COCOA GROWERS' BULLETIN

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Contents

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EDITORIAL

In this issue of the Cocoa Growers' Bulletin, we have published a somewhat speculative article entitled "Towards the Use of Pathogenic Micro-organisms in the Control of Some Cocoa Insect Pests in Ghana" by Ato H.Brew of the Cocoa Research Institute of Ghana.

Many forms of biological control could perhaps be usefully studied in all cocoa growing environments where many similar opportunities might also exist. Such studies should really be part of the work programme of every department of entomology and every department of plant pathology in every Cocoa Research Station. Regrettably, there seems to be very little evidence that consideration of biological control methods for cocoa are being given the emphasis which they merit.

There are very few successful records of control of pests or diseases of the cocoa tree or it's temporary or permanent shade trees by biological methods described in the literature. The economic application of biological control could give opportunities for reduced pesticide usage as part of programmes of Integrated Pest Management. Additional research input to this important area of pest and disease control would now seem to be very necessary.

The Editor would welcome any further contributions for future issues which describe successful applications of biological control to manage pests and diseases on cocoa plants or on the temporary or permanent shade for young cocoa.

EDITOR'S NOTE: We are revising the mailing list for the Cocoa Growers' Bulletin and in the last issue there was a tear-off card to be returned by anyone who wished their names to be kept on the mailing list. A number of people have not yet returned these cards and so this will be the last issue which they will receive.

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R.A.LASS, EDITOR

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REVIEW OF PRODUCTION, CONSUMPTION, STOCKS AND PRICES

May 1991 - May 1992
S.A.Wakeling
Cadbury Limited

PRODUCTION

Our last review was based on Gill and Duffus Cocoa Market Report No.340, dated May 1991. In their latest Report No.343, dated May 1992, minor changes to the world crops from 1986/87-1989/90 have been made. A large upward revision (from Report No.340) to the West African 1990/91 crops has significantly changed the 1990/91 world crop from 2452 TMT to 2548 TMT *.

The forecast for the gross World crop of 1991/92 of 2261 TMT indicates a fall from 1990/91 of 11.3%. The major falls are forecast in West Africa and South America. West African production for 1991/92 in forecast at 1,229 TMT, a fall of 15% from 1990/91. The largest falls in percentage terms are in Nigeria (40%) and Ghana (18%). In Brazil the 1991/92 crop is forecast at 308 TMT, a fall of 18% from 1990/91. In Malaysia the 1991/92 crop is forecast at 215 TMT, down 4% on 1990/91. It is reported that in Malaysia and Brazil, the low world prices have forced farmers to cut back on inputs of ferilisers and pesticides. The only major producing country where an increase is expected is Indonesia. The forecasted falls are reportedly due to a combination of adverse weather and the effect of low prices.

CONSUMPTION

The Gill and Duffus Cocoa Market Report No.343 reports that the consumption of cocoa in countries other than the former Soviet Union has continued to show a good growth rate of 2.6%. Within the former Soviet Union grindings are forecast to fall to 25 TMT. This is a major fall in consumption. The grind of the former Soviet Union was 201 TMT in 1988/89.

The Gill and Duffus Cocoa Market Report No.343 reports that the grind of origin countries will decrease. The decline of butter ratios reduced the profitability of bean processing in Brazil. Brazilian grindings in the first half of 1991/92 fell by 21%. Estimates of grindings from West Africa for 1990/91 were revised downwards as new data became available. In Nigeria the enthusiasm for local processing appears to be easing. A year ago, fifteen new processing plants were planned. Now, it appears that only four or five new factories will be built.

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* TMT = Thousands Metric Tonnes.

WORLD COCOA PRODUCTION DATA

Reproduced from Gill and Duffus Market Report No.343
Dated May 1992
(all figures in thousand metric tonnes (TMT))

	1987/88	1988/89	1989/90	1990/91	1991/92*
Cameroon	131	129	125	117	100
Cote d'Ivoire	674	849	708	822	750
Ghana	188	300	295	293	240
Nigeria	150	160	170	170	100
Togo	9	9	6	9	8
Others	39	33	33	32	31
Total Africa	**1191**	**1480**	**1337**	**1443**	**1229**
Brazil	385	333	352	377	308
Colombia	59	50	50	57	50
Ecuador	77	87	101	106	90
Mexico	44	42	43	43	43
Peru	12	12	13	11	11
Venezuela	12	10	14	14	13
Others	9	10	12	10	10
Total C.& S.America	**598**	**544**	**585**	**618**	**525**
Dominican Rep.	53	43	57	42	44
Others	11	8	10	9	9
Total West Indies	**64**	**51**	**67**	**51**	**53**
Indonesia	65	102	120	155	180
Malaysia	227	223	241	225	215
Papua New Guinea	33	48	41	33	37
Others	19	22	21	23	22
Total Asia & Oceania	**344**	**395**	**423**	**436**	**454**
WORLD TOTAL	**2197**	**2470**	**2412**	**2548**	**2261**
% change in production from previous season	10.1	12.4	-2.4	5.6	-11.3

* **Forecast**

N.B **Some figures may not add due to rounding**

WORLD COCOA GRINDINGS DATA

Reproduced from Gill and Duffus Market Report No.343
Dated May 1992
(all figures in thousand metric tonnes)

	1987/88	**1988/89**	**1989/90**	**1990/91**	**1991/92***
Belgium	35	41	44	49	45
France	40	44	59	70	70
Germany (Fed.Rep.)	225	244	273	295	303
Italy	46	46	51	56	58
Netherlands	215	234	241	268	296
Spain	43	40	44	45	47
United Kingdom	100	112	120	144	152
Others	55	59	61	57	57
Total Western Europe	**759**	**820**	**893**	**984**	**1028**
Eastern Europe	93	105	92	78	78
USSR	132	201	106	83	25
Total E.Europe & USSR	**225**	**306**	**198**	**161**	**103**
Cote d'Ivoire	105	120	109	100	100
Others	71	65	68	70	63
Total Africa	**176**	**184**	**177**	**158**	**175**
Brazil	241	210	236	292	235
Colombia	46	41	45	48	46
Ecuador	35	36	44	51	45
Mexico	40	40	43	44	45
United States	241	237	265	265	309
Others	59	58	64	62	64
Total America	**662**	**622**	**697**	**762**	**744**
Japan	40	40	47	52	52
Malaysia	40	47	72	77	85
Singapore	40	46	52	51	50
Others	58	69	80	100	109
Total Asia & Oceania	**178**	**202**	**251**	**280**	**296**
WORLD TOTAL	**2001**	**2134**	**2217**	**2345**	**2346**
% change in grindings from previous season	5.0	6.7	3.9	5.8	0.0

* **Forecast**

N.B From 1990/91 Germany includes East and West Germany
Some figures may not add due to rounding

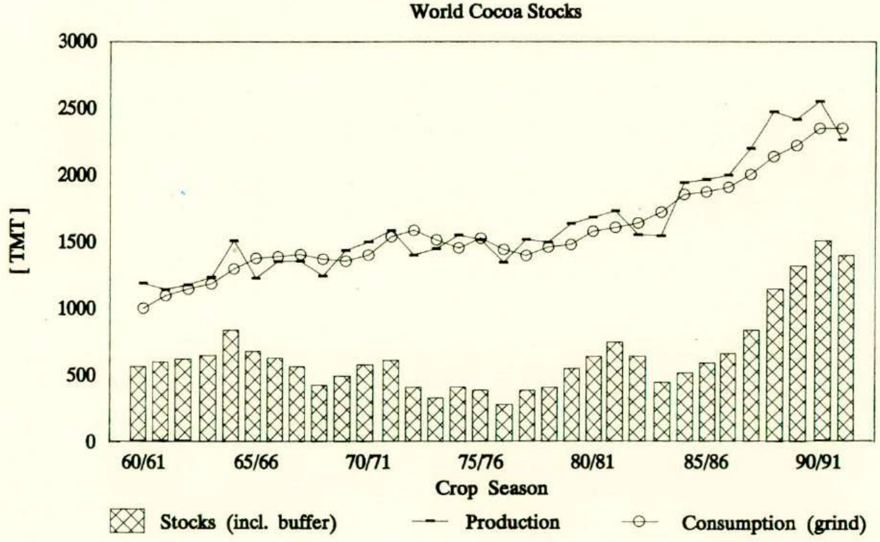
STOCKS

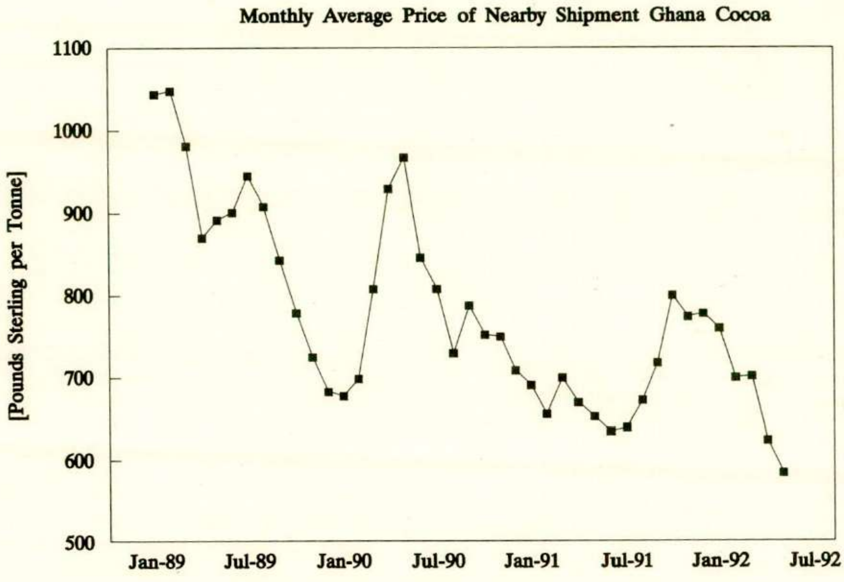
The Gill and Duffus Cocoa Market Report No.343 reports that 1991/92 will see the first deficit since 1983/84.

WORLD COCOA STOCK DATA

Reproduced from Gill and Duffus Market Report No.343
Dated May 1992
(all figures in thousand metric tonnes)

	1987/88	1988/89	1989/90	1990/91	1991/92
Closing stocks **(including buffer stock)**	840	1151	1322	1500	1393
Stock/consumption ratio **(including buffer stock)**	0.42	0.54	0.60	0.64	0.59





PRICES

The Gill and Duffus Cocoa Market Report No.343 reports that since January 1992 prices have declined by nearly 30%. Despite the first deficit since 1983/84, prices have remained low and recently touched 17 year lows. A number of factors have led to this decline:

* some manufacturers extended their cover when a larger deficit looked possible. They have allowed their cover to run down as the forecasted deficit became smaller.
* the sales position of the West African origins deteriorated and the expectation of imminent large sales depressed prices.
* speculative selling added to the downward momentum.

INTERNATIONAL COCOA AGREEMENT

The Gill and Duffus Cocoa Market Report No.343 reports that The Preparatory Working Group on a Fifth International Cocoa Agreement had successfully concluded its task and the first negotiating conference had been held under the auspices of UNCTAD. Both producers and consumers had agreed on the need for a co-ordinated production policy to be included in a new agreement. They also agreed that the buffer stock should be maintained with a maximum capacity of 250 TMT.

COCOA IN PENINSULAR MALAYSIA
I: THE EARLY HISTORY

J.K.C.Thong *, S.K.Ng *, H.S.H.Ooi * and K.Y.Leng *

This is a two part article, the concluding article by the same authors will appear in a future issue of the Cocoa Growers' Bulletin and will cover Soils, Cultivation and Processing of Cocoa in Peninsular Malaysia.

INTRODUCTION

Malaysia is already well known as the world's largest producer of palm oil and natural rubber. Cocoa, as an economic crop, is relatively new in this country and it is only in recent times that Malaysia has become an important producer of cocoa.

Cocoa, an indigenous crop of South and Central America (Cheesman, 1944; Cuatrecasas, 1964), was probably introduced into Malaya (now known as Peninsular Malaysia) by the Dutch in the 1700s, about 100 years earlier than oil-palm and rubber, which were brought into the country only in 1870 (Purseglove, 1977) and 1876 (Burkill, 1966) respectively. Cocoa's earliest presence in Malaya was reported in 1778 when it was found fruiting freely in the garden of a Portuguese widow in Malacca (Koenig, 1894). Although cocoa came to this country before its introduction to West Africa [ie. into Ghana from Fernando Po in 1879 (Swarbrick et al., 1964)], it generated little interest at that time and the initial plantings, up to the early 20th century, generally seem to have failed.

A Department of Agriculture report in 1947 said that there were between 200 and 300 surviving cocoa trees on private land and in villages over the whole country, scattered in groups of two or three trees in nearly every State, but especially common in Negri Sembilan (Cheesman, 1948a). This illustrates clearly the insignificance of Malaysia's cocoa industry before the Second World War. After the War, the potential of cocoa was recognized as a plantation crop in Malaysia's attempt to reduce the excessive dependence on rubber. This new interest was boosted by strong world demand and concerns at that time about the future of cocoa in West Africa and the West Indies due to Cocoa Swollen Shoot Virus and Witches' Broom disease, respectively.

However, little cocoa was planted until the late 1960s when the availability of superior Upper Amazon hybrid planting materials and reports of successful large scale cultivation of monocrop cocoa under established shade on inland soils in Malaysia, rapidly accelerated the commercial development of cocoa throught the 1970s and the 1980s. Subsequent plantings transformed cocoa into the third most important plantation crop in Malaysia, after oil-palm and rubber.

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TABLE 1: AREA PLANTED WITH COCOA AND COCOA PRODUCTION IN MALAYSIA: 1960 TO 1990

Year	Peninsular Malaysia Area (ha)	Peninsular Malaysia Tonnes (tm)	Total Malaysia Area (ha)	Total Malaysia Tonnes (tm)
1960	576	na	1,786	na
1961	575	na	2,113	na
1962	585	na	2,527	na
1963	591	na	2,614	na
1964	664	na	2,809	na
1965	761	369 *	2,940	785 #
1966	822	na	3,465	1,055 #
1967	865	na	3,658	1,340 #
1968	1,124	na	4,241	1,910 #
1969	1,902	na	5,233	1,781 #
1970	3,362	2,100 *	7,381	4,100
1971	7,492	na	12,009	5,200
1972	12,043	na	17,490	9,000
1973	15,715	na	21,956	10,200
1974	13,624	na	21,750	12,900
1975	17,586	6,241 *	27,409	17,100
1976	20,796	na	33,466	19,200
1977	29,708	na	47,221	16,700
1978	27,409	na	53,219	21,900
1979	45,168	na	88,991	31,600
1980	57,345	na	123,855	35,800
1981	64,618	na	158,784	49,200
1982	82,185	17,455 #	209,399	67,600
1983	83,949	17,082 #	231,080	69,200
1984	89,163	22,101 #	265,510	83,100
1985	106,932	28,554 #	303,897	101,500
1986	105,183	31,798 #	321,600	130,000
1987	122,772	37,197 #	363,000	185,400
1988	141,750	41,907 #	400,000	224,000
1989	145,000)	61,465 #	420,000	220,000
1990	148,400)		416,300	228,000

na Not available * Estimated # Based on cocoa bean exports

1960-1978 area figures consolidated into Sole Crop Equivalent area estimated on basis of: Sole Crop Equivalent (ha) = 100% sole crop area + 75% main crop area + 50% mixed crop area.

1979-1990 area figures not consolidated.

Source: International Conference on Cocoa and Coconuts Handbook: 1984.
Agricultural Statistics, DOA, Malaysia: 1988.
Malaysian Cocoa Growers' Council Annual Report: 1990.
Review of National Agricultural Policy - Cocoa Sector: 1991.
Prospects for the world cocoa market until the year 2005: UNCTAD/COM/5: 1991.

COCOA DEVELOPMENT IN MALAYSIA

Cocoa is grown in the three regions that comprise Malaysia, ie. Peninsular Malaysia (ex.Malaya) and the States of Sarawak and Sabah. Sabah is the principal cocoa State although commercial interest in cocoa only started there in the 1950s with the importations of Amelonado and other varieties from Ghana, Sri Lanka (ex.Ceylon), West Indies and Sulawesi (ex.Celebes).

In the last three decades, cocoa planting in Malaysia has expanded from 1,786 hectares in 1960 to about 416,300 hectares in 1990 (see Table 1). Sabah had 211,300 hectares in 1990 or 51% of the total hectarage, followed by Peninsular Malaysia with 148,400 hectares at 36% and Sarawak with 56,600 hectares at 13%.

Malaysian cocoa production increased at 20-30% per annum following the years of peak planting so that Malaysia is currently the fourth largest cocoa producer in the world, after Cote d'Ivoire, Brazil and Ghana. Most of the cocoa produced is being exported as beans, albeit significant quantities of cocoa products derived from them are shipped to Europe and North America through Singapore.

IN PENINSULAR MALAYSIA

In Peninsular Malaysia, the area planted to cocoa expanded rapidly from 761 hectares in 1965 to 145,000 hectares in 1989/90 and cocoa production from 360 tonnes in 1965 to about 61,465 tonnes in the 1989/90 crop season and accounted for 27% of the country's total production. The cocoa is generally cultivated as an intercrop or mixed crop on coastal soils along the west coast, though considerable monocrop cocoa has been planted on inland soils in the central and southern regions of the country (see Figure 1). Unlike Sabah, where cocoa is predominantly in mono-culture, in Peninsular Malaysia it is usually intercropped, often with coconuts (local tall or hybrid varieties). Smallholders may plant their cocoa with a mixture of other crops, such as coconut, oil-palm and various fruit trees and a substantial number do so as is shown in Table 2.

Besides private plantations and smallholders, a large number of Government agencies have been actively involved in the Peninsular's cocoa development. These are the Ministry of Agriculture (Department of Agriculture, DOA), Federal Land Development Authority (FELDA), Federal Land Consolidation Rehabilitation Authority (FELCRA), Rubber Industry Smallholders Development Authority (RISDA), State Economic Development Corporations (SEDCs), Federal Agricultural Marketing Authority (FAMA), Malaysian Agricultural Research and Development Institute (MARDI) and most recently the Malaysian Cocoa Board (MCB). The Ministry of Agriculture has also provided cocoa smallholders with appropriate subsidies under the Agricultural Inputs and Diversification Programme (AIDP) and the Coconut Smallholder Development Project (CSDP). This has encouraged smallholders to go into cocoa, a crop that is well suited to them both socially and economically. By the early 1980s, cocoa smallholdings had become the largest group accounting for 48% and 57% of the total area in 1982 and 1985 respectively in Peninsular Malaysia (see Table 3).

TABLE 2: AREA PLANTED WITH COCOA IN PENINSULAR MALAYSIA: 1960 TO 1988

Type of Cocoa Plantings in Peninsular Malaysia (ha)

Year	Sole Crop	Intercropped as		Total as Sole Crop Equivalent
		Main Crop	Mixed Crop	
1960	503	3	142	576
1965	493	na	536	761
1968	482	14	1,263	1,124
1970	814	891	3,759	3,362
1973	1,770	49	19,567	11,590
1975	4,040	na	27,083	17,587
1978	6,873	773	37,912	26,409

Source: Agricultural Statistics of Peninsular Malaysia, Department of Agriculture, Peninsular Malaysia: 1982.

Sole Crop Equivalent = 100% sole crop area
\+ 75% main crop area
\+ 50% mixed crop area

Type of Cocoa Plantings in Estates in Peninsular Malaysia (ha)

Year	Sole Crop	Plantation Cocoa Intercropped with			Total as Estate Plantings
		Coconut	Oil-Palm	Others	
1982	9,097	19,521	1,599	339	30,556
1983	9,044	20,431	2,826	340	32,641
1984	8,969	20,712	2,630	260	32,571
1985	9,334	21,640	2,503	56	33,533
1986	11,301	20,872	2,361	59	34,593
1988	13,474	22,054	2,024	91	37,643

Source: Handbook of Oil-palm, Cocoa, Coconut and Tea Statistics Malaysia, Department of Statistics, Ministry of Agriculture, Malaysia: 1982, 1983, 1984, 1985, 1986 and 1988.

FIGURE 1: COCOA AND COCOA/COCONUT PLANTINGS IN PENINSULAR MALAYSIA: 1991

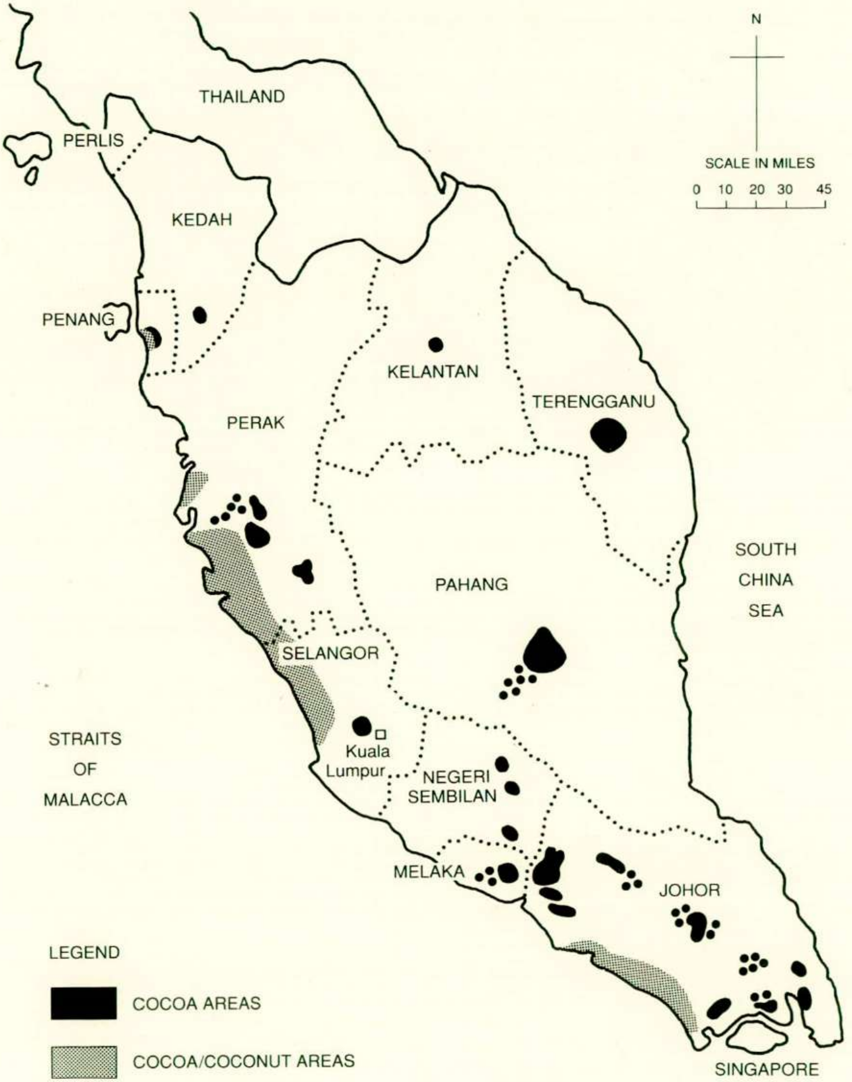


TABLE 3: AREA PLANTED WITH COCOA IN PENINSULAR MALAYSIA BY TYPE: 1979 TO 1988

Cocoa Plantings in Peninsular Malaysia (ha)

Year	Plantations	Government Land Schemes	Smallholders	Total
1979	20,606	7,922	16,640	45,168
1980	25,261	12,452	19,632	57,345
1981	28,556	12,641	23,421	64,618
1982	30,556	12,321	39,303	82,185
1983	32,641	12,326	38,982	83,949
1984	32,571	11,876	44,717	89,163
1985	33,533	12,265	61,134	106,932
1986	34,593	14,385	56,205	105,183
1987	35,996	13,593	73,183	122,772
1988	37,643	13,666	90,441	141,750

Source: Handbook of Oil-palm, Cocoa, Coconut and Tea Statistics Malaysia, Department of Statistics, Ministry of Agriculture, Malaysia: 1983, 1985 and 1988.

HISTORICAL BACKGROUND

The date of the first introduction of cocoa into Peninsular Malaysia is uncertain since the records are incomplete. However, a study of the history of cocoa in the country is helpful and sheds some light on why cocoa did not develop into a viable industry earlier than rubber and oil-palm, even though Forastero and Criollo cocoas were first introduced into Peninsular Malaysia (Malaya) about 100 years before rubber and oil-palm. There are a number of key events which are now described though in some cases the dates quoted are only approximate.

1778 : Earliest presence of cocoa was reported in Malacca when a cocoa tree was seen fruiting freely in the garden of a Portuguese widow in Malacca (Koenig, 1894). Since this tree was already fruiting freely, the tree must have been planted a few years earlier which indicates that the first introduction of cocoa into Peninsular Malaysia was somewhat earlier than 1778.

1802 : A few experimental cocoa trees were reported to be thriving in Penang (Hunter, 1909).

1823	: Sir Stamford Raffles, the founder of Singapore, encouraged cocoa planting in Singapore (Ridley, 1905) and some planters experimented with it (Logan, 1849). The origin and type of this planting material is not known. It is possible that they were Criollo types since it was later noted that there were about 1,000 mature Criollo trees widely distributed throughout the country (Rosenquist, 1950).
1850	: J.d'Alineida and W.Scott were two of the planters that carried out the original trials, but could not agree on the future or the potential of cocoa in Singapore (Thomson, 1850).
1866	: Soils in Singapore had been considered not fertile and this prevented further cocoa plantings in Singapore (Jagoe, 1866).
1880	: Cantley imported Trinitario-type cocoa from Sri Lanka (Ceylon) and also propagated the materials (probably of Criollo and Trinitario origin) already in Peninsular Malaysia (Malaya), but reported that there were serious pests attacking the cocoa (Cantley, 1880). Some of this material could have been planted on an estate at Bukit Ibul near Port Dickson, Negri Sembilan, while progenies were subsequently found growing at Tanah Datar, Negri Sembilan (Rosenquist, 1950).
1891	: The cocoa plantings in Malacca were abandoned as failures, although by this time cocoa had spread to other kampongs (villages) and was seen thriving in Kuala Kangsar (Burkill, 1966).
1920	: Some rubber companies were reported to have been willing to experiment again with cocoa planting in old rubber areas due for replanting, when planting material was available (Anon, 1948).
1923	: The Department of Agriculture imported some Forastero and Nicaraguan varieties from Sri Lanka (Ceylon) (Bunting and Milsum, 1931) and it was possible that a few of these trees and some of their progenies were distributed to, and survived on, the Agricultural Stations at Temerloh and Kuala Lipis, Pahang (Rosenquist, 1950).
1928	: A villager from Trong, north Perak, received some cocoa seeds from a friend in Sri Lanka (Ceylon) and a number of the trees survived in that neighbourhood (Rosenquist, 1950).
1931	: Early trial plantings by the Department of Agriculture on the Negri Sembilan and Federal Experimental Station (FES), Serdang, Selangor were disappointing due to poor soil conditions (Bunting and Milsum, 1931).

1934 : A small (0.2ha) test plot of Trinitario cocoa was established at the FES, Serdang. The seedling material was from a vigorous and freely fruiting tree growing near Klang, Selangor and thought to be of Ceylonese origin (Faulkner and Milsum, 1938). Rosenquist (1950) reported that some of the seedlings died, probably due to poor soil and serious insect pest attacks, and were replaced by seedlings raised in baskets from two Forastero pods imported from Peradiniya, Sri Lanka (Ceylon).

1937 : Seeds from the best yielding Trinitario trees that survived at the FES, Serdang, were used to establish new experimental plots at the Agricultural Stations at Cheras, Selangor, and Kuala Lipis and Temerloh, Pahang (Faulkner and Milsum, 1938; Hartley, 1949). More cocoa seeds were probably brought into Peninsular Malaysia (Malaya) which cannot be well substantiated. However, it appears that the following importations occurred at this time:

- from Java, Indonesia to Kampongs on the Perak river
- from Borneo (now Sabah) to Beranang, Selangor
- from Medan, Indonesia to Dusun Tua, Selangor

1938 : The Department of Agriculture of Malaya (DOA) reported that adequate shade was essential to get cocoa established well in Malaya (Faulkner and Milsum, 1938). This was substantiated by field trials later by Berwick (1950).

1939-45 : Cocoa was neglected during the Second World War and yields of all crops suffered badly in most plantings during the Japanese Occupation (Hartley, 1949)

1945/46 : The Policy of the DOA had always been to encourage the planting of crops with economic potential in Malaya, and cocoa was accorded special attention by the Department after the War. The cocoa, planted experimentally between 1923 and 1938, provided the first material for agronomic studies.

1946 : A plantation management agency with extensive plantation interests in Malaya imported Trinitario pods from Sri Lanka (Ceylon), from which 15,000 seedlings were raised at the Isolation Nursery in the Ayer Hitam Forest Reserve, Johore, under the strict scrutiny of the Department of Agriculture and distributed for trial plantings (Hartley, 1949).

1947/48 : The DOA made a careful survey of cocoa trees growing in Malaya especially those on Malay and Chinese kampongs and only found some 200 to 300 trees on private land, "mostly as isolated specimens or in groups of 2 or 3". They were located in nearly every State but were especially common in Negri Sembilan (Cheesman, 1948a; Rosenquist, 1950).

1947/48 : Prof.Cheesman (then working on cocoa in Trinidad) visited Malaya, Sarawak and Sabah (then called North Borneo) at the request of the Government of the Federation of Malaya, to assess the potential for cocoa cultivation. He reported that cocoa could be successfully grown in these areas (Cheesman, 1948a). Following this, the DOA intensified research into the breeding and selection of superior planting materials and in cocoa agronomy by planting cocoa trials on agricultural stations and plantations throughout the country.

1948 : A grant under the Colonial Development and Welfare Act (UK) for the collection and introduction of cocoa planting materials to Malaya enabled a co-ordinated programme of introduction and bulking of cocoa materials to be started. Importations from West Africa, the West Indies, Sri Lanka (Ceylon) and Java and other regions were made under careful supervision and thorough quarantine on Pulau Tekong Besar - an island off Changi, Singapore (Thompson, 1950). The DOA expanded their field trials to about 60 hectares (see Figure 2), though most of these were of unselected Trinitario seedlings probably originating from introductions from Sri Lanka (Ceylon) prior to 1934 and they tended to be of high variability, poor quality and low yield (Allen, 1953).

1949 : The first importation of Amelonado cocoa which was of 5,000 seeds, came from 200 pods harvested on 19th November 1949 on a plot in the Botanic Gardens at Aburi, Ghana. They arrived in Singapore on 30th November 1949.

1950 : The Amelonado seedlings were raised in baskets and transferred to the Singapore Botanic Gardens after satisfactory phytosanitary clearance. Subsequently, 4,956 seedlings were released for distribution (Thompson, 1950) as follows:

3,649	seedlings	:	Federation of Malaya
538	seedlings	:	Sarawak
570	seedlings	:	North Borneo (Sabah)
199	seedlings	:	Balance in Singapore

Four of the eight trials in Malaya (now Peninsular Malaysia) showed that Amelonado cocoa was superior to the local Trinitario and was recommended for commercial planting (Rosenquist and Sockalingam, 1953). After trials at Serdang and Cheras, 20 of the Trinitarios were cloned. Meanwhile collections of 80 Criollo cocoa were made, selected as the best from plantings in kampongs in Negri Sembilan, Malacca, Johore, Perak, Penang and Province Wellesley, Kedah and Perlis (Anon, 1950).

The first commercial monoculture of Trinitario cocoa in Malaya (Peninsular Malaysia) was established in Trengganu at Jerangau Estate (owned by Malayan Cocoa Ltd), on inland granitic soil and under thinned secondary jungle shade, which was then considered to be the most economical method of planting cocoa (Allen, 1953). The thinned jungle was considered more useful in providing shade for cocoa establishment (Vanter, 1956) as opposed to the alternative system of cocoa cultivation with shade from primary, secondary and tertiary shade species being planted prior to the cocoa (Berwick, 1950).

1950/51 : Haddon (1961) records that more materials were imported as seeds from Indonesia (open-pollinated seeds of seven of the best clones at Bogor), from West Africa (seeds of ten clones from WACRI and some ICS clones), from Papua New Guinea (seeds of five selected Keravat clones) and from one pod from the original Lafi-7 clone of Samoa, from which 25 seeds were germinated and planted at Serdang.

A second importation of Amelonado cocoa was made from Macassar, Sulawesi (Celebes) and these were tested at the Jerangau Research Station (Haddon, 1961).

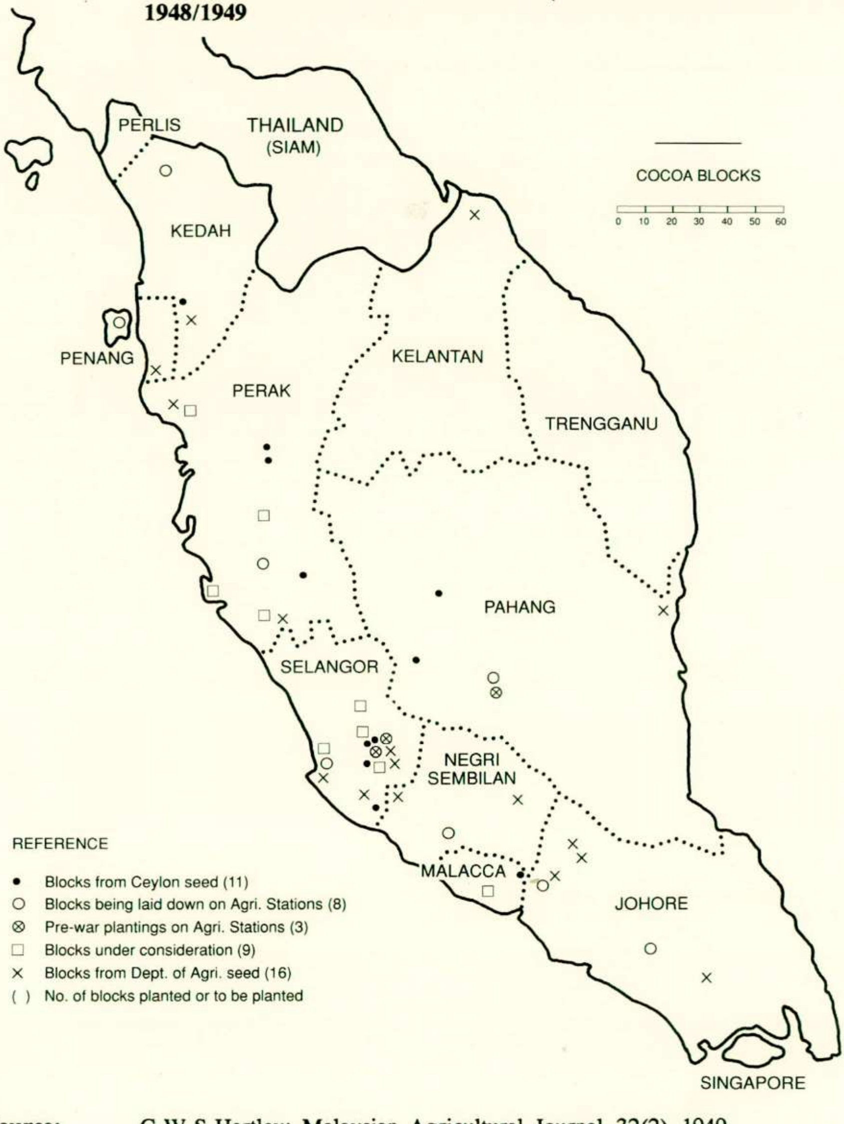
1951 : The DOA made further introductions and 39 open-pollinated (F_2) Upper Amazon seedlings were imported from the West African Cocoa Research Institute, in Gold Coast (now Ghana) and were established at the FES, Serdang (Haddon, 1961).

1951/52 : By the end of 1951, the DOA was conducting 46 trials on plantations and 25 trials on agricultural stations.

Some cocoa trees were observed to be affected by a cocoa "dieback" syndrome. This was later established by Keane in Papua New Guinea as Vascular-Streak Dieback (VSD) caused by *Oncobasidium theobromae* (Keane et al., 1972). The "dieback" was particularly serious in the Trengganu region on the Amelonado planting material. The infection became more severe and this coupled with poor soil conditions and a lack of knowledge of the cause meant that most of these early plantings performed badly in early 1950s. The long gap between the onset of this "dieback" and the identification of the causal agent had the important efffect of slowing down the development of cocoa in Peninsular Malaysia and discouraged a number of plantation companies from establishing more cocoa at that time.

1953 : More genetic material was imported and a good collection of the Imperial College Selection (ICS) clonal materials from Trinidad was planted at the Agricultural Research Station, Jerangau to augment the genetic materials and breeding efforts at the Research Station in Serdang (Arasu and Phang, 1972). Test plots of cocoa planted under oil-palm and coconut had been tried but the conditions of cocoa under coconut on coastal clays were considered to be "unorthodox" (Cheesman, 1948b). Nevertheless, early results of the cocoa under coconut plantings were promising and performed much better than the cocoa planted under rubber or oil-palm (Allen, 1953).

FIGURE 2: LOCATION OF EARLY DEPARTMENT OF AGRICULTURE COCOA TRIALS IN MALAYA (PENINSULAR MALAYSIA): 1948/1949



Source: C.W.S.Hartley: Malaysian Agricultural Journal 32(2), 1949.

1955 : This was an important year in the history of the cocoa industry of Malaysia (Malaya). Eight Upper Amazon (F_0) clones of Nanay, Parinari and Scavina populations were imported into Peninsular Malaysia (Malaya) from South America. They became the most significant primary germplasm on which the present commercial seed production and the bulk of Malaysian cocoa plantings have been based as they contained these as one, or both, parents (Arasu and Phang, 1972).

1956 : Much of the primary germplasm in Malaya (now Peninsular Malaysia) (Amelonado and more recent Upper Amazon importations) was introduced into Sabah and a cocoa research station was established at Quoin Hill, Tawau by DOA, Sabah. This laid the foundation for Sabah to become the principal cocoa state of Malaysia.

1957 : Malaysia became an independent nation.

1958-61 : The Upper Amazon cocoa grew very well under Sabah conditions, and so another 200 selected Upper Amazon clones from the Pound collections were imported from South America. From these, superior quality seeds of Upper Amazon x Upper Amazon, Upper Amazon x Trinitario hybrids were then mass produced in seed gardens. Initially Amelonado also grew and yielded well in Sabah.

1969 : Large commercial monocrop plantings with superior Upper Amazon hybrids planted under leguminous shades, (*Sesbania punctata* and *Tephrosia vogelii* as nurse shades, *Gliricidia maculata* as intermediate shade and *Albizzia chinensis* and *Eucalyptus sp.* as permanent shades) on inland soils were successful in North Johore (Mainstone, 1972). This boosted the rapid development of cocoa as a plantation crop in Peninsular Malaysia.

The Malaysian Agricultural Research and Development Institute (MARDI) was established to carry out and co-ordinate the research and development requirements of cocoa and coconuts in Peninsular Malaysia.

1972 : Keane and colleagues identified the dieback in Papua New Guinea as being caused by the pathogen *Oncobasidium theobromae*. This was some 20 years after the plantings in Trengganu started to be affected by a "dieback" syndrome (Keane et al., 1972).

1969-91 : There was still a need to broaden the genetic base (Arasu and Phang, 1972). Numerous new introductions were made in this period from Brazil, Costa Rica, Papua New Guinea, Miami and Mayaquez (Puerto Rico), by means of co-ordinated efforts of the DOA's of Peninsular Malaysia and Sabah, MARDI, FELDA and other commercial organisations.

1982 : The Malaysian Cocoa Growers' Council (MCGC) was registered in May 1982 and has as its function the co-ordination and promotion of cocoa research and development activities in the whole of Malaysia. It has been involved in importations of germplasm.

1983 : The Federal Agricultural Marketing Authority (FAMA) Export Grading Scheme was introduced in 1983 and came into effect in August 1984. Export beans are classified according to qualities in the Standard Malaysian Cocoa (SMC) grading system.

1986 : Infestation by the cocoa pod borer (CPB) caused by *Conopomorpha cramerella* was first detected in Peninsular Malaysia in a large commercial estate at Jasin Lalang, Malacca, in September. Since then the CPB had spread fairly rapidly and a recent census in 1991 records that 8,807 hectares of cocoa had been affected. Fortunately, the infestation has so far been restricted to the southern states of Negri Sembilan, Malacca, Johore and lately, a small area of Pahang, with Johore being the most seriously and widely infested (Anon, 1991). CPB had been gazetted by Government as a 'dangerous pest' and stringent measures of quarantine and control are enforced by the DOA and the industry which have accounted for the relatively satisfactorily control of this pest. Cocoa pod borer had previously become a serious pest in Sabah and is still causing significant economic losses.

1988 : The Malaysian Cocoa Board (MCB) was enacted in Parliament in July 1988 and became operational in 1989. It is responsible for strengthening all aspects of the cocoa industry by promoting and coordinating research, development, registration, licensing of processing and of grading and marketing activities in the country.

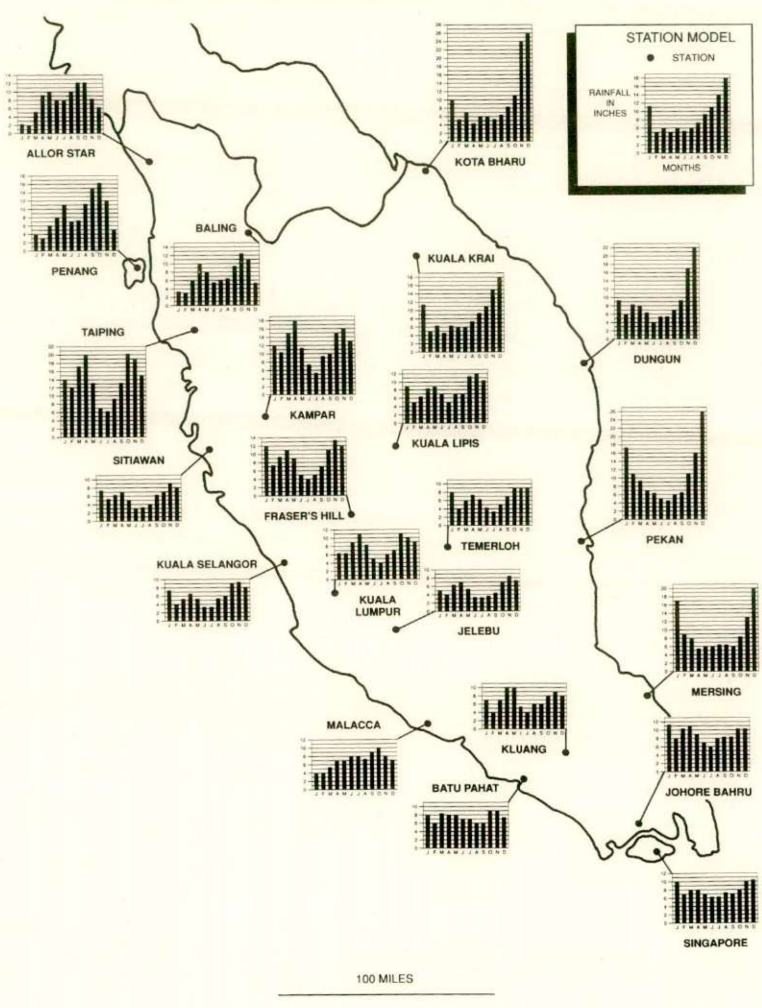
CLIMATE

Peninsular Malaysia, which lies between latitudes 1° 16'N and 6° 43'N in South East Asia, has a tropical rain forest climate that is characterised by high temperature, high precipitation and humidity throughout the year. It is generally suitable for cocoa cultivation.

Temperature

There is little variation of temperature through the year, the difference between the warmest and coldest months is less than 5°C. The mean annual temperature is 26.4°C. However, average daily temperatures can vary considerably during contrasting conditions of rain and cloud between day and night, eg. from 21°C to 32°C though at higher elevations temperatures can be lower.

FIGURE 3: AVERAGE MONTHLY VARIATION OF RAINFALL IN PENINSULAR MALAYSIA



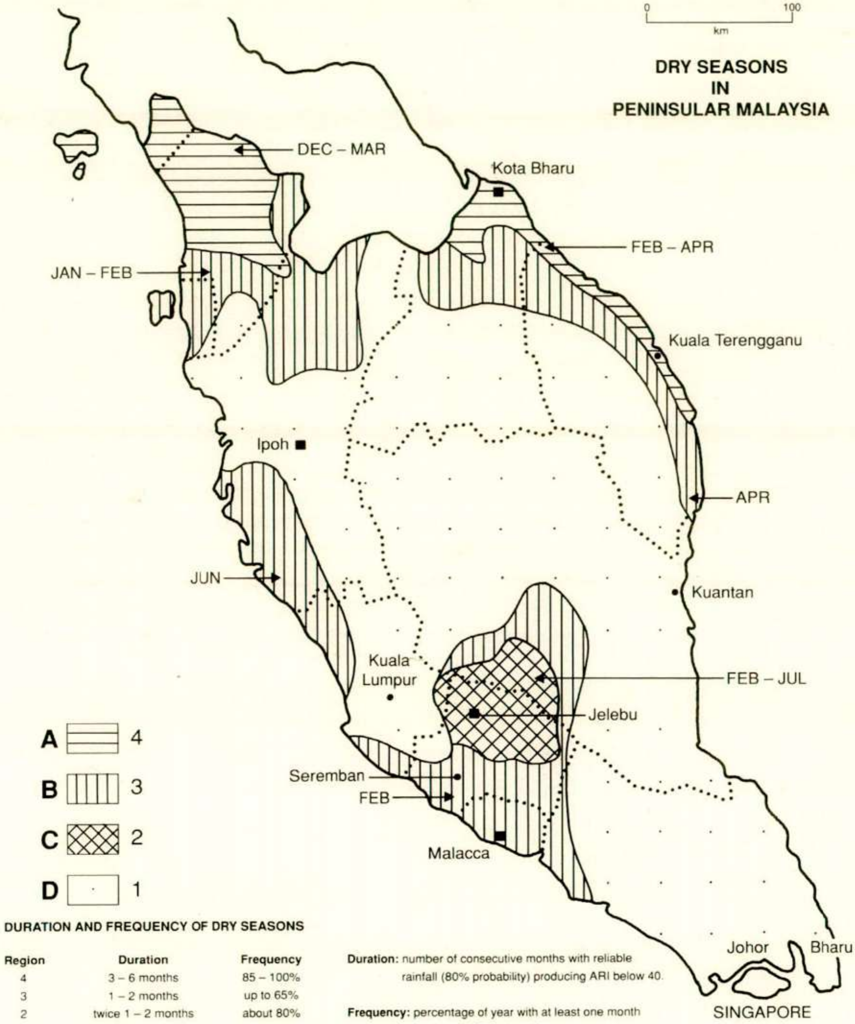
Source: Conference on Classification and Management of Tropical Soils (CLAMATROPS): Kuala Lumpur, Malaysia: 15-20 August, 1977.

TABLE 4: CLIMATE AND ENVIRONMENTAL FACTORS SUITABLE FOR COCOA IN MALAYSIA

Climatic/Environmental Factors		Desired Condition
CLIMATE		
Rainfall	Annual precipitation Distribution	1990-2200 mm uniform over the year
Dry months	(number months of severe moisture deficit)	Less than 1
Wind Speed		<1.0m/hr
TERRAIN		
Terrain class		Flat to gently undulating
Slope		0-6°
SOIL		
Effective soil depth		Not less than 90cm
Textural class		Sandy clay loam-clay loam
Laterite/stones		Nil
Structure		Well structured/friable
Drainage class		Well drained
Soil pH		5.5-6.5
Peat layer		Nil
Salinity		Non-saline
Acid-sulphate layer		Nil
Waterlogging/flooding		Nil
Organic matter status		High (Organic C > 1.6%)
Soil fertility:	Total N Total P Avail P Exch K Exch Ca Exch Mg CEC	> 0.16% > 320 ppm > 24 ppm > 0.45 meq % > 1.6 meq % > 1.0 meq % > 15 meq %
Soil water retention capacity		Good > 140 mm/m

Source: After Thong et al., 1987.

FIGURE 4: AGRO-CLIMATIC ZONING OF PENINSULAR MALAYSIA



DURATION AND FREQUENCY OF DRY SEASONS

Region	Duration	Frequency
4	3 – 6 months	85 – 100%
3	1 – 2 months	up to 65%
2	twice 1 – 2 months	about 80%
1	the regular dry period	up to 40%

Duration: number of consecutive months with reliable rainfall (80% probability) producing ARI below 40.

Frequency: percentage of year with at least one month having an ARI below 40.

Source: (a) Nieuwolt (1982)
(b) Mohammed Zaki Ghazalli et al., (1985)

Relative Humidity

Throughout Peninsular Malaysia, conditions are humid and relative humidity is usually high, around 85-90% the year round.

Sunshine Hours

The average number of sunshine hours is between 5.0 to 5.5 hours per day which favours cocoa in Peninsular Malaysia.

Rainfall

The rainfall and its distribution in Peninsular Malaysia are influenced significantly by the north-east and south-west monsoon seasons associated with the periodic changes in the prevailing winds. The annual rainfall is high over the whole of the peninsula and total precipitation ranges between 2,000 to 3,000 mm in general, with a mean of around 2,100 to 2,200 mm per annum. Usually rainfall distribution is satisfactory for cocoa most of the time in most parts of the country, though the extreme north tends to be relatively dry in the first two months of the year (see Figure 3).

Most of the rains fall during the monsoon seasons namely the south-west monsoon on the west coast (from April to October), and the north-east monsoon on the east coast (from October to March). From April to November the "Sumatras" (local squalls accompanied by sudden heavy thunderstorms and rain) are fairly common on the west coast. Heavy falls of rain are also common on the east coast and very heavy rains particularly in November and December may cause severe flooding. This is fortunately usually of short duration because longer periods of waterlogging of cocoa on these acid soils can cause loss of trees. By and large, rainfall favours cocoa planting in Peninsular Malaysia and in a study of agro-ecological regions of Peninsular Malaysia, 11 or 42% of the country's 26 agro-ecological regions were defined as suitable for cocoa cultivation (see Figure 4).

Ng (1983a), Ng and Thong (1985) and Thong et al., (1987) emphasize the importance of all elements of climate (though especially rainfall), and soil to the establishment, growth and yield of cocoa. These are defined in the critical factors for maximum yield performance under the MEGYP (Maximum Exploitation of Genetic Yield Potential) concept of Ng (1983b) and Ng et al., (1990) (see Table 4).

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TOWARDS THE USE OF PATHOGENIC MICRO-ORGANISMS IN THE CONTROL OF SOME COCOA INSECT PESTS IN GHANA

Ato H.Brew *

INTRODUCTION

Cocoa in Ghana has some serious pest and disease problems which have contrib uted greatly to reductions in annual production in Ghana. Of prime economic importance to the cocoa industry in Ghana is the Cocoa Swollen Shoot Virus (CSSV) disease transmitted by mealybug species. The disease has been devastating in Ghana, resulting in the cutting out of over 200 million trees in a disease eradication programme begun in 1946 (Adomako, 1983). It is estimated that just as many trees remain to be destroyed. Control of the mealybug vector by removing the attendant ants, leads to disruption of the ecosystem and the build-up of a number of pests which had previously only been regarded as of minor importance (Legg, 1981). Some systemic insecticides which were found effective were too toxic to permit safe handling while exotic parasites and predators introduced in Ghana failed to establish themselves (Thorold, 1975). The search for cocoa types resistant to CSSV has resulted in the breeding of new inter-Amazon cocoa varieties in which the rate of spread of the virus is slower than in the old types such as Amelonado.

In Ghana observations indicate that the damage caused by caterpillars are of greater importance to the cocoa industry than was previously believed. Experiments show that cocoa pods tunnelled by caterpillars, *Characoma stictigrapta* predispose them to attack of black pod disease caused by *Phytophthora palmivora*. An increase in the incidence of this disease was found to coincide with an increase in caterpillar incidence (Akotoye, 1975). In times of serious water stress as in the harmattan season instars bore into tips and branches and cause serious dieback in cocoa. It has been found that as many as 16 young caterpillars can infest one shoot bearing only a few leaves (Akotoye, 1975). Insecticides were mentioned as one method of control for the caterpillars, *Earias biaplaga*, but it is likely that these would be ineffective for *Characoma* since most of the population is found inside pods and so other methods have to be adopted.

Capsids (*Distantiella theobroma* and *Sahlbergella singularis*) are the most economically important pests of cocoa in Ghana. The activities of capsids alone may reduce the annual production of the crop by 50% (Vernon, 1964; Gordon, 1976). The fungus *Calonectria rigidiuscula* is known to establish itself in lesions caused by feeding capsids and to cause dieback in cocoa trees. Furthermore, capsid damage to cocoa tends to weaken cocoa trees already infected with CSSV and reduce their ability to withstand the disease. Broken canopies which follow capsid attack cause competition by weeds and induce poor growth of the trees. The only certain method of control available is spraying with insecticides, but it is to be hoped that other methods can be evolved for cost and ecological reasons.

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The risk of insecticide resistance by cocoa pests (Dunn, 1963; Entwistle, 1964), the destruction by insecticides of beneficial insects such as the parasites and predators of major pests leading to an increase in minor pest populations (Anon, 1957; Entwistle, Johnson and Dunn, 1959), the risk of accumulation of some pesticides making the environment increasingly hazardous to human health (Huffaker, 1980), and the potential side-effects, means that we seek alternative methods which are more economical, lasting and more benign to humans and the environment. Some insect control agents other than chemicals have been studied with the aim of incorporating them into an integrated cocoa pest management scheme in Ghana.

1. The Effect of Bacillus Thuringiensis on Cocoa Leaf-eating Caterpillars

Over the last decade there has been an increase in outbreaks of caterpillar defoliators in Ghana. Large scale application of insecticides might be the cause, as beneficial insects such as predators of the pests might have been destroyed.

The effect of a commercial preparation of Thuricide HP (Sandoz S.A, Switzerland), on two cocoa leaf defoliators, *Teinorrhyncha sp.* (Limacodidae) and *Anomis leona* (Noctuidae) was therefore studied in two separate field trials in the ornamental garden and in the nursery at the Cocoa Research Institute (CRIG). The active agent in the preparation of Thuricide is the *Bacillus thuringiensis*. Two weekly sprays of the Thuricide concentrate at the rate of 0.1kg/ha were made on the foliage of young cocoa seedlings using a pneumatic hand sprayer. About 100 larvae of *Teinorrhyncha* were then released to feed on these and also in the control (unsprayed) plot. This was repeated with 100 larvae of *Anomis* in separate plots. The trials were replicated twice.

After three to four days of feeding on the Thuricide treated foliage, the caterpillars ceased to feed, entered into a state of quiescense and eventually died. The bodies became watery and disintegrated readily. The results of the field trials (see Table 1) show that all the *Teinorrhyncha sp.* and *Anomis leona* caterpillars which fed on the Thuricide treated foliage were killed.

2. Unidentified Entomogenous Moulds Destroying Capsids of Helopeltis sp.

While collecting cocoa capsids for biological studies in August-December 1979, it was noted there were many dead *Helopeltis* capsids under the cocoa trees and that the dead insects were covered with fungal spores. All the *Helopeltis* capsids appeared to be infested with the same type of fungal spores and so it seemed likely that this was a case of fungal parasitism. Some dead insects were placed on artificial nutrient culture (nutrient agar). After seven days the fungus culture developed. Two batches of 25 young, healthy *Helopeltis* individuals which had been collected fresh from the field were treated with the fungus as follows: each of the 25 insects of the first batch was dropped onto the developed mould in separate chimney glasses covered with wire gauze and left for 24 hours. A second batch (of 25) was left untreated as control and the experiment was replicated twice.

The precise life span of *Helopeltis sp.* in Ghana is not known, but the untreated (control) samples observed in the insectary lived for about 20 days. Those contaminated with the unidentified fungal pathogens lived for an average of 6 days and after death the cadaver became dry and mummified. A similar observation was reported by Burges (1971) in his study of the mode of action of the bacterial pathogen of the genus *Clostridia* on some susceptible insects.

TABLE 1: THE EFFECT OF BACILLUS THURINGIENSIS ON COCOA LEAF EATING CATERPILLARS, TEINORRHYNCHA SP. AND ANOMIS LEONA

Area	Numbers Treated		Rate of Mortality	
	B.thuringiensis	**Control**	**No.Treated**	**Control**
	Teinorrhyncha sp.			
Ornamental garden	131	109	100 %	0
Nursery	116	113	100 %	0
	Anomis leona			
Ornamental garden	101	100	100 %	0
Nursery	122	103	100 %	0

3. Unidentified Entomogenous Fungi Infesting Mealybugs Reared on Cocoyam in the Insectary

Dead adult mealybugs, especially *Planococcus citri*, without attendant ants are sometimes found attached to plants or pods and covered with fungi, suggesting that the mealybugs could be parasitised by a fungus. Normally the mealybugs secrete honeydew which is consumed by attendant ants, but it is possible that infestation by fungi could arise where mealybugs lacked attendant ants.

Twenty batches of adult *P.citri* (10 to 15 insects/batch) were separately caged on 20 cocoyam (Taro, Colocasia) stalks raised in black polythene bags using the cotton wool method described by Firempong (1981). At the insectary an average of twelve adult mealybugs of *P.citri* per cocoyam stalk established well under the absorbent cotton wool, laid eggs which hatched to give about 300 crawlers (nymphs). These nymphs escaped to settle under cocoyam foliage and on reaching the adult stage, produced an enormous quantity of honeydew on their bodies. As there were neither ants to tend them nor cotton wool to absorb the honeydew, the insects were invaded by a fast growing fungus which covered their whole body, killing the insect. The honeydew of mealybugs is mostly secreted through the median dorsal strip and is deposited at the back of the body. However, in the present study the mealybugs were observed to have been trapped ventrally by the sticky honeydew, making it impossible for them to move. It is assumed that the honeydew ran down from the back along the sides. The growth of the micro-organisms started at the ventral side of the insect and quickly developed covering the whole body of the insect and thus killing it.

DISCUSSION

The above account shows that the *Teinorrhyncha* caterpillars were destroyed after ingestion of Thuricide. Bolton (1973), working on cocoa discovered a bacterial pathogen which parasitised the capsid, (*Sahlbergella singularis*) causing massive septicaemia and the generation of viscid fluid from the internal organs. He found that contamination occurred where the capsids fed at previously infested sites. He obtained an average percentage mortality of 94% for the capsids, *Distantiella theobroma*, and 73% for *Helopeltis bergrothi*. Burges (1971) also reported that ingestion of *Bacillus thuringiensis* by unidentified caterpillars led to rapid growth of the spores inside their bodies, resulting in destruction of the body cavity; and that prior to death of the host there were thick walled refractile spores which appeared white through the integument. The name "milky disease" was used to describe the attack of the bacteria.

The results obtained with *Helopeltis* and *P.citri* also suggest that the unidentified fungal pathogens are potential parasites which should be further studied. Rojter et al., (1966) working at the Cocoa Research Institute discovered the fungus, *Cephalosporium corda* which was highly pathogenic to the mealybug *P.citri*. The possibility that the unidentified fungus studied in the present work is the *Cephalosporium* species cannot be ruled out and efforts are being made to have it identified.

Practical problems may be expected in the application of these findings for large-scale pest control. For example, destroying all attendant ants would leave mealybugs exposed to attack by the unidentified fungal pathogen. Samson et al., (1981) have shown that ants too have entomogenous fungal parasites but this has not been exploited practically. Another possibility is to culture the pathogenic fungus and spray the mycelium in the cocoa farm, as described by Rojter et al., (1966). This technique proved partially effective in reducing the mealybug pepulation on an experimental scale but has not been exploited commercially. The encouraging results of the experiment suggest that entomogenous micro-organisms might prove to be promising biological control agents against cocoa insect pests, but large-scale tests need to be conducted.

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MANAGEMENT STRATEGIES FOR CONTROL OF VASCULAR-STREAK DIEBACK OF COCOA

J.J.C.Dennis * and P.J.Keane **

INTRODUCTION

The basidiomycete fungus, *Oncobasidium theobromae* Talbot & Keane (1971), is the cause of Vascular-Streak Dieback (VSD) disease of cocoa (*Theobroma cacao L.*) in South East Asia and Papua New Guinea (PNG) (Keane & Lamb, 1972; Prior, 1980).

VSD was first recognized as a destructive disease of cocoa, clearly distinguishable from dieback induced by stress or pest damage, in PNG in the early 1960s (Shaw, 1962; Bridgland, Richardson & Edward, 1966a; 1966b; 1967). VSD had become a major epidemic in certain parts of PNG, destroying plantations and preventing re-establishment of seedlings (Bridgland et al., 1966a; 1966b; 1967). Byrne (1976) reported estimates of 25-50% yield loss in certain regions of PNG due to VSD infection. In Malaysia the disease resulted in large yield losses in older plantings (11-17 years) and delayed early production of new plantings (Keane et al., 1972).

VSD infected plants can be detected in the field by the following symptoms (Keane et al., 1972), which are listed in their order of appearance. The bark of an infected stem becomes roughened as the lenticels become enlarged. The next symptom to appear is the yellowing of usually one leaf, often on the second or third flush behind the tip. The pattern of yellowing is very distinct, with small circular patches of green tissue giving a spotted appearance to the leaf. The first infected leaf falls prematurely, and leaves above and below it also turn yellow and fall as they become infected. Axillary buds often begin to grow on infected stems, but they never fully develop. If the dry surface of a leaf scar (resulting from the fall of a diseased leaf) is scraped away, the three vascular traces which served the diseased leaf may be seen clearly as three black patches. When the diseased stem is split longitudinally, brown streaking of the wood is evident. This streaking is associated with the presence of the fungus in the xylem vessels of the wood and provides the basis for the name "Vascular-Streak Dieback". If the bark is stripped away at this stage, the cambium will very rapidly become a rusty brown. Intervienal necrosis in the tip leaves of a diseased branch or seedling is a commonly associated symptom. Initially the fungus is not present in these leaves, and it is thought that the symptom is of calcium deficiency induced by blockage of vascular tissue below the tip. If diseased leaves fall during wet weather, the fungus can grow out of the resulting leaf scar, forming a white, velvet-like sporophore closely adpressed to the bark around the scar.

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There are three main phases in the disease cycle of *O.theobromae* which could be manipulated to control VSD. To date only two of these have been investigated in relation to disease control. The first is the establishment of infection which can be measured as the number of new infections per unit number of shoots per unit of time and has been shown to be reduced by both chemicals (Holderness, 1990) and host genotype (Anon, 1967; Tan & Tan, 1988). The second is the rate at which the fungus colonizes the host stem, which can be measured as the length of streaking visible when an infected stem is split longitudinally after a certain period of infection; this is reduced by host genotype (Tan & Tan, 1988). The third, and arguably the most important and most neglected phase of the disease cycle is the rate at which the fungus sporulates. The only known propagules of *O.theobromae* are basidiospores which are produced externally on distinctive sporophores (Keane et al., 1972). It is not known whether the number and size of the sporophores produced on infected branches can be influenced by chemicals, host genotype or management practices.

One of the first practices recommended for controlling VSD, apart from the use of resistant genotypes, was regular pruning of infected branches which removes infections from the tree, reduces internal colonization, and also prevents the spread of the disease by reducing the number of fungal sporophores. In Malaysia, a pruning interval of no longer than three months has been suggested (Chan & Syed, 1976), although it was found that monthly pruning was more effective in reducing VSD incidence (Jayawardena et al., 1978). Regular monthly pruning has also been recommended in PNG (Prior, 1980). Recent studies in Malaysia (Zainal Abidin et al., 1986) have shown that pruning at three weekly intervals was ineffective in reducing the number of new infections, and actually increased the number of infections compared to unpruned controls, apparently because pruning caused an increase in the production of new flushes available for infection (Zainal Abidin et al., 1986). However, this result was obtained in an experiment where plots of pruned trees were growing adjacent to plots of unpruned trees, which remained a strong source of infection. This effect would not be expected when larger commercial areas are pruned of inoculum sources. Chan & Syed (1976) found that pruning at four monthly intervals resulted in higher incidence and severity of VSD than pruning at two or three monthly intervals, but still reduced the incidence and severity compared to unpruned controls. It would appear that the optimum interval between pruning rounds is from one to three months. Longer or shorter intervals may prove detrimental.

It is generally observed that VSD is more frequent in very damp areas, and especially in densely shaded cocoa. Little attention has been given to manipulation of shade type and density for control of VSD. There are two main shade species widely used for cocoa in PNG today, *Gliricidia sepium* (Jacq.) Walp. and coconut palms (*Cocos nucifera L.*). Shade is necessary for seedling establishment (Wessel, 1985), but the long term necessity for shade is unclear. Yields were highest in unshaded blocks in a shading trial in Ghana (Ahenkorah, Akorofi & Adri, 1974), but fertilizer application was needed to maintain the high yields. *G.sepium*, as a legume, may add to soil fertility, which may increase yields. *Leucaena leucocephala L.* was the main legume shade tree for cocoa in PNG, but is now less common since the invasion by the defoliating psyllid, *Heteropsylla cubana*. Furthermore *L.leucocephala* is a host for many major cocoa insect pests, and because its canopy is frequently contiguous with that of the cocoa growing beneath it, so the pests have easy access to the cocoa (Smith, 1979). Coconut palms provide taller shade, allowing more air penetration around the cocoa canopy.

Nursery losses from VSD have been severe in Malaysia but are not usually significant in PNG (Prior, 1987), although during the early days of VSD build-up in PNG production of seedlings in temporary nurseries located under older, infected cocoa was a major source of early infection in plantings (Keane, 1972). The use of a plastic roof over a nursery provides excellent protection of seedlings (Anon, 1967; Sidhu, 1987) by excluding rain and reducing dew formation, thus minimising the occurrence of conditions suitable for infection of leaves (Keane et al., 1972). If watering of seedlings is carried out in mid-morning so that leaf surfaces have ample time to dry out before release of spores in the evening, the chance of infection is further reduced. Although chemicals for use in nurseries are available in PNG, they should be used with extreme caution since no studies have been conducted on the long term effects of these compounds. The use of a plastic roof is far cheaper and easier, with no detrimental effects on the seedlings. The effect on VSD incidence of nursery roofing materials (eg. palm and fern fronds) that do not exclude rain, but which may reduce dew deposition, needs investigation.

Holderness (1990) reported that monthly foliar sprays of the triazole fungicides, hexaconazole, tebuconazole and triadimenol, all gave good protection against VSD in PNG, but resulted in stunting of the seedlings. Lower doses resulted in less stunting but also resulted in reduced protection. While triazole-treated seedlings had fewer infections there was no significant reduction in the rate of colonization of the fungus within the host (Holderness, 1990).

This paper reports a study of the effect of shade on disease epidemiology in both cocoa seedlings and mature trees, as well as a study of different management strategies used in regions of PNG that are badly affected by VSD.

MATERIALS AND METHODS

Effect of Shade on VSD

The effect of shade on VSD in seedlings was investigated using two shade levels. Unpruned *G.sepium* provided densely shaded blocks, and severely pruned *G.sepium* provided lightly shaded blocks, with 4 replicates. The average shade level was calculated from 20 recordings from each shade treatment using a Sunfleck Ceptometer (Delta-T Devices Ltd). A line of pigeon pea (*Cajanus cajan*) was planted between each block to reduce edge effects. Two guard rows of cocoa were planted around the edge of the trial and four guard rows were used between the blocks. The entire trial site was surrounded by a dense planting of 3-year-old commercial, mixed Trinitario x Amazonian hybrid cocoa infected with *O.theobromae*, which acted as an inoculum source. Three open pollinated, VSD-susceptible cocoa genotypes were used - K13 (Trinitario), K20 (Trinitario) and Amelonado. These genotypes were randomly mixed and planted at 1m square spacing with at least 64 seedlings (8 x 8m), excluding guard rows, per block. The trial was planted in December 1989, which was the beginning of the wet season.

The number of VSD infections, and the number and size (length and width) of sporophores of *O.theobromae* were recorded at monthly intervals after planting.

The effect of shade level on VSD in mature cocoa was studied in an infected 10-year-old block of commercial, mixed Trinitario x Amazonian hybrid cocoa planted at 4m square under *G.sepium* shade, with 36 cocoa trees per block and 4 replicates. Half of the shade trees were pruned to produce blocks with light shade and the remainder were left unpruned to provide blocks with dense shade. One month after the light shade treatments were established, the number and size (length and width) of sporophores were recorded in the two environments. Five infections between 2.0 and 2.5m above the ground on each of five trees chosen at random, giving a total of 25 infections in each shade treatment, were checked for the presence of sporophores of *O.theobromae*. The age of infections was standardized by measuring new infections in which about 10 leaves had fallen. The number of leaf scars was recorded to check that each infected branch had approximately an equal number of potential sporophore sites.

The surface areas of sporophores were calculated using the formula for the area of an ellipse, Πab, where a and b are the two radii measured at right angles to each other. Occasionally a sporophore completely surrounded the stem and in this case the surface area was determined using the formula for the surface area of a rectangle, length x width, where the width was determined from the circumference of the stem.

Extent of Infection in Mature Hybrid Cocoa

Six randomly chosen, 5-year-old commercial, Trinitario x Amazonian hybrid cocoa trees infected with VSD, planted at 4 x 4m square spacing under old coconut palms on Raulawat Plantation, East New Britain Province, were removed and the extent of infection by *O.theobromae* determined by splitting the branches and trunks longitudinally and examining longitudinal sections of the wood under a light microscope.

Field Observations

In October 1990, observations were made on Marangis Plantation, Coconut Products Ltd (CPL), on Kar Kar Island and on a plantation on the north coast of mainland, Madang Province. Both plantations had areas with a high level of VSD and the management strategies practised were assessed for their effectiveness in controlling VSD.

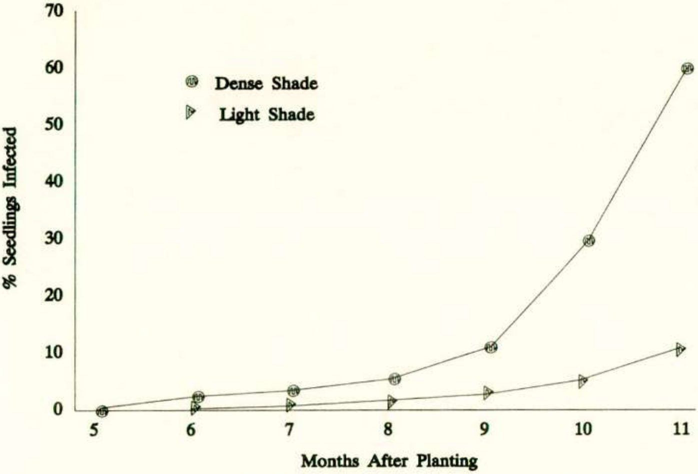
RESULTS

Effect of Shade on VSD

In both experiments the light shade treatments allowed 80% direct sun to penetrate the *G.sepium* canopy, whereas the dense shade treatment allowed only 20%. Blocks with light shade were noticeably warmer and dried out much faster during the day than the blocks with dense shade.

The first infections in the seedlings were observed 5 months after planting. The trial was stopped 11 months after planting, by which time 9.8% of seedlings under light shade were infected compared with 63% of the seedlings under dense shade. The proportion of infected seedlings increased exponentially (see Figure 1). The rate of disease increase was determined by taking logarithmic transformations of the exponential curves and calculating the gradients of the disease progress lines, which were 0.42 for dense and 0.31 for light shade (see Figure 2). Regression analysis revealed that the transformed values for both the dense and light shade were very close fits to a straight line ($P < 0.005$, $R^2 = 0.98$ and 0.97 respectively). The light shade treatment reduced the rate of the disease epidemic and delayed the onset of the epidemic (see Figure 2). A total of only 9 sporophores (mean area $2.5 +/- 0.4 cm^2$) was recorded during the 7 months of observations on this trial, and all occurred in blocks with dense shade. Many of the seedlings in the lightly shaded blocks had obvious flush leaf damage, and some flushes were totally destroyed. This flush leaf damage did not occur in the densely shaded blocks.

FIGURE 1: THE PROPORTION OF COCOA SEEDLINGS INFECTED BY VSD UNDER LIGHT AND DENSE SHADE TREATMENTS, PLOTTED AGAINST TIME AFTER PLANTING



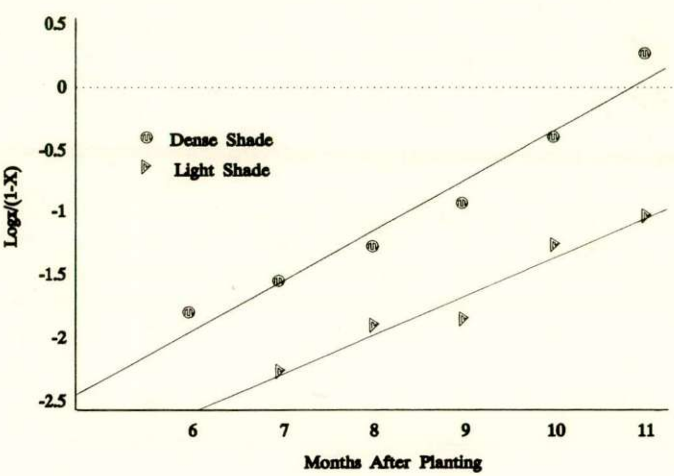
Thinning the shade trees in a mature stand of cocoa reduced the number of new sporophores by 47% and reduced the mean size of the sporophores by 52% compared with densely shaded blocks (see Table 1). There was no significant difference ($P < 0.05$) in the mean number of leaf scars sampled from the two shade treatments.

Extent of Infection in Mature Hybrid Cocoa

External symptoms were very limited in the 5-year-old cocoa trees observed on Raulawat Plantation, with only a few branches showing typical symptoms (ie. chlorotic leaves with green islands, raised lenticels and the presence of sporophores). Microscopic examination of longitudinal sections of xylem of split branches of all six trees examined revealed that

O.theobromae was present in at least 50% of xylem vessels of the major fan branches, and extended right through the trunks (mean girth 40 +/- 5cm, mean height of jorquette 120 +/- 10cm) and down into the main tap roots to an average depth of 70cm below ground level. Although these trees were extensively infected, as shown by the amount of streaking and the extent of infection of xylem vessels by *O.theobromae*, the disease appeared to have had very little detrimental effect on the trees at this stage. Yield and growth of the trees were not greatly affected by the infections (pers. comm. M.Mitchell, Manager, Raulawat Plantation).

FIGURE 2: LOG_{10} X/(1-X), WHERE X IS THE PROPORTION OF COCOA SEEDLINGS INFECTED, IN LIGHT AND DENSE SHADE TREATMENTS, PLOTTED AGAINST TIME AFTER PLANTING



Field Observations

The only rainfall information available for Madang Province was from Kar Kar Island, which experienced an unusually high annual rainfall and number of rainy days in 1988 and 1989.

Several large areas of 18-month-old commercial, Trinitario x Amazonian hybrid cocoa on a plantation on the north coast of the province were severely affected by VSD. The areas had been totally cleared of old cocoa before planting, and no old cocoa remained adjacent to or even close to the new plantings. Weeds had been well controlled but the shade provided by *L.leucocephala* was too dense as shown by the very high jorquettes on the cocoa seedlings. All of the seedlings in one hectare that were closely examined were infected and over 90% of all branches were infected. Scraping of the leaf scars revealed that all of the seedlings had extensive infections in the trunk. Many branches had died and although losses of seedlings were not high, it could be expected that many would eventually die. There were no pods, cherelles or even flowers. The seedlings had been raised on the plantation in an open air nursery shaded by *L.leucocephala*. Plantings of old cocoa heavily infected with VSD were located within 2m of the nursery.

TABLE 1: NUMBER AND SIZE OF SPOROSPHORES OF O.THEOBROMAE FORMED ON VSD-INFECTED BRANCHES ON MATURE COCOA AFTER APPLICATION OF LIGHT AND DENSE SHADE TREATMENTS

	Light Shade	Dense Shade
Number of infections sampled	25	25
Mean number of leaf scars per infection	10.3^{a} +/- 0.9	9.0^{a} +/- 1.0
Total number of sporophores	18	34
Mean surface area of sporophores (cm^2)	1.1^{b} + 0.2	2.3^{b} + 0.3

Means with standard errors
a Not significantly different
b Significantly different ($P < 0.05$)

Establishment of new plantings by CPL on Kar Kar Island has been very successful despite the high incidence of VSD in the area. Large areas of old cocoa on the edge of existing plantations were totally cleared and replanted. After 12 to 18 months there were very few VSD infections in the new material.

Among the worst affected areas of mature trees were those with a very high planting density. Marangis Plantation on Kar Kar Island has a large planting of 6-year-old commercial, mixed Trinitario x Amazonian hybrids planted at 3.6 x 1.8m spacing. These trees were found to be severely stunted with thin trunks and very severe VSD infections. Most of the trees in this area were extensively infected and several trees had died. The shade was provided by old coconut palms which appeared to be providing an ideal level of light shade. Blocks of the same material of similar age in this area, planted at 3.6 x 3.6m and even greater spacings, were far less severely affected by the disease. The trees that appeared to be the healthiest in this heavily infected area were often those near gaps in the plantings where the trees had been allowed to grow much larger than usual.

Two pruning strategies had been carried out on severely infected 6-year-old commercial, mixed Trinitario x Amazonian hybrids planted at 3.6 x 3.6m spacing at Marangis Plantation. These trees were so extensively infected that pruning of all infected wood would have involved the almost total removal of the trees. The first method of pruning was 'skeleton' pruning which involved cutting out the worst infected of the branches, leaving 2m of trunk and very few side branches, in an attempt to remove a large proportion of the infected branches. The result of this severe pruning was a deterioration in the health of the trees and a marked increase in the number of new infections. The second method of pruning was 'cosmetic' pruning, which involved pruning to prevent the canopies interlocking, thinning of the centre of the crown to increase exposure of the trunk to air and light, and removal of dead wood. No attempt was made to remove VSD infections. Although the trees were obviously infected, they generally appeared not to be suffering marked damage from the infections. Another common strategy in Madang Province involves no pruning of infections in the early stages and very little canopy pruning. The reasons often given for this were that the cost of pruning was too high given the current depressed cocoa prices or that, since VSD was not at a high level, there was no need to prune any infections. Older stands had badly interlocked canopies and a high level of VSD, resulting in some deaths due to the disease.

DISCUSSION

The results from the seedling trial show that the level of shade greatly affects the incidence of VSD in cocoa. The beginning of the epidemic in the lightly shaded blocks lagged behind that in the densely shaded blocks by 1 to 2 months. The fact that the lightly shaded blocks had fewer infections in the early stages of the trial than the densely shaded blocks was probably partly due to the damage to the flush leaves in the lightly shaded cocoa. The shade was so light that direct sun and drying winds damaged many new flushes. Only flush leaves are susceptible to infection by *O.theobromae* (Prior, 1978; Keane, 1981) and a reduction in the number of flush leaves could account for a reduced number of infections. The difference in disease incidence between lightly and heavily shaded cocoa is also likely to be partly due to the more rapid drying of flush leaves in the mornings in the lightly shaded cocoa. The infection efficiency of spores is likely to be increased by prolonged leaf wetness. This could also account for the slower rate of epidemic development in the unshaded as opposed to the shaded treatment. It is also likely that the different rate of epidemic increase was affected by the fact that there was only production of sporophores in the densely shaded blocks. This provided an additional localized inoculum source which would have accelerated the increase in disease. Since the experimental blocks were small, inoculum from the densely shaded blocks may have spread to the lightly shaded blocks and may have masked the full extent of benefits to be gained from reducing the density of shade over cocoa.

The large reduction in the number of new sporophores and the significantly smaller size of the sporophores that resulted after thinning of the shade trees in a mature stand of cocoa, was almost certainly due to increased dryness in the lightly shaded blocks. Sporophores require very damp conditions to develop (Keane et al., 1972) and one immediate effect of thinning of the *Glincidia* shade was to increase the rate at which the cocoa trees dried out during the early mornings.

While reducing the density of shade reduces the inoculum in the field by restricting the number and size of sporophores, and consequently the rate of dispersal of the fungus, some level of shade is necessary for the establishment of seedlings (Wessel, 1985) and for stable production of cocoa with minimal inputs. Removal of shade requires a higher standard of management plus fertilizer inputs to maintain health of trees and yield (Ahenkorah et al., 1974). Mature coconut palms provide an ideal level of light shade and also provide the farmer with a second cash crop as well as a very important food source.

A plant is said to be tolerant, relative to another, if for a given degree of infection by a pathogen it suffers less damage and yield loss (Frey et al., 1977). Based on this definition, it is evident that the trees examined from Raulawat Plantation, which had a high level of infection but sustained minimal damage and yield reduction, can be said to show a degree of tolerance to VSD. It would have been impossible to prune out all the infections in the hybrid cocoa on Raulawat Plantation without removing the entire tree and in fact there was no need for such control measures since yield was considered to be unaffected. The spread of VSD infections into the roots has been reported in seedlings (Keane, 1972), but never before in mature cocoa and the significance of root colonization is unknown. The long term consequences of selection for, and widespread use of, tolerance are unclear. One effect is that the level of inoculum may build up, depending on whether the tolerant trees allow sporulation. This could potentially lead to a destructive epidemic. The nature of the apparent tolerance to VSD observed in these trees, the extent of the phenomenon and its occurrence in different cocoa genotypes requires further study.

The severe VSD problem in the seedlings on the plantation on the north coast of Madang Province was almost certainly due to the seedlings having been infected in the nursery. The high incidence of VSD in the seedlings at this young age, and also the number and uniformity of infections, indicates that the seedlings were infected at the same time. Once exposed to spores of *O.theobromae*, seedlings take from 3 to 6 months (Keane et al., 1972), or even longer for some hybrids, to develop symptoms. As a consequence, seedlings exposed to spores in the nursery are unlikely to show any obvious symptoms until well after they are planted out in the field. The absence of a strong inoculum source near the new plantings and the uniformity of distribution of the infections (the lack of an infection gradient from an inoculum source) indicate that the original infections most probably did not occur after planting. Since the nursery was close to old infected cocoa and the seedlings were planted during a long wet period, it is most likely that the weather conditions resulted in production of sporophores on the old cocoa and dispersal of spores to the nursery. As symptoms appeared in the field the continuing wet period would have favoured the production of sporophores from the first infections with the consequent spread of disease to all new shoots. This would account for the current disease epidemic. Thus, there were two main factors which contributed to the VSD epidemic on this plantation. The first was the long period of wet weather, which was unusual for this area, and the second was the management and location of the nursery. Nurseries should ideally be isolated from old cocoa by at least 100m to minimise the likelihood of spores reaching the seedlings (Keane, 1981). The use of a roof of thin polyethylene film over the nursery provides very effective protection of seedlings (Anon, 1967; Sidhu, 1987). This excludes rain and reduces dew formation, thus reducing the occurrence of conditions suitable for infection (Keane et al., 1972). The VSD situation on this plantation highlights the need for simple precautions to be taken at the nursery stage.

The successful establishment of new plantings by CPL on Kar Kar Island despite the high incidence of VSD in the area, provides further evidence that the fungus, although wind dispersed (Keane, 1981), does not spread very far. To minimise the likelihood of infecting new plantings, replanting is best done in areas not surrounded by old infected cocoa.

It has been suggested that vigour of the Trinitario x Amazonian hybrids may enable them to rapidy replace branches lost to VSD (Tan & Tan, 1988) and to outgrow infections. High density plantings such as those observed on Marangis Plantation, greatly reduced the vigour of the trees and may account for the extensive damage being caused by the disease. The high density of planting allowed the canopies to become interlocked at an early stage of development, thus severely restricting vegetative growth. Cocoa of similar age and genotype in the same area, planted at wider spacing, was larger and far less severely affected by the disease. It was apparent in the field that the very large trees were coping best with the disease. They were still extensively infected but the overall health of the trees was far superior to that of the trees in very dense plantings. The growth of trees is greatly affected by inter-tree competition for solar radiation and soil nutrients and this competition is minimized in low density plantings. In close plantings the micro-climate is also likely to favour strongly the development of VSD through its direct effect on the fungus, as demonstrated in the shade experiments. While close spacing gives a higher yield in the early years, once a canopy forms and the soil becomes fully exploited, the difference in yields between close and wider spacing is reduced (Wood, 1985).

'Skeleton' pruning of trees heavily infected by VSD at Marangis Plantation had two detrimental affects. Firstly, the trees were stressed due to the large amount of physical damage from the pruning and, secondly, the amount of flushing was greatly increased. The extended wet period following this treatment was ideal for sporulation and infection and consequently the level of infection greatly increased. The effects of 'skeleton' pruning were compounded by the high density plantings which greatly inhibited growth of the trees. Once a tree is extensively infected it is not possible to remove all the VSD infections and so the best management strategy is to encourage strong growth of the tree by minimizing the amount of damage that results from pruning.

There is a widespread belief that diseases need be treated only when they are causing obvious damage. This attitude is catastrophic for a disease such as VSD and as a consequence growers often only realise that there is a problem with this disease when it is too late. Preventative action is most effective when VSD is at a low level and is not causing any significant problem. Growers have to learn to live with, and manage, VSD, beginning in the nursery.

The key to good management of VSD is to avoid infection in the early growth stages of the cocoa, as infections in the main stem are mostly fatal (Keane, 1981). Once established, cocoa trees are more likely to be able to tolerate infections. Clearly, practices such as the use of unsuitable planting material, or neglect of the necessary precautions to prevent infection of seedlings in the nursery, are likely to result in an increased VSD problem before the seedlings are even established in the field. Suitable planting material should be raised in a nursery that is covered by a polyethylene sheet and sited as far away from other cocoa plantings as possible. New plantings also should be as far away from other cocoa plantings as possible and no old infected cocoa trees should be left in an area that is being replanted. This will minimize the chance of the new seedlings being exposed to VSD spores at an early age. Underplanting of seedlings beneath infected mature cocoa should be discouraged, as this creates a 'green bridge' for transfer of infection to the new plantings.

Management strategies for the control of VSD can be divided into two distinct categories. One strategy is for areas where the incidence of VSD is low or for replanting, when only preventative management is necessary. The second, and by far the most difficult, is for areas where the level of VSD is already very high and rehabilitation of the infected cocoa is required.

Where the level of VSD is low, priority must be given to maintaining a very low level of infection. This is best achieved with regular rounds of pruning to cut out infected parts of branches at intervals of about 2 months, and certainly no greater than 3 months. This removes infections from the tree, reduces internal spread of the disease, and also prevents the external spread of the disease by removing the source of fungal sporophores. Neither removal from the plantation nor burning of the infected prunings is necessary because the fungus cannot live in or sporulate on dead or dying wood (Prior, 1977). During pruning the branches are first split to reveal the extent of brown streaking in the wood and then cut 30cm below the last detectable streak. This is necessary because the fungus may be present beyond the region of discolouration (Keane et al., 1972). This very simple method will ensure the long term health of the trees and, even if a long wet period occurs, the disease is unlikely to reach epidemic proportions as the pruning will maintain a low inoculum level. The added cost of regular pruning must be considered in relation to the potential savings through preventing an epidemic of the disease. Pruning of infections could be combined with regular canopy pruning, which is required for management of vigorous hybrid cocoa. The disease may be more efficiently controlled if the frequency and thoroughness of pruning rounds is increased just before the onset of the rainy season. Since disease incidence is strongly associated with higher rainfall during the wet season, which increases flushing and thus the number of susceptible sites for infection and provides an environment conducive to sporulation and infection by the fungus (Dennis, Holderness & Keane, 1992), it is likely that eradicative pruning will be most effective if carried out at least one month prior to the wet season. This would greatly reduce inoculum production, and in turn reduce the number of new infections occurring during the wet season.

In situations where the disease is causing widespread damage or most of the trees are extensively infected, more drastic action is required. Tolerance to infection must be promoted through management strategies. High density plantings should be pruned or thinned to encourage strong vegetative growth and canopies must not be allowed to interlock. If the shade is too dense, it should either be pruned or thinned to provide a minimal amount of shade. This will increase growth and yield (Wessel, 1985) and also reduce the occurrence of micro-climatic conditions which favour the spread of the disease. Drastic pruning and removal of infected wood is not recommended, as this will further stress the trees and may result in increased flushing and consequent increase in number of infections, particularly if it is done prior to a wet period. The emphasis should be on encouraging strong growth of the trees in order to enhance their tolerance to the disease. The application of suitable fertilizers may be of some benefit through encouraging growth and improving tree health.

The management strategies discussed here, particularly control of shade levels, cocoa planting densities and canopy pruning, which greatly affect the micro-environment by reducing high relative humidity are also likely to reduce the incidence of two other important diseases of cocoa in the region, *Phytophthora* pod rot (caused by *Phytophthora palmivora*, Butler) and pink disease (caused by *Corticium salmonicolor*, Berk & Br). These two diseases, like VSD, are most active during the wet season.

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THE INCREASING IMPORTANCE OF CUPUASSU (THEOBROMA GRANDIFLORUM) IN THE AMAZON REGION OF BRAZIL

H.A.Laker * and O.Trevisan **

INTRODUCTION

The cupuassu (*Theobroma grandiflorum* (Willd Ex Spreng) Schum is a fruit tree of the family Sterculiaceae. The tree's natural habitat is the forest in the south and south east Amazon region where it is still found in the wild state.

The fate of cupuassu in Brazil has been closely linked with that of *Crinipellis perniciosa* (Stahel) Singer, the causal pathogen of witches' broom disease of cocoa (*Theobroma cacao L.*). There are suggestions that *C.perniciosa* originated on cupuassu and then spread to other *Theobroma* species native to the Amazon forest (Pound, 1938; Alencar et al.,1988). To avoid the inadvertent dissemination of this pathogen to the cocoa growing States of Bahia and Espirito Santo, a Decree from the Brazilian Ministry of Agriculture in 1920, banned the movement of cupuassu out of the Amazon region. Another Decree from the same ministry in 1940, extended the ban to include all *Theobroma* species and members of the Sterculiaceae family from the States of Acre, Amazonas and Para.

The increase in cocoa cultivation in Rondonia and Para States after 1976, coupled with the appearance of epidemic levels of witches' broom disease in the region instigated the establishment of the "Campaign to control Witches' Broom Disease" (CAVAB). Phytosanitary inspectors were strategically located to rigorously check the movement of botanic materials out of the Amazon region. A Decree in 1978, widened the "cordon of vigilance" to include the States of Amapa, Acre, Amazonas, Goias, Mato Grosso, Maranhao, Para and Rondonia (see Figure 1). By the end of that year, check points were already mounted at the main airports of Bahia, Amazonas, Acre, Para and Rondonia States and on the principal ports and roadways (Alencar et al., 1988). To reduce the spread of the disease within Amazonia, a Decree in 1979 prohibited the movement of *Theobroma* species from municipalities with *C.perniciosa* to those where the pathogen was not known to occur. Cupuassu seeds, seedlings and pods were the botanical materials most frequently apprehended and incinerated by CAVAB agents from 1979 to 1988. The activities of CAVAB were suspended early in 1990 when the existence of *C.perniciosa* in Bahia was confirmed in 1989.

With the restrictions to its distribution lifted, cupuassu is rapidly changing from being a back-yard tree and emerging as one of the potentially most promising crops of the Amazon

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region. Two factors in its favour are the prevalent low prices for cocoa, coffee and rubber (the principal perennial cash crops of the region) and the steadily increasing interest of foreign agro-industrialists to purchase large quantities of cupuassu pulp.

FIGURE 1: MAP OF BRAZIL SHOWING THE STATES WITH LARGE AREAS OF CUPUASSU

DISTRIBUTION

Cupuassu is a typical Amazonian tree found growing wild in Brazil, Bolivia, Costa Rica, Ecuador, Guyana, Peru and Venezuela. According to Correa (1984), it is cultivated in all Brazilian states from Maranhao to Sao Paulo. However, the states with significant planted areas of the crop are Acre, Amapa, Amazonas, Bahia, Maranhao, Mato Grosso, Para, Rondonia, Roraima and Tocantins (see Figure 1). Because cupuassu is only now being accepted as a commercial crop, there is little information on the extent of its cultivation in most of these areas. In Para, most of the cupuassu marketed is gathered from "spontaneously" growing tree's in the forest. However, large areas of the crop have recently been established at Tome Acu and Maraba municipalities in the State of Para. About 2,500ha of planted cupuassu exist in that State (EMATER - Para, pers. comm.). Amazonas State has approximately 600ha of cupuassu plantations and many trees growing wild on the river banks and in the forests (EMATER - Amazonas, pers. comm.). In Rondonia, where the crop is relatively new, 1,200ha of cupuassu has already been established with 10% of this in production (Anon, 1991). According to the same source, farmers and researchers have shown such a high interest in cupuassu that a ten fold increase in production can be expected within the next four years. The annual production of cupuassu pulp from Acre State is approximately 350 tonnes.

USES

Cupuassu produces a mucilage which is acid and has a strong, pleasant aroma and taste. This is used in the preparation of juices, ice creams, liquors, sweets, fruit preservations, tarts, pies, nectar, yoghurts and biscuits. In a pilot trial conducted in Belem, Para State, 'cupulate' in powder and tablet forms was found to closely resemble chocolate in colour, smell, taste, consistency and consumer acceptability (Anon, 1988). However, at the moment, the bulk of the cupuassu seeds are not yet used commercially.

ECOLOGY

Cupuassu is concentrated within the humid tropics and grows well in deep, firm, fertile soils with good water retention capacity. It tolerates soils with low fertility levels, but with good physical structures (Venturieri et al., 1985). The plant thrives in regions with annual rainfall in excess of 1,800mm, which should be well distributed throughout the year and with average temperatures above 23°C.

VARIETIES

Calzavara (1987) grouped the present cupuassu cultivars into three "varieties" based on their pod characteristics, as follows:

(i) **Round cupuassu (redondo)**: This is the commonly grown fruit in the region. It is medium sized, weighs about 1.5kg, has rounded ends and a 6-7mm thick husk;

(ii) **Large cupuassu (mamorana)**: This is the large sized pod, average 2.5kg in weight although some reach 4.0kg. The pod is elongated at the ends and has a 7-9mm thick husk;

(iii) **Seedless cupuassu (mamau)**: This is a well defined cultivar which resulted from a spontaneous mutation. Average weight of the pods is 2.3kg of which 67% is pulp.

AGRONOMIC REQUIREMENTS

The research on cupuassu is still at an early stage. Consequently, many suggested agronomic practices are based on information derived from research on cocoa.

Shade

Cupuassu may be planted in areas totally or only partially cleared from forest. It is important that temporary shade be established before young plants are transferred to the field. Bananas at a spacing of 5 x 5m is recommended, but cassava, paw paw, or other crops which provide shade in addition to some income for the farmer could also be used (Venturieri & Alves, 1984). To ensure a smooth transition from the provisional shade trees to the permanent trees after four years, it is advisable to plant both tree types at the same time. Recommended shade trees for the Amazon region include inga (*Inga edulis Mart.*), leucaena (*Leucaena glauca Benth*), golden apple (*Spondia lutea L.*) planted at a spacing of 20 x 20m. Peach palm (*Bactris casipaes H.B.K.*) or coconut (*Cocos nucifera L.*) at a spacing of 10 x 10m may also be used. Venturieri and Alves (1984) recommend the planting of several tree species for permanent shade to avoid severe damage that may be caused by an upsurge of pests or diseases.

Planting

Young, robust seedlings should be transplanted into the field when 6 to 8-months-old. Planting should be at the beginning of the rainy season. Adequate shade should already be established so that the young plants receive a maximum of 75% direct light (Venturieri et al., 1985).

Spacing

Venturieri and Alves (1984) recommend planting cupuassu at a spacing of 7 x 7m organised in a triangular arrangement. This gives a population of 234 plants per ha. Plants from cuttings may be established at 6 x 6m spacing organized in a triangular or quadrangular pattern. These systems would result in 277 and 319 plants per ha respectively.

Cultural Treatments

Although cupuassu thrives in a wild habitat, its growth, development and productivity is improved with good maintenance. Weeds around the tree trunks should be eliminated manually. The tree should be mulched towards the end of the wet season.

Structural pruning, involving removal of branches less than 1.5m from the ground, facilitates cultural treatments on mature trees (Calzavara, 1987). The trees also require phytosanitation to remove dry branches and tissues infected with witches' brooms.

Fertilizers

There is still inadequate data on fertilizer use on cupuassu. However, extrapolating from information on cocoa, Calzavara (1987) recommends application of NPK and Mg at the rate of 300-600g/plant/year for adult trees. The fertilizer should be applied in three applications at the onset, middle and towards the end of the rainy season. Excellent response was observed when fertilizer use was supplemented with animal or chicken manure (Venturieri et al., 1985).

HARVEST

In the States of Amazonas and Rondonia, cupuassu flowers during June to March with peaks between November and January. Peak pod production occurs during February and June. Pods mature some four to four and a half months after flowering and fall spontaneously to the ground from where they are collected.

Venturieri et al., (1985) estimate that on a technically well-maintained plantation with fertilizers applied correctly, pod production per ha reach 400 in the second year in the field, 4,000 in the fifth year and stabilizes around 9,000 from the ninth year onwards. On average, such trees produce 20-30 pods per tree at 4-5 years, and may reach 60-70 pods per tree after seven years. In economic terms, 10kg of cupuassu with seeds produce 4.6kg of pulp, 3.8kg of "cupulate" (Venturieri et al., 1985).

PROCESSING

This involves separating the cupuassu seeds from the mucilage and transforming the latter into pulp. Increasing numbers of depulping machines capable of processing 60 to 2,500kg of pulp per hour are being established in centres where cupuassu is concentrated. Besides cupuassu, these machines are also utilised for processing a range of tropical fruits such as plums, mango, pawpaw, guava, pumpkin, passion fruit, tomato etc. available in the locality and for local consumption.

COMMERCE

Cupuassu pods are sold in road side stalls, markets and small stores within the producing region. The ice cream, juice, sweets, yoghurts, tarts etc. are sold in ice cream parlours, supermarkets and restaurants in most Brazilian cities. Present demand for the commodity highly exceeds supply and is reflected in the price of US$3-4 paid to the farmer for a kilogram of pulp. Interest in regular purchases of large quantities of cupuassu has been indicated by agro-industrialists from Holland, Sweden, France, England, Germany and Japan.

PESTS

Cupuassu seedlings in the shade house may be attacked by crickets (*Grillus sp.*), leaf cutting ants (*Atta sp.*) and nocturnal caterpillars which feed on the leaves and hide in the soil during the day. These are easily controlled with insecticides. The pod borer (*Conotrachelus humeropictus*) is potentially the most serious pest of cupuassu in the field in Amazonas and Rondonia States at the moment. The adults deposit their eggs deep into the interior of the pods. The larvae which emerge feed on the placenta and then burrow out of the pod to pupate and complete their life cycle in the soil. These burrows facilitate the entrance of fungi and bacteria into the pods. Pod losses equivalent to 50% of the annual production was observed on a plantation in Rondonia in 1990. Other frequently encountered pests are leaf destroying aphids (*Aphis sp.*), beetles (various *Colepteras* of the family Clyzomelidae) and an unidentified trunk borer of the family Cerambycidae. Mirids of the *Monalonion* sp. attack young shoots and pods.

DISEASES

Witches' broom disease caused by *C.perniciosa* is the most important disease of cupuassu. The vegetative shoots are highly susceptible to the pathogen but pods are rarely infected. Control is through regular phytosanitation to remove the brooms. Anthracnose caused by *Colletotrichum gloeosporioides* attacks stems, leaves and pods and occasionally causes serious pod losses. It may be controlled by pruning and elimination of all infected materials and application of a copper fungicide if the intensity is severe. Thread blight caused by *Pellicularia koleroga* is common. All affected branches and leaves should be cut off and burnt.

Progressive death of cupuassu caused by *Lasiodiplodia theobromae* was observed for the first time near Manaus in Amazonas State (Lima et al., 1991). The fungus colonizes the internal stem tissues causing necrotic rings on the affected areas. In the advanced stage, the colonized tissues may become deformed and expose the xylem. Drying of the stem progresses until death of the tree. A leaf spot caused by *Phomopsis* sp. was reported to be widespread in Castanhal and Belem in the State of Para (Stein et al., 1991). The disease causes defoliation or reduction of the photosynthetic areas of cupuassu trees. Dieback caused by the fungus *Ceratocystis fimbriata* Ellis and Halst in association with damage by the insect vector of the genus *Xyloborus* was recently observed in Rondonia.

DISCUSSION

The present supply of cupuassu is insufficient to meet the demand for its various products even within the region where the crop is produced. With the lifting of the restrictions on free movement, there are indications that the area planted with cupuassu will expand rapidly during the next 3-5 years to meet the requirements of the export market. The stimulus for this is the high price cupuassu receives compared to the other traditional plantation crops. In addition, the tree is ecologically well adapted to the climatic and edaphic conditions of Amazonia and can be established with minimum interference to the forest ecosystem.

However, there are problems of processing and marketing cupuassu that still require attention. The ripe cupuassu pod must be processed within 10 days of harvest otherwise it rapidly deteriorates in quality. Large scale commercial production of pulp by depulping machines requires a reliable energy source. The pulp must be stored frozen until ready for use. Depulping machines and cold storage facilitates can be easily installed on large plantations, but, small scale farmers are the backbone of the agriculture of the Amazon region. Electricity supply in many rural areas is frequently irregular or non-existent, and the transport systems in many areas are precarious. With several middle men separating the producers from the consumers, the present lucrative prices of cupuassu will be difficult to maintain. It is therefore important that marketing strategies should be devised to ensure fair prices to producers and adequate supplies to consumers. Existing, or new, associations of fruit growers could form the basis for marketing cooperatives to assist the small scale farmers.

There are presently no devastating pest or disease problems of cupuassu in Amazonia. Unlike cocoa which suffers pod losses of 50-70% of its production to witches' broom disease, losses on cupuassu remain low because it flowers and sets the bulk of its pods during the period of low inoculum intensity. Although many cupuassu trees with hundreds of dry brooms in their canopies continue to bear healthy fruits, phytosanitation at least twice a year, is recommended. This is because brooms reduce the phytosynthetic capacity of the tree and consequently its productivity. According to Pound (1938), there was a saying in the lower Amazon region that cupuassu and cocoa trees are not good neighbours. This is most probably due to the diseases and pests that the two *Theobroma* species have in common. Attacks on cupuassu by pests and diseases presently restricted to cocoa should be expected. It is advisable that the two trees should not be planted jointly.

The fledgling research on cupuassu requires strengthening. Emphasis should initially be directed to botanical surveys within the Amazon forest to collect the wild genotypes which could disappear as a consequence of development of the forest lands. This germplasm should be assembled in collections and selected and evaluated at various sites within the region. To increase the production of cupuassu in the short term, research should assess high density planting of the trees. Investigations should also establish the profitability of cupuassu interplanted with other fruit trees such as bread fruit, avocado, golden apple or valuable wood trees such as cordia (*Cordia goeldiana*), mahogany (*Swietenia macrophylla King*), inga and *Erythrina sp.*

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OCTOBER 1991

Bioeconomic modeling in agroforestry: A rubber-cocoa example
WOJTKOWSKI,P.A., JORDAN,C.F. and CUBBAGE,F.W. School of Forest Resources, University of Georgia, Athens, Georgia, USA - *Agroforestry Systems (Netherlands)* v.14(2) p.163-177; 1991
A rubber (Hevea)-cocoa agroforestry combination was bio-economically modelled for a 40-year cycle using data from Bahia, Brazil. A number of scenarios were simulated to find the planting densities and management strategies that achieve the best production and profit levels for each situation. This example is presented to demonstrate the possibilities and advantages of a simulation approach to agroforestry modelling.

Cocoa Husk borer, (Cryptophlebia encarpa Lep. Tortricidae) pest of cocoa in Sarawak
GUMBEK,M. Agricultural Research Centre, Kuching, Sarawak, Malaysia - *Planter (Malaysia)* v.67(780) p.101-106; Mar 1991
The cocoa husk borer, Cryptophlebia encarpa, is an important pest of cocoa in Sarawak, Malaysia. The life-cycle, insect biology, nature of damage, pest incidence, host plants, pest control measures and potential crop losses are highlighted. The life-cycle takes 27-32 days. The larvae damage pods of all sizes. Pyrethroids were effective in the control of the pest.

[Effect of seasonal variables on the relationship between pod weight and fresh bean weight of cocoa in the Ivory Coast]. Effet de quelques variables saisonnieres sur la relation entre poids de cabosse et poids de feves fraiches chez le cacaoyer: bilan d'observations en Cote d'Ivoire
LACHENAUD,P.H. Institut de Recherches de Cafe et du Cacao (IRCC), CIRAD, Kourou, French Guiana - *Cafe, Cacao, The (France)* v.35(2) p.113-120; Apr 1991
The relationship between fresh bean weight and pod weight of different hybrids of cocoa was studied for 3 years in the Ivory Coast. The fresh bean weight/pod weight ratio (R) increased over the years with successive harvests. There was a positive correlation between R and the harvest date (in days since the beginning of the harvest) within each season. The mean pod weight was negatively correlated with R. The date of harvesting had much more influence on the size of the pods and their contents than the availability of water and nutrients during their development. The mean fresh bean weight was positively correlated with the mean pod weight. Three models for the determination of mean fresh bean weight per pod are presented. The mean pod weight was found to be the most useful variable for the determination of the mean weight of fresh beans. The weight of fresh beans produced by a hybrid may be calculated in terms of the number and total weight of the harvested pods. Conditions for use of the model are discussed as well as the implications of these results in terms of cocoa physiology.

NOVEMBER 1991

[Production and consumption]. Produccion y consumo
CUBILLOS Z., G. Compania Nacional de Chocolates, Medellin, Colombia - *Cacaotero Colombiano (Colombia)* v.13(38) p.5-11; Jun 1990
World cocoa production for 1990/91 is estimated as 2,427,000t, and a breakdown of this figure on a regional and country basis is provided together with actual production figures for the period 1979/80 - 1989/90.

Situations in various producer countries (Ghana, Brazil, Malaysia and Indonesia) and in the principal consumer countries (USSR, Germany, Netherlands, USA and Singapore) are discussed. Colombian production for the first 6 months of the 1990/91 season is reported as 28,118t and the estimate for the whole year is 45,000t, no increase over the production of the previous year (data on annual production in Colombia and its different regions between 1980 and 1989 are tabulated). The world market is entering its seventh consecutive year of excess production with world reserves for 1990/91 estimated to reach 1,561,000t,exceeding the reserves of the previous year by 130,000t. Nevertheless, a 3% increase in world consumption is hoped for in 1990/91 and with a sustained increase in grinding activity in consumer countries there could be a significant and sustained recovery in prices in the future.

Studies on cocoa processing: influence of moisture reduction and mixing on the changes in fermentation and quality of the dry beans in monsoon season
BOPAIAH,B.M. and SHANTARAM,M.V. Regional Station, Central Plantation Crops Research Inst, Vittal, Karnataka, India - *Indian Cocoa, Arecanut and Spices Journal (India)* v.14(1) p.1-7; Jul 1990
In Karnataka, India, fresh cocoa beans were analysed for pH (cotyledon and pulp), pulp content, total soluble solids and bean weight, in the wet and the dry season. The moisture content of the cocoa beans was reduced prior to fermentation by sweating in baskets or gunny sacks and by mechanical pressing. Four schedules for mixing during fermentation were tested to improve the aeration, moisture content and temperature of the bean mass. An experiment was conducted to achieve rapid substrate reduction prior to fermentation. Beans from freshly opened baskets were spread in a layer of 7.5cm for 18 hours. This improved the quality of the dry beans. Changes in temperature and cotyledon and pulp pH were monitored during fermentation. Moisture reduction improved bean acidity. All the mixing schedules had a similar effect on bean acidity and fermentation.

[Rosellinia spp. in cocoa]. La Rosellinia del cacao
MERCHAN V., V.M. Seccion Fitopatologia, Instituto Colombiano Agropecuario (ICA), Manizales, Colombia - *Cacaotero Colombiano (Colombia)* v.13(38) p.13-19; Jun 1990
Fungal root rot of cocoa caused by Rosellinia pepo, Rosellinia paraguayensis and Rosellinia bunodes in Colombia is described. The aspects covered are: disease incidence in Colombia; damage and importance; disease symptoms; plant hosts and resistant plant species; factors important to the propagation of the disease, and disease control. The use of the tolerant hybrids IMC 67, P 7 and UF 613 is recommended.

Effects of foliar application of selected insecticides on cocoa pests and pollinators
IBRAHIM,A.G. Department of Plant Protection, Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia - *Pertanika (Malaysia)* v.13(3) p.361-366; Dec 1990
In Malaysia, cocoa plants sprayed with insecticides such as gamma-HCH, methamidophos and cypermethrin using mistblowers at weekly intervals for 20 consecutive weeks produced high numbers of cocoa flowers but the percentage of effective pollination was not significantly different from the control. The effects of insecticides on the insects varied. The population of the insect pest Helopeltis spp. decreased, but the population of the pollinators (Forcipomyia spp.) and minor insect pests (Aphis spp. and Cataenococus spp.) were not eliminated. The emergence of midges from the ground traps indicated that sprayed insecticides did not affect the breeding of the midges in the cocoa field.

Annual Report for 1988/89
International Cocoa Organization, 22 Berners Street, London, UK p.40; 1990
Subjects dealt with in the annual report of the International Cocoa Organization include: (1) membership, and the work of the Council and its subsidiary bodies; (2) the operation of the buffer stock and the economic provisions of the 1986 Agreement, and (3) the world cocoa situation. Figures on the production, import and export of several countries are included. The world production of cocoa beans in 1988/89 attained a new all-time record of 2,441,000t.

DECEMBER 1991

Cocoa growers in Dominican Republic show the way
ROSE,I. DE LA, ROCHE,G. and KIESSLING,R. - *Gate (Germany)* v.2,p.4-8; Jun 1991
Sanchez is the main cocoa variety grown in the Dominican Republic, and about 40,000t of cocoa are sold to the USA. This cocoa is of inferior quality mainly because of inefficient processing methods. A technology transfer project was initiated in 1985 to improve cocoa quality, with the objective of increasing the income of cocoa producers with <5ha. Three types of cocoa bean fermenters were tested: (1) wooden fermenting boxes (efficient but expensive because of the imported wood); (2) small plastic boxes with a capacity of 25kg, and (3) heap fermentation completely covered with black plastic sheet. The cost-benefit ratio is discussed. The small farmers formed the "National Federation of Dominican Cocoa Growers" for the marketing of cocoa, and the provision of advisory services and training courses.

[Intercropping of cocoa and coconut]. Tumpangsari Kakao-Kelapa
SYAMSUL ANWAR, SJARHRUM LUBIS and NAPITUPULU,L.A. - *Buletin Perkebunan (Indonesia)* v.21(3) p.134, 159-174; Sep 1990
Intercropping of cocoa and coconut in Indonesia is reviewed. Coconut provides shade during all seasons, can withstand strong wind, provides a crop of its own and is the host of the ant Dolichoderus thoracicus, a natural enemy of the insect pest Helopeltis spp. In order to obtain the optimum production of cocoa and coconut planting density and other cultural practices should be adapted.

[Criteria for land classification for bulk cocoa]. Kriteria dan evaluasi kesesuaian lahan kakao lindak
POELOENGAN,Z - *Buletin Perkebunan (Indonesia)* v.21(2) p.69, 73-84; Jun 1990
Land suitability criteria were defined for cocoa in Indonesia. According to the modified land suitability criteria for bulk cocoa, the land condition of Adolina Estate PTP-6 is classified as S2 (moderately suitable) and S1 (highly suitable). The average production of S2 and S1 is 1500-2100 and >2100kg dry cocoa beans/ha/year, respectively.

Wine and jam from cocoa or how to turn "waste" into food
BAENSCH,W. - *Gate (Germany)* v.2,p.7-10; Jun 1991
The preparation of food and feed items from cocoa materials considered as waste is described. The methods are easy, and marketable produce can be made without buying any major equipment. These methods have already been tried by women's groups in the Dominican Republic. The materials utilized are the fruity sweet pulp juice or puree of the cocoa fruit and the fruit pods. The products prepared are drinks (refreshment drinks and fruit wine), vinegar, jam, animal feed and fertilizer. The collection of the pulp juice and quality control of the produce is also described.

[Technical aspects and cost of production of clone and seedling cocoa plantations: a case study]. Tanaman klon dan semaian kakao ditinjau dari aspek teknis dan biaya

produksi: suatu kajian kasus
NAPITUPULU,L.A., DJA'FAR and SIAHRUM LUBIS - *Buletin Perkebunan (Indonesia)* v.21(3) p.135, 195-209; Sep 1990
Information is provided on the profitability of growing cocoa using clone and seedling material in Sumatra, Indonesia, based on studies of labour requirement and material costs. Cost-benefit analysis showed that cocoa planting using either clones or seedlings is profitable. However, clonal material gave a higher profit than seedlings as shown by the net present value, cost-benefit ratio and internal rate of return. The pay back period is shorter and the break even point is reached sooner. Another advantage of clonal production is improved cocoa bean quality in terms of bean size, uniformity and higher butter fat content.

[Performance of some cocoa hybrids at different planting densities under coconut trees]. Keragaan beberapa hibrida kakao dan kerapatan tanam di antara kelapa
SYAMSUL ANWAR and NAPITUPULU, L.A.- *Buletin Perkebunan (Indonesia)* v.21(2) p.69, 85-91; Jun 1990
The growth of cocoa hybrids at different planting densities was studied in Sumatra, Indonesia. Fourteen hybrids were tested at 2 planting densities. The parameters observed were vegetative and generative growth 6 to 18-months after planting. There were no interaction effects between hybrid and planting density except for the percentage of jorquetting at 12-months. The effect of variety on growth was significant, but planting density did not have a significant effect on growth. The performance of the hybrid Simirik was best.

MARCH 1992

Cocoa pod-and-husk meal as a feed ingredient in layer diets
OSEI,S.A., ATUAHENE,C.C., HEATHCOTE,D., FRIMPONG,E.B. and ADOMAKO,D. Animal Science Dept, University of Science and Technology, Kumasi, Ghana - *Animal Feed Science and Technology (Netherlands)* v.35(3-4) p.283-288; Nov 1991
A trial was conducted in Ghana, to investigate the nutritive value of cocoa pods-and-husk (CPH) meal for laying chickens. At an age of 37 weeks, 288 AF Bosbek brown egg layers were randomly allotted in equal numbers to 4 experimental diets incorporating 0, 25, 50 or 75g CPH meal/kg. Among the production parameters studied were hen-day egg production, egg, weight, yolk colour score, shell thickness and interior quality (Haugh unit) score. In addition, several haematological variables, including blood haemoglobin and serum total protein and cholesterol, were measured. With the exception of the Haught unit scores, which showed a significant positive response to dietary CPH levels, none of the other production parameters were influenced by the treatments. The addition of CPH did not significantly affect any of the haematological variables studied.

Chemical composition of cocoa pod husk and its effect on growth and food efficiency in broiler chicks
DONKOH,A., ATUAHENE,C.C., WILSON,B.N. and ADOMAKO,D. Department of Animal Science, University of Science and Technology, Kumasi, Ghana - *Animal Feed Science and Technology (Netherlands)* v.35(1-2) p.161-169; Oct 1991
Research conducted in Ghana showed that cocoa pod husk (CPH) contained (in g/kg dry matter) 76.6 crude protein, 43.7 ether extract, 325 crude fibre, 101 ash, 414 acid detergent fibre, 522 neutral detergent fibre and 108 hemicellulose. The metabolizable energy content was 4.72 MJ/kg. In comparison with maize, CPH contained less amino acids, except lysine. In a feeding trial 5 diets containing 0, 50, 100, 150 and 200g CPH/kg, with maize and fishmeal as major ingredients, were given ad lib to 450 1-week-old broiler chicks (AF Bosbek strain) for 7 weeks. The birds had free access to water. Addition of graded levels of CPH broiler diets increased food intake

by nearly 60% for the highest level of inclusion, reduced growth and hence reduced efficiency of food utilization compared with the control. Cocoa husk-fed birds consumed more water with a trend towards increased water consumption with each increment of CPH. A high negative correlation was observed between the concentration of CPH in the diet and carcass dressing percentage. There were no deaths attributable to CPH in the diet.

APRIL 1992

[Study of cocoa production in Brazil]. Etude de la production cacaoyere au Bresil
ICCO, London (UK) p.85; 1989
An analysis is presented of the structure of the cocoa economy in Brazil (production, trade, consumption, chocolate industry and organisations involved), economic aspects of cocoa pod production (production structure, inputs, productivity, production costs and prices), national policies and programmes, and prospects of cocoa production in Brazil.

MAY 1992

The cocoa market in selected East European countries
BYSKOV, B. International Trade Centre UNCTAD/GATT, Geneva, Switzerland - *International Trade Forum (UNCTAD/GATT)* v.27(4) p.20-22; 1991
Countries in Eastern Europe may offer potential for increased sales over the medium term for exporters in developing countries. The present, per capita, low consumption of cocoa-based products in these markets offers prospects for market growth, as does the increasing number of joint ventures being concluded in the cocoa-processing industries. The cocoa markets of Czechoslovakia, Hungary and Poland are briefly discussed.

[World cocoa directory 1991]. Annuaire mondial du cacao 1991
International Cocoa Organization, London (UK), p.449; 1991
This directory provides information on associations, representatives, brokers and traders, manufacturers, producer associations and other institutions connected with cocoa production, processing or trade. Section A contains details and listings of the various cocoa associations and/or organizations, section B comprises companies, and section C gives statistical information on cocoa and cocoa products. Information is provided on production, exports, re-exports, imports, grindings, consumption and prices, from 1960 to 1990. Telephone and facsimile numbers are included. The directory is to be updated annually.

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