Rica, diallel crosses were made between seven cocoa clones known to possess certain genes for compatibility, and the clones Pound 7, Pound 12, Catongo, SPA.9, UF.29, and UF.68 whose compatibility relations were unknown. Genotypic formulae for these six clones in terms of the S-alleles and the A-B system of Cope were postulated on the basis of the percentage of cherelles remaining on the trees ten days after hand-pollination. English summary. Tables. 7 refs.

Situmorang, S. Pengudjian primer beberapa klon kakao. (Primary test of some cocoa clones). Menara Perkebunan 40, 1, p. 3-5 (1972).
Testing of 3 series of cocoa clones, viz. GC, DRC and KWC, at Kaliwining Experimental Garden in Java, Indonesia, showed that many clones yielded as well as or better than the control clone DR2, a clone which has been recommended for large-scale planting since 1931. Commercial testing should now be undertaken to determine which clones can be recommended to growers. From author's English summary. Table. Photos. 3 refs.

Ghosh, B. N., and Silva, P. Algumas observaçoes sobre armazenagem de cacau no Brasil. (Some remarks on cocoa storage in Brazil). Cacau Atualidades 9, 1, p. 11-21 (1972).
Measures to prevent deterioration of cocoa bean quality before and during storage are outlined. Subjects discussed include causes of deterioration, the moisture equilibrium of the beans, the environmental requirements and control of the storage insects occurring in Bahia, Brazil, and the design and heating of stores. Normally, beans are stored for up to one month at the farm, for up to several months in buyers' warehouses, and for up to 15 days in the port of Ilheus; special measures have to be taken in years when prolonged storage is necessary. Most stores, in particular those in and around Ilheus, are old and urgently in need of improvement. Tables. Graph. Fig. Map. 7 refs.

Ram, C., et al. (Div. Fitopatol., Centrol Pesquisas Cacau. Caixa Postal, 7.45.600, Itabuna, Brasil). **Novo tipo de podridão do fruto de cacau na Bahia.** (A new type of cocoa pod rot in Bahia). Rev. Theobroma 2, 2, p. 3-9 (1972).
A new type of soft rot of cocoa pods was observed in 1972 in several localities in the Bahia, Brazil, cocoa belt. Dark brown patches with a sunken centre later coalesced until the whole pod surface was affected; finally the seeds were attacked as well. The pathogen was identified as a *Macrophoma* sp.; inoculation tests showed that all local varieties are susceptible. A similar disease has been reported from the Cameroon Rep. Laboratory tests indicating that 500 ppm a.i. of maneb or mancozeb are effective against the fungus. English summary. Table. Fig. Photos. 2 refs.

Rocha, H. H., et al. (Div. Fitopatol., Centro Pesquisas Cacau, Caixa Postal, 7.45.600, Itabuna, Brasil). **Controle de podridão parda do cacaueiro.** (Control of black pod disease of cocoa). Rev. Theobroma 2, 2, p. 15-26 (1972).

Trials on the control of *Phytophthora* pod rot of cocoa in Bahia, Brazil, indicated that the usual number of four sprayings a year can be reduced to two; spraying with copper hydroxide resulted in 10 per cent more pods than spraying with cuprous oxide. Other trials showed that dusting with copper fungicides is less effective than spraying; however, a copper hydroxide dust gave a fair amount of control. Inoculation tests with 67 clones confirmed that SCA.6, SCA.16, several Catongo clones, and a few other clones are fairly resistant to *Phytophthora*; tests of their progenies indicated that resistance is due to dominant genes. English summary. Tables. Graphs. 12 refs.

Smith F., H. As principais pragas do cacaueiro no Estado do Espirito Santo, Brasil. (The main pests of cocoa in the State of Espirito Santo, Brazil). Cacau Atualidades 9, 1, p.22-7 (1972).
The Brazilian State of Espirito Santo has 20,000 ha of cocoa along river banks, producing 7,500 tons of beans a year. In the humid tropical climate with a dry winter season, yields are limited by the attacks of many indigenous and introduced insect species. The main pests of cocoa and their control are briefly discussed; included are the weevil *Cosmopolites sordidus* damaging bananas planted as temporary shade, and the moth *Terastia meticulasalis* which attacks *Erythrina glauca* trees used as permanent shade trees. Table. 6 refs.

July 1973

Oni, S. A. (Dep. Agr. Econ. and Ext., Univ. Ibadan, Ibadan, Nigeria). **Estimating supply responses via producer panel approach – a case study of western Nigeria cocoa farmers.** Indian J. Agr. Econ. 27, 2, p. 56-66 (1972).
The present policy of the Western Nigerian government is to encourage new cocoa plantings in the Ondo and Oyo provinces and rehabilitation of old plantations in the Ibadan, Abeokuta and Ijebu provinces. In view of the tremendous farmers' response and the availability of large areas for new plantings, the Ondo province appears to possess the greatest potential for cocoa expansion under the new planting programme. The potential for expansion is also great for the Oyo province. However, for the Ibadan, Abeokuta and Ijebu provinces, new plantings are very marginal; consequently, efforts should be directed at rehabilitating the old cocoa trees in these areas. Tables. Refs. in footnotes.

Jadin, P. Etude de la fertilisation minérale des cacaoyers en Cote d'Ivoire à partir du diagnostic "sol". (Study on the mineral fertilizing of cocoa trees in the Ivory Coast on the basis of soil diagnosis). Café Cacao Thé 16, 3, p. 204-18 (1972).
In the Ivory Coast, research is being conducted on relations between cocoa yields and chemical soil characteristics. Results of studies reported here concern: (1) the effects of balances in the soil between pH-N-exchangeable bases, pH-K-Ca-Mg, and N-P on cocoa yield; (2) field trials on the effect of 12-15-18 fertilizer mixture on growth and development of cocoa conducted in an attempt to find confirmation of the findings of the correlation studies; and (3) tests on fertilizer mixtures composed on the basis of soil analysis for obtaining an optimum equilibrium between exchangeable bases and N at a given pH, and on the other hand between exchangeable bases (K-Ca-Mg). English, German and Spanish summaries. Tables. Graph. Map.

Oyebade, I. T. (Cocoa Res. Inst. Nigeria, P.M.B. 5244, Ibadan, Nigeria). **A comparative growth analysis study of four cacao varieties.** Turrialba. Rev. Interamer. Ciencias Agr. 22, 3, p. 275-81 (1972).
In Nigeria, the initial growth of cocoa seedlings was studied over a period of 26 weeks and compared in four varieties. The results were assessed in terms of fortnightly leaf production, leaf area, stem height and fresh and dry weight determinations. The differences between the varieties were small but significant. A few points in the discussion suggest that further research is needed before cocoa breeders can eventually use this technique of productivity forecasting. Spanish summary. Tables. Graphs. 14 refs.

Sundaram, S. A comparison of direct seeding with transplanting of cocoa. Turrialba, Rev. Interamer. Ciencias Agr. 22, 3, p. 354-7 (1972).
To clarify the relative merits of direct seeding and transplanting in cocoa establishment, field trials laid out at three different localities in Fiji have shown so far that at two localities directly sown (1·5 × 1·5 m) Amelonado seedlings at an age of 1 to 2 years had better developed as compared to nursery plants of equal age transplanted at 3 × 3 m spacing. At the third site no difference between the two methods of cocoa establishment was observed. Spanish summary. Tables. 11 refs.

Soedarsono, and Soenarjo. (Balai Penelitian Perkebunan Bogor, Djember, Java, Indonesia). **Djarak tanam sempit pada tanaman tjoklat (kakao).** (Close spacing of cocoa). Menara Perkebunan 40, 3, p. 95-100 (1972).
Results of a spacing and thinning trial on cocoa, carried out in Central Java, Indonesia, showed that the highest yield has been obtained with the closest spacing. There are no differences in tree growth and in the incidence of *Phytophthora* pod rot between the different spacings. Furthermore, close spacing leads to a rapid formation of a dense canopy, enhancing the early suppression of weeds. Because of less requirement of shade trees, the difficulties in regulating shade intensities at transitional seasons of the year can be avoided. Maintenance costs will be reduced, indirectly resulting in a reduction of the cost price. Four spacings varying from 4 × 4 m to 4 × 2 m were compared. English summary. Tables. 11 refs.

Trocmé, O. Contribution à l'étude d'une maladie du cacaoyer en Ouganda: le dessechement éco-fongique des branches. (Contribution to the study of a disease of cocoa in Uganda: the eco-fungic drying-up of branches). Café Cacao Thé 16, 3, p. 219-35 (1972).
This report of studies conducted in Uganda since 1967 on a disease in cocoa characterised by drying-up of branches, includes: (1) a description of the symptoms; (2) observations on causative fungi possibly involved; (3) experimental work which confirmed *Verticillium dahliae* or *V. albo-atrum* to be the responsible fungus; and (4) assessment of ecological conditions which favour disease incidence. The slight virulence of the fungus concerned and other observations do suggest that physiological conditions of cocoa trees conditioned by the environment play a major role in disease manifestation. English, German and Spanish summaries. Tables. Graphs. Photos. 15 refs.

Ehsanullah, L. Controlling capsids in cacao. World Farming 14, 10, p. 8-10 (1972).
A brief account is given on the control of capsids, mainly *Sahlbergella singularis* and *Distantiella theobroma*, a major pest of cocoa in W. Africa. Maintaining a closed canopy and the planting of Amazon cocoa and Amazon hybrids reduce infestation, but chemical control is more effective, in particular when gang spraying is done at time of maximum capsid build up, using powerful mist-blowers with a reach of at least 8-9 m. BHC is still the best and cheapest pesticide. For areas where capsids have developed resistance to it, other chemicals are to be used, such as propoxur and 0.5353. The green shield bug (*Bathycoelia thalassina*) has become a major pest, probably as a result of insecticidal treatment. Table. Photos (one coloured).

Benizé, N., et al. (Lab. Chimie-Technol. IFCC, Nogent-sur-Marne, France). **Le "white spot" des fèves de cacao.** (White spot of cocoa beans). Café Cacao Thé 16, 3, p. 236-42 (1972).
Investigations were conducted in France, using samples of over-fermented beans, on the exact nature of white spot in cocoa beans ("fèves beurrées") and on its effect in the manufacturing of and on organoleptic characteristics of chocolate products. It has become apparent that: (1) the white spots mainly consisted of theobromine; and (2) rheological properties of paste from affected beans were changed, but not the organoleptic properties. The correlation between occurrence of white spot and climatic conditions remains to be clarified. English, German and Spanish summaries. Tables. Graphs. Photos. 7 refs.

August 1973

Essang, S. M. Impact of the marketing board on the distribution of cocoa income in Western Nigeria. Nigerian Geogr. J. 15, 1, p. 35-47 (1972).
A study of incomes in a sample of cocoa farmers and licensed buying agents (LBA) revealed that: (1) the operations of the marketing board have resulted in income transfer from the relatively poorer rural farmers to the more affluent urban areas, thus widening the rural-urban income gap; (2) the LBA have received a substantial proportion of this income transfer; (3) the distribution of the income received by both LBA and the cocoa producers is highly unequal; and (4), in the case of the producers, the inequality of income is a consequence, in part, of LBA who get a disproportionately high share of total cocoa income of the sample. Tables. Graphs. Map. 17 refs.

Quesnel, V. C. Quimica y tecnologia de la cura del cacao. (Chemistry and technology of cocoa processing). Cacao, Bol. Inform. 8, 2, p. 1-17 (1971).
Text of a lecture delivered at a conference on cocoa technology and trade held at Caracas, Venezuela, in April 1971. Successive sections discuss the components of chocolate flavour and their development during roasting, the chemical composition of the cotyledons, chemical changes in the bean during fermentation, the practical control of aeration with special reference to box fermentation, methods of curing small amounts of beans, and drying methods. Fig. 18 refs.

Fordham, R. (Univ. W. Indies, St. Augustine, Trinidad). **Effects of soil moisture and atmospheric humidity.** Ann. Rep. Cacao Res. 1971, p. 28-38 (1972).
In Trinidad, cocoa cuttings were grown for 31 weeks in conditioned rooms at relative humidity (r.h.) values of 45-50 and 90-100 per cent, combined with three levels of soil moisture deficit. Flushing was most intense and the increase in leaf area was greatest in the wettest soil, more or less independent of the r.h. Flowering also increased with available soil moisture, but was reduced by the higher r.h.; ion uptake was likewise reduced by high r.h. Leaf wax formation was more abundant at the higher r.h. Tables. Graphs. Photos.

Besse, J. Comparaison de deux méthodes d'établissement de cacaoyéres. (A comparison of the two methods of cocoa establishment). Café Cacao Thé 16, 4, p. 317-32 (1972).
Cocoa planting between natural regrowth on cleared forest land is described and compared with establishment under managed forest. Advantages and disadvantages of the two methods are considered with respect to land preparation, planting, field operations, harvesting and mechanisation, growth, physiology and longevity of the crop, sanitary conditions, and field research. Results are presented of field trials conducted in the Ivory Coast on the impact of establishment methods both on yield and pod rot losses due to *Phytophthora palmivora* for different clones and hybrids and on the variance coefficient in field experiments. English, German and Spanish summaries. Tables. Graphs. Photos. 10 refs.

Owusu-Domfeh, K. (Animal Res. Inst., P.O. Box 20, Achimota, Ghana). **The future of cocoa and its by-products in the feeding of livestock.** Ghana J. Agr. Sci. 5, 1, p. 57-64 (1972).
This is a review article summarising the results of investigations on the nutritive value of cocoa and its by-products, and the problems involved in their utilisation as feed for livestock. It is suggested that further work should be conducted with the aim of developing cocoa products which are suitable for livestock feeding. It is concluded that cocoa and its by-products can be an excellent source of protein and energy for livestock, especially ruminants, but because of the theobromine content which is toxic to animals, it is necessary that the theobromine be first extracted. Alternatively, the cocoa products should be fed in very limited quantities. Author's summary. French summary. Tables. 23 refs.

Tarjot, M. Contribution à l'étude du comportement des feuilles de cacaoyer envers le Phytophthora palmivora. (Contribution to the study of the behaviour of cocoa-tree leaves towards *Phytophthora palmivora*). Café Cacao Thé 16, 4, p. 333-8 (1972).
The testing for resistance of cocoa trees to *Phytophthora palmivora* by leaf inoculation instead of pod inoculation is considered. The variation in the susceptibility to *Ph. palmivora* of cocoa leaves of different age, during different seasons and under different light conditions preliminarily studied in the Ivory Coast appeared to be different from those observed in cocoa pods. English, German and Spanish summaries. Tables.

Dakwa, J. T. (Cocoa Res. Inst., Tafo, Ghana). **Occurrence of mealypod disease of Theobroma cacao in Ghana.** Plant Disease Reporter, USDA 56, 11, p. 1011-3 (1972).
Mealypod disease of *Theobroma cacao* is caused by the fungus *Trachysphaera fructigena*. Isolation of the fungus from suspected mealypod lesions showed that the disease is more common on cocoa in Ghana than has hitherto been indicated. It was observed in different parts of the cocoa-growing areas in the Eastern Region between June and November 1971, but not from December 1971 to April 1972. In the survey the disease, wherever found, was associated with wounds, particularly those caused by rodents. Table. 16 refs.

Scheu, J. J. Los cacaos finos y el mercado norteamericano. Perspectivas y posibilidades para su desarrollo. (Fine cocoas and the North American market. Prospects and possibilities for its development). Cacao, Bol. Inform. 8, 3, p. 1-25 (1971).
The market for flavour cocoa from Criollos and Trinitarios in the U.S.A. is described, and price-forming discussed at some length. Because increasing prosperity leads to a switch from chocolate bars to quality chocolate creams, the demand for flavour cocoa is expected to expand. Owing to its higher shell percentage and lower butter content, its price is not much higher or even lower than that of ordinary cocoa but is much more stable. On account of this price stability, Venezuela would do well to concentrate on the growing of flavour types.

September 1973

Pérez Zamora, A., et al. Programa de mejoramiento genético de cacao en Venezuela. (Programme of genetic improvement of cocoa in Venezuela). In: Publicaciones cientificas sobre cacao, chapter 1, p. 1-32 (1972).
This progress report of the cocoa breeding and selection programme initiated in Venezuela in 1959 presents lists of introductions and local selections, yield and/or growth data of clones and progenies obtained in comparative trials, and results of tests for resistance to witchbroom, *Ceratocystis* and gall-forming fungi. The progenies investigated comprise crosses within the Criollo type and hybrids between Criollo, Trinitario and Amazon clones. The value of some clones as parents is assessed; IMC-67 was found outstanding with respect to yield, bean size, and resistance to diseases. An introductory section presents data on the main cocoa types and prevalent diseases in the principal cocoa-growing zones. Tables. 8 refs.

Asare-Nyako, A., et al. (Cocoa Res. Inst., P.O. Box 8, Tafo, Ghana). **Nursery diseases of cocoa in Ghana. 1. Pre- and post-emergence deaths of seedlings caused by Phytophthora palmivora.** Ghana J. Agr. Sci. 5, 2, p. 127-33 (1972).
The incidence of pre- and post-emergence deaths and the blight of seedlings caused by *P. palmivora* in nurseries is reported. The disease occurred whether seedlings were planted directly on harrowed seed beds or in plastic potting bags. Crosses involving clones known to be resistant to black pod in the field (eg. SCA.6, Pa 7, T 79/501) were little affected, but clones known to be highly susceptible (e.g. Na32) were heavily diseased. Kocide at a concentration of

0.91 kg in 45 l of water was found to control pre- and post-emergence seedling deaths when applied as a seed dressing and a soil drench. Author's summary. French summary. Tables. Photos. 11 refs.

Lopez Neto, A. S., and Aguirre, J. A. Costos de replantacion de cacao. (The costs of replanting cocoa). Proc. Trop. Region Amer. Soc. Horticult. Sci. 15, p. 31-48 (1971; received 1973).
In an experiment conducted in Costa Rica, the cost and benefits were determined of replanting old cocoa groves. The groves were 12 ha in extent and managed by two men. Old trees and shade trees were cut down and new trees of high-yielding varieties were planted. It was concluded that 1.5 ha was about the maximum area that could be replanted yearly. The average cost was C$ 6,520.75/ha. (US$ 1 = C$ 6,62). Shading of the trees is not recommended. Tables. Graph. 4 refs.

Reyes, E. H., et al. Efecto de dos especies de Erythrina – glauca y poeppigiana – sobre la produccion de 10 híbridos biclonales de cacao. (Effect of two *Erythrina* spp. – *glauca* and *poeppigiana* – on the yield of ten biclonal cocoa hybrids). In: Publicaciones cientificas sobre cacao, chapter 3, p. 1-15 (1972).
In a trial established in Venezuela in 1961, progenies of crosses between five local Criollo cocoa selections and SCA-6 and SCA-12 were planted at a spacing of 4 × 4 m under shade of two *Erythrina* spp. at 12 × 12 m. In the first nine productive years, the plots under *E. glauca* yielded 29 per cent less than those under *E. poeppigiana*, which intercepted a smaller proportion of the solar radiation. The relative difference reached a maximum in 1966-68 and decreased after half of the *E. glauca* trees had been removed in 1968. Tables. 9 refs.

Reyes, L. C. de, et al. "La mancha de agua" des las mazorcas de cacao en Venezuela. ("Watery spot" of cocoa pods in Venezuela). In: Publicaciones cientificas sobre cacao, chapter 5, p. 1-13 (1972).
In Venezuela, the fungus *Phytophthora megasperma* causing the watery spot disease of cocoa, damages more pods that other *Phytophthora* spp. or *Colletotrichum* but fewer than *Monilia*. A detailed description is presented of the symptoms of the disease and the morphology of the pathegen. Inoculation of wounded stems, bark pieces, leaves, and pods confirmed the pathogenicity of the fungus. Resistant, moderately susceptible and highly susceptible clones and progenies were found among Criollo, Trinitario and Amazon types of cocoa. Spraying with a copper fungicide appeared to give satisfactory control. Tables. 10 refs.

Pereira, C. Peixoto. (Centro Processamento Dados, CEPEC, Itabuna, Brazil). **Tamanho de parcela e numero necessário de repetiçoes em experimentos de produção com cacaueiros.** (Plot size and required number of replications in cocoa yield trials). Rev. Theobroma 2, 4, p. 3-7 (1972).
Calculations based on individual tree yields from cocoa fields in Bahia, Brazil, indicated that a progeny trial with uniform spacing and a regular shade canopy of *Erythrina glauca* should have at least nine trees per plot and five replications; yield differences of 20 per cent could be detected with this arrangement. A trial in a less evenly planted commercial field shaded by several tree species was

found to require at least fourteen trees per plot and six replications, this arrangement permitting yield differences of 30 per cent to be detected. It made no difference to the precision of the first trial whether yields were expressed in numbers of pods or in weight of wet beans. English summary. Tables. Graphs. 8 refs.

Ghosh, B. N. (Agr. Engineering Div., CEPEC, Itabuna, Brazil). **Engineering aspects of cocoa drying in Brazil.** Rev. Theobroma 2, 4, p. 23-37 (1972).
The general principles of cocoa bean drying are discussed with emphasis on the physical properties of the beans which affect drier designs, and on the dehydration rate. Types of drying installations commonly found in Brazil are briefly described. New approaches to the problem, all of them still in the experimental stage, are: (1) reinforced plastic covers for drying platforms; (2) a drier consisting of platforms with a glass roof combining drying by solar and artificial heating; (3) replacement of wood as fuel by propane-butane gas; (4) freeze-drying; and (5) a tunnel drier. Portuguese summary. Graph. Photos. 20 refs.

October 1973

Mamangkey, F. J. Th. Systeem pangkasan jang rationeel pada tjoklat di Djawa – Timur. (A rational pruning system in cocoa in E. Java). In: Budidaja kopi – tjoklat; djilid satu (I). 3, p. I-V, 1-24 (1971; received 1973).
The pruning system used in cocoa in E. Java. Indonesia, is described. Merits and demerits of pruning cocoa trees are discussed. Practical experiences have shown that for E. Java conditions and for the planting material used there, fruit production is greatly influenced by rational and systematic pruning. Tables. 14 refs.

Soenarjo. (Balal Penelitian Perkebunan Tjab. Djember, Djember, Java, Indonesia). **Pertjobaan pemupukan N.P.K. pada tanaman tjoklat mude dengan djarak tanam jang sempit.** (NPK fertilizer experiments in close-spaced young cocoa planting). In: Budidaja kopi – tjoklat; djilid dua (II). 7, p. I-II, 1-14 (1971; received 1973).
On an estate in E. Java, Indonesia, two series of NPK fertilizer experiments were conducted in close-spaced young cocoa plantings without shade. Planting distances used were 2 × 2.5 m and 2.5 × 2.5 m, respectively. In combination, soil and leaf analyses were also taken. The results obtained so far indicated that for young cocoa most attention should be paid to N and Mg fertilizing. P and K contents in the leaves proved to be sufficient for good growing. Production data are yet to be collected. Tables. 15 refs.

Reyes, L. C. de, and Reyes, E., H. El género Phytophthora en el cultivo de cacao (Theobroma cacao L.) en Venezuela. (The genus *Phytophthora* in cocoa fields in Venezuela). In: Publicaciones cientificas sobre cacao, chapter 6, p.1-11 (1972).
Nine *Phytophthora* isolates from diseased cacao pods or seedlings were found to comprise the species *Ph. palmivora*, *Ph. parasitica*, *Ph. syringae* and *Ph. megasperma*. Inoculation trials showed that all four species are pathogenic to seedlings and pods, and that the degree of susceptibility of clones varies according

to the species of the pathogen. Characteristics of each species *in vitro* are briefly described. *Ph. megasperma* produces reddish-brown patches on the pods; the other three species produce similar dark-brown patches. All four species are also pathogenic to citrus. Tables. 17 refs.

Situmorang, S. (Balai Penelitian Perkebunan Tjab. Djember, Djember, Java, Indonesia). **Pemberantasan Helopeltis dengan berbagai majtam insektisida.** (*Helopeltis* control with various insecticides). In: Budidaja kopi – tjoklat; djilid tiga (III), 8, p. I-III, 1-15 (1971; received 1973).
Various insecticides for the control of *Helopeltis* in cocoa were tested in E. Java, Indonesia. They were applied between 18.00 and 22.00 hrs. in four sprayings with intervals of 7, 10 and 10 days between each spraying. Best results were obtained with 0·4 per cent Endrin 19·2 EC, followed by 0·5 per cent BHC spray and 0·2 per cent Basudin 60. No negative influence was observed on fruit setting, indicating that the insecticides did not harm *Forcipomyia* spp., the most important pollinating insects in cocoa flowers. The evening proved to be the most appropriate time for spraying. Tables. 23 refs.

Reyes, E. H. and Vivas, S., J. Caucagua – nuevo secador rustico de cacao. (The Caucagua, a new rustic cocoa drier). In: Publicaciones cientificas sobre cacao, chapter 8, p. 1-15 (1972).
In view of the high cost of concrete platforms in the interior of Venezuela, a simple and cheap cocoa bean drier has been designed that can largely be made from locally collected materials. It consists of a wooden frame covered with a sheet of transparent plastic, and a bamboo floor 1 m above the ground on which reed mats can be spread. Trials showed that the quality of cocoa dried with this apparatus is equal to that of beans dried on concrete. Appendixes. Tables. Graphs. 10 refs.

Vivas S., J. A., and Reyes E., H. Estudios concernientes al uso del fermentador Rohan en Venezuela. (Studies on the use of the Rohan fermentation system in Venezuela). In: Publicaciones cientificas sobre cacao, chapter 9, p. 1-18 (1972).
Trials in Venezuela showed that tray fermentation of cocoa beans can be improved by filling the lowest tray with sawdust instead of leaving it empty, and by turning the beans at 48 hour intrevals. The size of the tray made no difference when the thickness of the bean layer was equal. The number of trays in the pile should not be less than three and not more than five for optimum results. Trinitario and Trinitario × Amazon types required fermentation during six days while five days were sufficient for the Criollo × Amazon type. Tables. Graphs (7 p.). 11 refs.

November 1973

Soetardi. Biaja dan rentabilitas perusahaan tjoklat di Djawa Tengah dan Djawa Timur. (Costs and rentability of the cocoa culture in Central and E. Java). In: Budidaja kopi – tjoklat; djilid empat (IV). 12, p. I-III, 1-26 (1971; received 1973).
This article outlines Indonesia's role in the world cocoa market and analyses the

economic rentability of the Indonesian cocoa industry. Due to neglect during the last years, among others, because virtually no rejuvenation has been carried out, the present situation on most of the cocoa plantations in Central and E. Java is not favourable. However, it is calculated that under present Indonesian and world market prices, the cocoa industry in Central and E. Java, estimated to produce under optimum conditions about 780 kg/ha, could be economically very attractive. For optimal exploitation, a cocoa estate should plan a continuous rejuvenation programme. Appendixes. Tables. Graphs. 6 refs.

Barros Nieves, O. (I.C.A. Palmira, Valle, Colombia). **Comparacion de tres orígenes de semillas sexuales, en el rendimiento comercial del cacao.** (Comparison of the yields obtained with cocoa seeds from three different sources). Fitotecn. Latinoamer. 8, 3, p. 29-31 (1972).
In Colombia, the yields of cocoa plantations established from different seed material were compared. The types of seed used were: (1) seed from the best trees in a plantation; (2) seeds from clones; and (3) hybrid seed from controlled pollination. Trees from groups 1 and 2 showed a great variability in age of first bearing and yields, and did not produce a profit during the first four years of production. Trees of group 3 all yielded within three years after planting and gave a profit from the second year of production. English summary. Table. Graph.

Boyer, J. Cycles de la matiére organique et des éléments minéraux dans une cacaoyére camerounaise. (Organic matter and mineral element cycles in a Cameroon cocoa plantation). Café Cacao, Thé 17, 1, p. 3-24 (1973).
A study conducted in the Cameroon Rep. makes it possible to set up an annual balance of the major nutrients N, P, K, Ca and Mg in a plantation consisting of unshaded 30-year-old cocoa trees and to specify the existing relationships between the various components of the mineral balance; quantities of elements returned to the soil, quantities not returned, total quantities absorbed by the trees, and total reserves of the agricultural profile.This overall balance makes it possible to calculate the needs of the cocoa plantation as a function of its production level; it does not take into account, however, the distribution of needs throughout the year. English, German and Spanish summaries. Tables. Graphs. 37 refs.

Amponsah, J. D., and Asare-Nyako, A. (Cocoa Res. Inst. (C.S.I.R.), New Tafo, Ghana). **Glasshouse method for screening seedlings of cocoa (Theobroma cacao L.) for resistance to black pod caused by Phytophthora palmivora (Butl.) Butl.** Trop. Agr., Trinidad 50, 2, p. 143-52 (1973).
A new method for screening cocoa seedlings for resistance to black pod was developed in Ghana. Pre-germinated seeds are inoculated with a culture of the fungus. Seedling mortality at eight weeks appears to be related to the susceptibility of the parents to black pod in the field. Unlike previous methods for testing resistance, the new method may make possible the screening of large quantities of seedling progenies from clones with known field resistance, leaving relatively resistant seedlings for field planting. The method offers prospects for studying the genetics of black pod resistance. From authors' summary. Tables. Graphs. Photo. 31 refs.

Meza Sanoja, C. R., and Leon, V. (Cátedra Fitopatol, Fac. Agron., Univ. Zulia, Maracaibo, Venezuela). **Control quimico de la moniliasis y mancha de agua del cacao.** (Chemical control of *Monilia* and watery spot in cocoa). Rev. Fac. Agron., Univ. Zulia, Venezuela 2, 1, p. 17-29 (1972).
Results of field experiments conducted in Venezuela on the effect of four fungicides on the control of *Monilia* pod rot and watery spot diseases of unknown origin in cocoa showed that the fungicides Cupravit, Dithane M-45, Dithane Z-78 and Antracol were significantly effective in the control of *Monilia* pot rot only. Cupravit was superior to the other fungicides and thus is recommended to be used in 0·06 per cent concentration at the rate of 2·5 kg/ha and at a three-week spraying interval. English summary. Tables. Graphs. 13 refs.

Tarjan, A. C., et al. (Univ. Florida Agr. Res. and Education Centre, Lake Alfred, Florida 33850, U.S.A.). **Increasing yields of cacao by application of nematicides.** Turrialba, Rev. Interamer. Ciencias Agr. 23, 2, p. 138-42 (1973).
In Costa Rica, four nematicides were applied to the soil around cocoa trees in two fields infested by several genera of free-living nematodes, and in one of the fields by *Meloidogyne* as well. This resulted in a considerable improvement of the condition of the trees within a few months and in a yield increase over that of untreated plots during the year after treatment. It is, however, thought possible that the effect of the chemicals may partly be due to a systematic insecticidal and/or fungicidal action. Spanish summary. Tables. Graphs. 10 refs.

Situmorang, S. (Balai Penelitian Perkebunan Tjabang Djember, Djember, Java, Indonesia). **Usaha2 pemberantasan cacao mot pada tjoklat.** (Measures for the control of the cocoa moth in cocoa plantings). In: Budidaja kopi-tjoklat; djilid tiga (III). 9, p. I-III, 1-10 (1971; received 1973).
This article reviews the biology and life history of the cocoa moth *Acrocercops cramerella* and briefly discusses the two methods of control applied in Indonesia, viz. the mechanical and the chemical method. With the mechanical method, i.e. taking away all fruits at a given moment, the life cycle of the insect is interrupted; this method is still considered to be the best method for the moment. No satisfactory results have been obtained yet with chemical control using various insecticides. 11 refs.

Lass, R. A., and Wood, G. A. R. Cocoa in India. Planters' Chron 68, 5, p. 94-6 (1973).
A brief account is presented on some aspects of the cocoa industry in India, including possible future developments. Actually interest in cocoa is centred in the States of Mysore, Kerala and Tamil Nadu in southern India; the 1971-72 crop was estimated at 50 tons. Substitution of imports for the local industry is aimed at. Narrow spacing, planting under coconut palms, arecanut palms and thinned forest, irrigation, use of Forastero planting material, breeding and selection for drought resistance and assistance given to and response of farmers in cocoa planting are dealt with. Photos. 4 refs.

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