COCOA GROWERS' BULLETIN

Number 12 Spring 1969
Published twice a year

Contents

Cadbury Group Limited
Publications Department Bournville

Editorial

Black Pod Disease

The brief outline given below indicates the vital need for an intensification of research on black pod disease. It is with pleasure, therefore, that we can report that a survey of current research work is being undertaken by Dr. P. H. Gregory, F.R.S., formerly head of the plant pathology department at Rothamsted. This survey has been made possible by financial assistance from the London Cocoa Terminal Market Association.

Of all the many negative factors affecting cocoa production, black pod disease is probably the most costly both in terms of lost production, which affects both the farmer and producing country, and in terms of the money spent on its control. This disease is almost universal so it is one with which most cocoa growers are concerned.

The incidence of the disease varies greatly, from almost nil in parts of the Far East, to well over 50 per cent in the most humid areas of West Africa. Although it is generally known that incidence rises with rainfall and humidity, this is not the complete picture, and other factors also influence the incidence of the disease. Temperature may be one of these; the patterns of rainfall and sunshine may be others. We are still not clear as to the relative importance of these factors, nor has it been clearly shown how the disease is carried over from one wet season to the next.

In West Africa it is the custom to spray the pods but not the canopy; in Latin America both are normally sprayed as the canopy is thought to be a source of infection. Both practices may be right, but if so, what is the main source of inoculum in West Africa where the disease disappears during the dry season?

There is still much to learn about the epidemiology of black pod. Control of the disease is costly and may amount to as much as £10 per acre per annum. At Ikiliwindi the annual cost of controlling the disease is about £11,000 or just over £8 per acre, and this represents half the total field costs.

To be economic this expenditure must result in an increase in crop of greater value; this will depend on the effectiveness of the spray, the yield level and the price received by the grower. It is clearly important to attempt calculations of the likely returns from spraying, but with several variables this may not be easy to do with any accuracy. In those areas where losses are moderate, spraying may be uneconomic except in wetter years, and these cannot be forecast—at least not yet.

The cost of spraying will doubtless increase, so new developments must be watched. A new fungicide might be developed, possibly a systemic one. In the long run varieties of cocoa showing some resistance to the fungus would offer the best solution, and it is encouraging to find that some degree of resistance has been found in the Amazon population. It will, however, be many years before resistant varieties can be offered to growers.

Ghana Cocoa Growers' Research Association Ltd.

The first issue of the *Cocoa Growers' Bulletin* was introduced by Mr. John Cadbury who retired from business in 1967. He has always been keenly interested in West Africa and cocoa growing generally, so readers will be interested to learn that during the past year he has provided funds for the formation of the above company. The purpose of this company is to finance research on cocoa at the University of Legon in Ghana. Some money is already assigned for work on the insects found on cocoa farms and it is expected that further research projects will be started.

G. A. R. Wood.

Review of Production and Consumption

(February 1969)

A. P. Williamson, Cadbury Brothers Limited

Introduction

In the past we have always quoted the cocoa statistics published by the F.A.O. but, because they are only published quarterly, it has often meant that the figures quoted were out of date even before we went to print. In future, with the agreement of Messrs. Gill and Duffus, one of the leading trade houses and the subject of an article in an earlier issue of this Bulletin, we will be reproducing figures published in their monthly cocoa market reports.

Production

This season's main crop in West Africa was badly affected by the heavy rains in July, August and September, and the most pessimistic predictions at the time have been borne out. In their latest report, Gill and Duffus forecast that production in Ghana in 1968-69 will be 22·6 per cent less than in the previous year. In Nigeria the drop is expected to be 17·8 per cent and in the Ivory Coast 11·8 per cent. In addition, the Brazilian main crop has been very poor, estimated at 34 per cent less than last year and, unless the *temporao is* better than average, total production in Brazil will be significantly down.

Overall, total world production in 1968-69 is put at 1,185,000 tons, or nearly 160,000 tons less than in 1967-68.

Grindings

The Gill and Duffus estimate of 1968 grindings is 1,368,000 tons. This is 1·3 per cent up on 1967 and similar to the F.A.O. prediction published in our last Bulletin. A small drop in the grindings in Western Europe and North America was more than compensated for by the increased usage in Eastern Europe and by the increased grindings for export in the producing countries.

For 1969 a reduction of 2 per cent to 1,358,000 tons is predicted, the reduction being spread among all the major consuming countries.

Stocks and Prices

After making the generally accepted 1 per cent allowance to the production figures for miscellaneous losses, the effective deficits in recent years have been:

1966	..	177,000 tons
1967	..	43,000 tons
1968	..	60,000 tons
1969	..	185,000 tons

On the basis of these estimates, world stocks, in terms of months' usage at the end of 1969, will be lower than at any time since the war.

The effect of this on prices has been dramatic, and the price for spot Ghana cocoa rose from £280/ton at the beginning of July to £495/ton on December 11. The market then fell by nearly £100/ton, although it has since recovered a little and prices are now around £430/ton.

WORLD COCOA PRODUCTION AND GRINDING DATA

Reproduced from Gill and Duffus Market Report dated

February 19th 1969

(Thousand long tons)

Production

	1966-67	1967-68	1968-69 (forecast)
Africa	953	958	815
America	308	295	284
West Indies	43	48	46
Asia and Oceania	33	37	40
World Total	1,337	1,338	1,185
Principal Countries			
Ghana	376	415	320
Nigeria	263	231	190
Ivory Coast	147	144	125
Cameroon	84	91	98
Guinea (Spanish)	38	33	37
Brazil	173	143	139
Ecuador	53	68	60
Dominican Republic	28	30	28
Mexico	25	26	25
New Guinea	21	24	26

Grindings

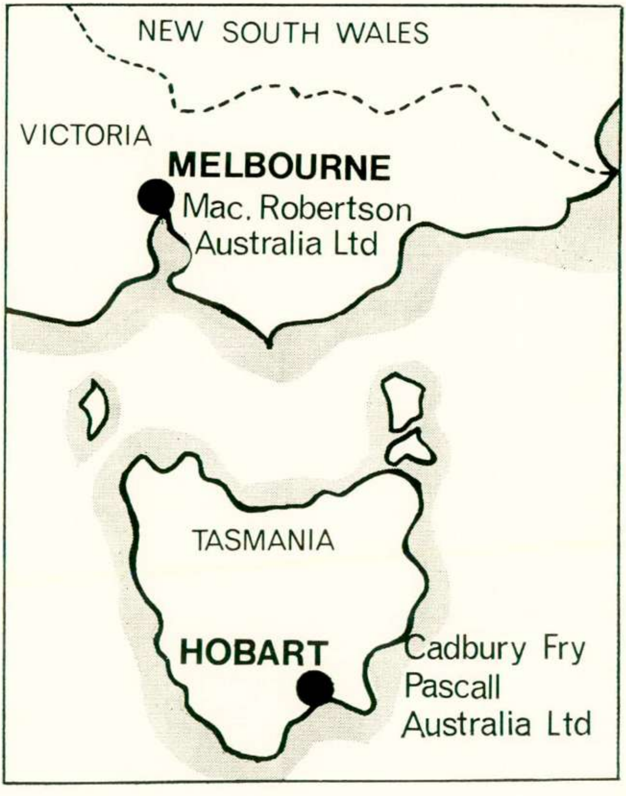
	1967	1968	1969 (forecast)
Western Europe	554	527	532
Eastern Europe and U.S.S.R. ..	168	176	172
North America	307	304	298
Australia and New Zealand ..	17	17	17
Central and South America ..	163	156	154
Asia	54	51	49
Africa	105	137	136
World Total	1,368	1,368	1,358
Principal Countries			
United States	289	286	280
Germany (Federal Republic) ..	142	140	138
Netherlands	110	110	105
United Kingdom	94	92	90
U.S.S.R.	83	95	95
France	51	48	47
NOMINAL DEFICIT	—30	—47	—157

Cadbury Fry Pascall Australia Limited Claremont, Tasmania, Australia

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

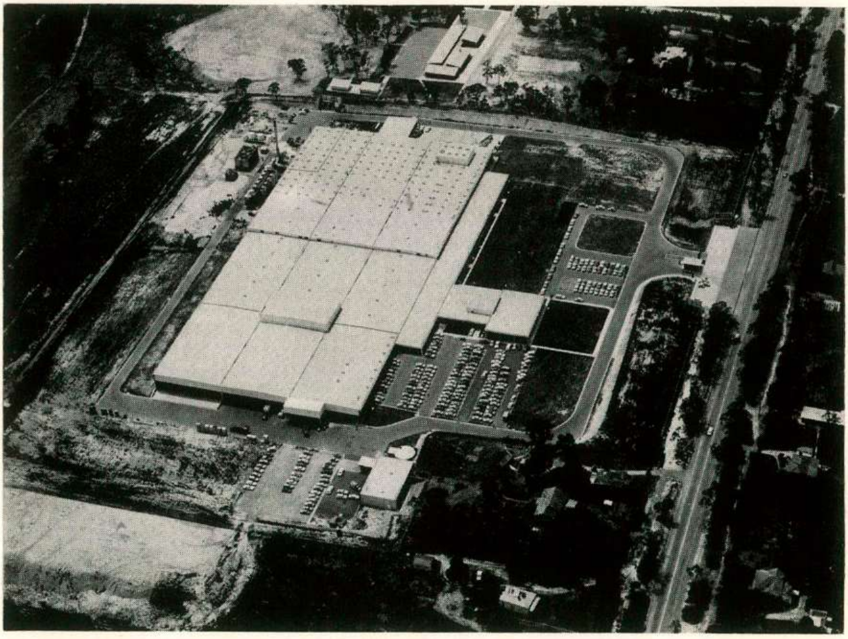
The Australian Company is the largest in the Overseas Division of the Cadbury Group and is also the largest manufacturer of cocoa, chocolate and sugar confectionery lines throughout Australia. The Company has two large modern production units—at Claremont, near Hobart, Tasmania, and at Ringwood, near Melbourne. The setting for a chocolate factory at Claremont, Tasmania, eight miles up-river from Hobart, with Mount Wellington in the background, is probably the finest in the world.

The Claremont factory was built in 1922 after a commission had gone out from Bournville to decide whether the Australian trade was worth developing, in view of the imposition of heavy tariffs on the imports of chocolate and confectionery. The commission urged the Board at home to make every possible



The Cadbury Fry Pascall factory at Claremont, near Hobart, Tasmania.

Air view of the Tasmanian factory.



effort to regain the trade lost during the war by local manufacture inside the tariff wall. The first Cadbury export representative had been sent out to Australia in 1881 and the Firm had an immense fund of goodwill on which to re-establish itself. The site chosen was on a promontory off the River Derwent where the climate was temperate, there was freedom from labour disputes, cheap electricity and an ample water supply. What more could be asked? An extensive modernisation plan has been carried out in recent years and manufacturing capacity has been greatly increased.

The MacRobertson acquisition

In 1967 the MacRobertson business at Melbourne was purchased. This gave the Company a very strong position in the Australian market and, of the greatest importance, a modern plant on the mainland. The new (1967) MacRobertson plant occupies a 55-acre site at Ringwood, 16 miles from Melbourne. The Company is now well placed to exploit all the prospects in a lively, fast-growing market. The possibilities of further expansion are apparent. The annual consumption of chocolate and confectionery in Australia is 18·5 lb. per head as compared with 24·7 in the U.K. and 19·6 in the U.S.A. Diversification will also have a place in the future of the business and a recent successful venture has been the establishment of a cake factory in Hobart.

At this point the activities of Cadbury Fry Pascall Australia are quite varied since, following the acquisition of MacRobertson (Australia) Limited, the Australian Company now owns a printing factory and has interests in several small confectionery firms and a jam business.

Technological advance

In line with this expansion, Cadbury has maintained and increased its lead in the production of milk chocolate in Australia. Much research and development work has been done on the famous C.D.M., and the results have been applied, on a larger scale, in the parent Company's production in England. The technological advance made in this field is revolutionising milk chocolate manufacture.

Many of the other well-known English lines of the Cadbury Group are made at Claremont, including Milk Tray and Roses Assortments, Nut Milk, Brazil Nut and Fruit and Nut Chocolate Blocks, Bournville Cocoa, Bournvita, Drinking Chocolate and Flake, from Bournville, and Crunchie and Chocolate Cream Bars from Fry, Somerdale. Cadbury Fry Pascall introduced its Energy Chocolate many years ago and this has been copied by other members of the Cadbury Group. In more recent years Cadbury Fry Pascall developed a new type of heat-resistant milk chocolate in co-operation with the Army, and this has found acceptance as an emergency ration too. It is being used by the Australian forces in Vietnam.

Pascall withdrew its direct interest in the business in 1937 and thereafter Pascall lines were made in Australia under licence. In more recent years the Pascall business has been acquired by the Cadbury Group, and Cadbury Fry Pascall Australia Limited was then able to share its expertise in this field with the parent Company. Indeed, one of the major developments at Claremont in the last decade has been a rapid growth in the sales of Pascall sugar confectionery. The greatly increased output called for has been accomplished by streamlined methods of manufacture and marketing, including the extensive use of plastic film packaging.

Expansion has been made into the export field also. In the last three years, Claremont has exported to Japan 8,400 tons of partly-processed materials, and a big tonnage of milk powder has been shipped to various Asian countries.

Now that it has settled down at its new Ringwood factory, MacRobertson is continuing to produce such well-known favourites as Old Gold, Cherry Ripe, Snack and Columbines. Both the Claremont and Ringwood factories make a considerable amount of couverture chocolate for the trade.

Total sales of all Cadbury and MacRobertson products in 1967 totalled 37,246,000 dollars and this was achieved with a labour force of 3,200.

Raw materials

Claremont has always bought the bulk of its cocoa beans from West Africa, chiefly Ghana. However, since before the last world war, it has taken an interest in the growing and processing of cocoa in Papua and New Guinea. A Cocoa Buyer was appointed in Rabaul in 1957 and he has bought on the spot significant quantities of New Guinea cocoa. In addition Cadbury Fry Pascall Australia Limited has played a leading part in the development of cocoa processing in the Territory by examining countless samples from the Lowlands Agricultural Experiment Station at Keravat, and from many planters. Furthermore, it has always encouraged the establishment of quality standards, and in 1958 Cadbury Fry Pascall led a delegation of Australian chocolate manufacturers at a Rabaul conference, after which the administration gazetted an export ordinance for New Guinea cocoa. In recent years, the Firm has given financial help for research work on cocoa diseases, including cocoa dieback.

Of the other main raw materials used at Claremont, sugar and peanuts come from Queensland, almonds and dried fruits from South Australia, and other nuts from traditional sources overseas. Milk, which formerly was collected from farms around Hobart, now comes from Northern Tasmania. It is concentrated at several centres and sent down by road tankers to Claremont, 200 miles away. In recent years, a milk spray drying plant has been operated at one of these centres.

Distribution

Cadbury Fry Pascall Australia Limited has, in many ways, followed the pattern of development set by its parent Company in England. However, in one respect it has had to pioneer new fields—distribution to customers. Quite apart from the fact that the bulk of its output goes over the Bass Strait to the mainland, vast distances have to be covered by rail and road before goods reach warehouses and shops. It follows that wide areas have to be covered by Sales Representatives, and every effort is made to ensure that the Firm's products reach the public in the freshest possible condition.

Thirty-six thousand visitors were welcomed to the Claremont factory last year and the number grows annually. Everyone enjoys seeing Cadbury's factory at Claremont "By Mountain and Sea".

Ikiliwindi, Cadbury Brothers' Plantation in Cameroon

2. Black pod disease

G. A. R. Wood

Black pod, caused by *Phytophthora palmivora*, is the most important disease at Ikiliwindi, and the control measures employed form a major item of expense.

The seriousness of black pod in West Cameroon is well known. When the country was a German colony many cocoa plantations were formed, and further plantings were made on German estates between 1925 and 1939. These plantations produced two grades of cocoa, one of which was "Black Cocoa" made from diseased pods, the beans being treated by a different process. West and Voelcker (3) have described these plantations and studied the factors influencing the incidence of black pod disease. They concluded that the disease was influenced by monthly rainfall, elevation and crop pattern. The data show how black pod incidence increases as the monthly rainfall rises during the period from June to September, the monthly losses going as high as 82 per cent in one case. High monthly losses can be borne if they apply to a small proportion of the crop. On the Molyko estate, which lies between Victoria and Douala, the heavy losses in August and September coincided with the peak of the crop, resulting in an annual loss of 52 per cent. On the other hand, at K.K.C. estate near Kumba, the crop came later in the year so that losses of over 40 per cent in August and September had less effect on the whole crop, the annual loss here being 19 per cent.

Elevation had a marked effect, and plantations on the slopes of Mount Cameroon suffered heavier losses. This could be interpreted as being due to lower temperatures and higher relative humidity favouring the fungus.

At Ikiliwindi, records have been kept of temperature and relative humidity in two blocks under the cocoa canopy. These records, when combined with data on spraying and harvests, have indicated that black pod can be kept under control until there is a day or two when the relative humidity remains at 100 per cent. Such days—wet and overcast—occur towards the end of July and during August; in most years there are only three or four such occasions. The incidence of black pod rises after these prolonged periods of high humidity, and control is difficult to re-establish. The breakdown of control may be due to highly favourable conditions for the production and dissemination of spores or to the washing-off of the protective coating of fungicide. The difficulty in re-establishing control is partly due to the rain in July and August—on average these months have 26 and 28 rain-days respectively—which makes it extremely difficult to spray effectively; a further reason may be the build-up of inoculum and increase in number of pods on the trees. Conversely, the disease may be easier to control during May, June and early July because the amount of inoculum is small and the pods are small in size and number.

One can conclude from these observations that rainfall does not have a direct relationship with black pod incidence, and that high humidity for long periods is the factor affecting the spread of the disease. In Malaysia there is little black pod, despite rainfall which is heavier than in Cameroon; this is probably due to the absence of dull, overcast weather, so that temperature and sunshine hours are higher and relative humidity shows strong diurnal variation.

Data on black pod losses are given in Department of Agriculture Annual Reports (1). Spraying trials were conducted at the Agricultural Station, Barombi Kang near Kumba, between 1954 and 1958 and the control plots had an incidence of 63–84 per cent black pod, depending on the season, while sprayed plots had an incidence of less than 20 per cent.

In the early years at Ikiliwindi, one block was left unsprayed to assess possible losses, and this gave the following results:—

	Black pod percentage	
	1960	1961
Unsprayed block 20 ac.	24·8	43·9
Sprayed blocks	1·9	5·25

The yields in these years were less than 200 lb. per acre.

Control methods

Spraying with a copper fungicide was started at an early stage, and it became standard practice to start spraying during the third year after planting.

In the first place, low-volume spraying using a shoulder-mounted mistblower was employed. The dosage was 2 lb. Perenox (cuprous oxide) in 6 gallons water per acre, and 5–6 applications were made at intervals of 3–4 weeks. In the initial spraying the operators walked along every fourth row, but later in the season they walked along every second row.

This method was abandoned after the 1962 spraying season, largely because it proved ineffective that year as the following figures show:—

	1961		1962	
Month	**Total pods harvested**	**Black Pod Percentage**	**Total pods harvested**	**Black Pod Percentage**
July	2,767	3·5	3,464	51·5
August	1,121	37·0	35,024	81·2
September	8,763	44·4	132,376	72·5
October	71,843	14·0	312,208	20·0
November	116,852	5·1	441,572	3·3
December	123,156	1·4	135,862	2·1
Whole Year	352,186	6·6	1,167,800	18

The use of a mistblower inevitably involves some waste of fungicide, so that higher rates of application are normally necessary; it was also over-optimistic to assume that the spray would be conveyed effectively over such a large distance as would be inferred from the spacing of the sprayers.

At the same time experiments were carried out with tractor-mounted mistblowers. These were not successful. Hislop (2) has reported on a trial in Nigeria in which a tractor-mounted mistblower was compared with a pressurised knapsack and a shoulder-mounted mistblower. The two mistblowers required heavier doses of copper in order to obtain the same degree of control. The cost of this heavier dose far out-weighed any advantage they might have in speed of application.

At Ikiliwindi the mistblowers were replaced by pressurised knapsack sprayers with which the spray can be applied more directly onto the pods. At first the rate of application was 4 lb. Perenox in 100 gallons for the first two cycles and

Fungicide spraying with pressurised knapsack.

Cocoa tree with black pod disease.

8 lb. per 100 gallons for the third and subsequent cycles, 33 gallons of spray being applied per acre. The machines used were Mysto three-gallon pressurised knapsack sprayers, and one tankful was sufficient for one row of 40 trees.

There have been some changes since this method was started in 1963. The Mysto machine was satisfactory but went out of production. It has been replaced by a knapsack sprayer with a hand pump. The dosage has been altered and the details of the method used up to 1968 are:—

Mixture: 28 lb. Perenox in 250 gallons.

Cycle 1: 3 gallons per 27 trees—5·5 lb. Perenox/acre.

Cycle 2 *et seq.*: 3 gallons per 40 trees or more—3·7 lb. Perenox/acre.

Since adopting knapsack sprayers the results have been as follows:—

Year	Production (tons)	Black Pod percentage
1963-64	60	0·9
1964-65	164	5·4
1965-66	235	6·0
1966-67	338	10·9
1967-68	284	10·0

Assuming that 50 per cent of the crop would have been lost if the trees had not been sprayed, then the spraying programme has saved the following tonnage:

1963–4	..	30
1964–5	..	78
1965–6	..	110
1966–7	..	148
1967–8	..	127

Timing of sprays: Spraying normally starts at the end of April or early in May and continues at intervals of 3–4 weeks until the end of September or early October. The major difficulty occurs in July and August when the weather may prevent spraying for several days and dry periods are too short to allow the spray to dry and stick to the pods.

Costs: The costs of spraying during the 1966 and 1967 seasons were:—

Spraying season	1966	1967
Acreage	686	625
Man-days per acre ..	7·1	10·0
Perenox used (lb/ac) ..	19·0	27·5
Total cost*	£6·1	£9·0

*Cost of labour and materials converted at 692 CFA frs = £1

The costs rose in 1967 because more sprays were applied.

Conclusion: In one sense no real conclusions can be drawn, and this description of our methods of control is merely an interim report. There are many aspects of our method of control which are based on assumption rather than experimental evidence. The dosage used is high and control might be equally effective with lower doses or with a different pattern of treatments; the timing of the sprayings at the beginning and the end of the wet season could be tested. In addition, new fungicides are being produced and will be tried if they appear to offer some real economic advantage. However, we may have to wait for a systemic fungicide before seeing a real advance in this direction.

REFERENCES

1. Anon. Dept. of Agric., Southern Cameroons. Ann. Rep. 1955 and 1957.
2. Hislop, E. C. (1963). "Studies on the chemical control of *Phytophthora palmivora* (Butl.). Butl. on *Theobroma cacao* L. in Nigeria. V. Comparisons of three spraying machines for applying fungicides". *Ann. appl. Biol.* **52.** 481–492.
3. West, J. and Voelcker, O. J. (1942). "Plantation Cacao in the British Cameroons". *Trop. Agric.* (Trin.), **19,** 4.

The use of small polyclonal seed orchards on Commercial Cocoa Plantations

H. Toxopeus, Cocoa Research Institute of Nigeria, Ibadan

ABSTRACT

In running a seed orchard of half-an-acre there will be an additional cost for employing one labourer throughout the year and two labourers for three months of the year to do the pollination work and to care for developing hand-pollinated pods. These costs should only be a fraction of the additional income due to the higher level of production of the new varieties.

Introduction

New "hybrid vigour" cocoa varieties will become available for commercial planting in increasing numbers, and will offer considerable advantages over old varieties, but seed has to be produced in special so-called "polyclonal seed orchards". These varieties, however, do not breed true to type, and the seed must be produced by crossing particular parents. For large-scale seed production the parents are multiplied vegetatively by cuttings or buddings. All cuttings originating from one tree are collectively referred to as belonging to the same clone. The parent clones are planted so that hand-pollination is easy to carry out. When the plants start flowering the hybrid seeds are produced by hand-pollinating the flowers of trees of the one parent with pollen from flowers of the other. The use of hand-pollination is advantageous mainly because it limits the size of a seed orchard and brings it into production earlier.

In the case of *Theobroma cacao*, insects are the only known agents of pollination. As long as a newly-opened flower is protected from insect visits for at least 36 hours after opening, insect pollination will not result in fertilisation.

As a protective device, conical hoods of gauze pinned to the trunk or branch are most economical to use. The hoods are made out of nylon mesh with a weave of 22 meshes/cm., each mesh being 0·32 mm. square. A piece, about 12×6 cm. in size, is cut and hemmed in on all sides to prevent unravelling. This is first folded into a 6 cm. square and then into a triangular shape and sewn together on one side only (1).

The actual hand-pollination is done as follows: with a pair of forceps a stamen with open anthers is taken from a flower of the pollinator parent that has just opened. The anthers are rubbed against the whole length of the pistil of a flower on a female parent tree, and eventually the stamen plus anthers are left on the sticky surface of the pistil. The removal of stamens from flowers to be pollinated is undesirable as pollen may be forcibly removed from the stamen and mistakenly put on the pistil during the operation. The hand-pollinated flower is then marked provisionally with a pin carrying a piece of brightly-coloured material. After a fortnight the set fruit should be finally marked with a plastic label containing information on parentage and date of pollination.

Between 20 and 50 per cent of the number of pollinations made usually results in ripe pods.

Productivity

At the present stage of cocoa breeding the parents of the new varieties are usually vigorous and good yielding. The Upper Amazon parents of the WACRI series II varieties are capable of the following production in the main cropping season, planted at 10 ft. square spacing and with pods produced by hand-pollination:—

Third year after planting	..	10 pods per tree.
Fourth year after planting	..	20 pods per tree.
Seventh year after planting	..	40 pods per tree.
Mature production	.. ..	60–80 pods per tree.

Trinitario or Amelonado clones will show the same yield pattern starting a year later.

The following assumptions are made in this paper:—

(a) One acre of seed orchard contains 400 productive trees.

(b) One seed pod produces 25 good seedlings.

(c) Five hundred seedlings (20 seed pods) are required for the successful establishment of an acre at 10 ft. spacing.

Based on these assumptions the productive capacity of a one-acre seed orchard, up to 15 years after planting, in terms of plant material for field planting, in acres, is shown in table 1. For an annual planting programme of 200 acres a seed orchard of half-an-acre is thus adequate.

Table 1:

Acres of commercial cocoa that can be planted with seeds from a one-acre seed orchard

Age	Annually	Cumulative
4th - 6th year	400	1,200
7th - 10th year	800	4,400
11th - 15th year	1,200	10,400

Establishment: The seed orchard could conveniently be made an integral part of a large cocoa area. It should be located on a good piece of soil and as near as possible to water in case watering is needed in the dry seasons of the early years of establishment. To encourage maximum growth and production, overhead shade should not be provided. Weeding and pest control must be intensive. Assuming good growth, the plants must be pruned in the third year after planting, at the end of which the first hand-pollinations can be made for seed production the following year. Local fertiliser recommendations should be followed.

Seed Production: An assumed annual planting programme of 200 acres would require plant material from 4,000 seed pods. At 30 per cent success about 13,000 hand-pollinations will have to be made during the main flowering period, usually lasting three months, i.e. 1,000 pollinations per week. This can be done by a team of three experienced pollinators. One of these will be retained during the off-season to keep records and look after the hand-pollinated pods, such as encaging them with chickenwire to keep rodents away, applying insecticides and fungicides, removing all cherelles arising from natural pollinations, harvesting and pruning.

A stock of about 1,200 pollination hoods is required to cover the needs for a week's pollination programme. The same hoods can be used every week, and with careful handling should last for two seasons.

Discussion

The exploitation of a seed orchard has its expenses, but the gains in terms of more profit from the use of the new varieties are considerable. At 15 years of age the seed orchard will have produced seeds to raise enough seedlings for planting $12 \times 200 = 2{,}400$ acres of commercial cocoa planting. If the old variety produced half-a-ton of cocoa annually per acre and the hybrid varieties give 10 per cent more, the 2,400 acres would produce an extra 120 tons every year.

An additional source of income from a seed orchard is the sale of surplus seed to other plantations. If new seed orchards for seed production of new varieties have to be planted the old seed orchard should continue to be profitable as a commercial plot.

To have experienced pollinators on the plantation has further advantages in that local breeding programmes can be carried out with little extra cost.

REFERENCES

1. Ruinard, J. (1963). "A contribution to the technique of hand-pollination in cacao". *Trop. Agric.* (Trin.), **40,** 285–6.

Acknowledgement

The advice of Ir. M. Wessel of the Cocoa Research Institute of Nigeria is gratefully acknowledged.

Co-operative Fermentaries in the Solomon Islands

D. E. Gollifer, British Solomon Islands Protectorate

This paper has been adapted from Mr. Gollifer's paper "Small-scale processing by rural societies" presented at a Technical Meeting on Cocoa Production held in Honiara, B.S.I.P. in April 1966. *The meeting was held under the auspices of the South Pacific Commission, who have issued the working papers and discussion and with whose permission this paper is published.*

The small fermentaries described in this article form an interesting comparison with the large central fermentaries in Jamaica and the Tolai Cocoa Project in New Britain, which were described in articles in the third and sixth issues of this Bulletin.

Introduction

Solomon Islanders began to plant cocoa in quantity in the Western District during 1959. By 1963 pods were ready for harvesting, and because of the scattered nature of the district it was decided to encourage the growers to do their own processing in small fermentaries and dryers. To enable them to do this they formed co-operative societies where there were 50 acres or more of bearing cocoa planted fairly close together.

Once a society was formed and a committee elected, each member had to buy a share of about £2 so that a sum of approximately £120 could be made available. A start was then made on selecting the site and building the fermentary and dryer. All members worked voluntarily and provided leaf and timber for the building and erected it themselves.

The main building measures 24 ft. × 24 ft. and has a cement floor; it contains a Samoan dryer, fermenting boxes and space for receiving wet beans; a firewood store is placed in a lean-to.

Once the building had been erected the staff of the Agricultural Department helped members to install the dryer and build fermenting boxes. Part of the money collected by members was used to buy the dryer parts, cement for the floor, and wood and nails for the fermenting boxes, tables, etc. A spring balance for weighing the wet beans, and a few wooden tools for turning the cocoa, were also bought. The balance of the society's fund was used to purchase wet beans. Each society appointed a fermentary manager, and his job was to buy the wet beans with the help of the committee, and then process them.

All managers were given a course on the fermenting and drying of cocoa in Gizo, and in the early stages were assisted by staff from the Department of Agriculture. (A booklet on processing procedure was also prepared for them).

History

The first cocoa society to be formed was in the Shortlands, where the dryer was built in December 1963. Next followed two on Vella Lavella at Lambu Lambu and Barakoma, both dryers being built in January 1964. In August 1964 a dryer was built at Ugele on Rendova, and one at Hunda on Kolombangara during September 1964. Towards the end of 1965 four more societies were formed and dryers built at Lokuru-Rendova, Dovele-Vella Lavella, Sasamungga on Choiseul and at Pienuna on Ganongga. The Government Samoan dryer at

Gizo was purchased by the Western Co-operative Cocoa Marketing Association Limited to process cocoa from neighbouring islands that did not have enough bearing acreage to justify a dryer, and also to recondition any cocoa purchased by the central society and in need of redrying.

There will thus be 10 co-operative dryers working in the Western District during 1966, with one Government Samoan dryer at Munda.

Development

When several cocoa dryers had begun to produce dry cocoa, the Western Co-operative Marketing Association Limited was formed, with its headquarters at Gizo. This is known as W.C.C.M.A.L.

The job of W.C.C.M.A.L. is to buy the dry cocoa from the societies, bag it up properly if necessary, mark the bags, and then submit it for grading. All marks are painted in green, and each lot number or ferment number is put on each bag so that the societies know which ferments sell well. The grade is put on by the grader together with the date. New bags and twine are supplied to member societies. The cocoa is then stored until shipping to the U.K. is available. The function of W.C.C.M.A.L. is very important because it pays the small societies immediately, and then acts for them as shipping agent.

To join W.C.C.M.A.L. all the member societies have to pay £50 each so that the co-operative has money with which to do business.

All the societies have a different mark on their bags, and just before the cocoa is shipped, a sample of ½ lb. is sent by airmail to agents in England, who divide it between several manufacturers. In this way, if the cocoa is acceptable, it is sold on sample before it reaches the U.K. W.C.C.M.A.L. can thus see how much profit is made by individual societies. If there is a balance after the expenses of handling, storage, shipping, insurance, and an association fee, it is paid to the society which sold that particular cocoa. When the small processing societies have their accounts drawn up for the year, any profit goes to members according to their sales of wet beans.

Processing of cocoa

The function of a cocoa co-operative society is to process cocoa for its members. All these are cocoa farmers, and when the crop is ready for harvesting they decide amongst themselves on a collection date. The pods are broken and the wet beans delivered to the fermentary in leaf baskets or sacks. Here the manager looks at the beans on a grading table, rejects all of the germinated and faulty ones, and then weighs the good beans. The farmer is paid immediately at 4d. per pound from society funds. As the beans are purchased they are put into a resting box and left overnight to sweat, without being sealed.

The following morning the beans are put into a fermenting box, covered with clean banana leaves and then a layer of sacks weighed down with stones. They are turned every day from one box to another at the same time, until fermentation is complete. The manager knows when the beans are fermented by their smell, colour, appearance, temperature, and by the cutting test. The temperature usually goes up to 49°C by the fourth day. Most ferments of society cocoa have been done in five days.

The size of the fermenting box is 3ft. × 3ft. × 2ft. 8ins. and each box will hold about 1,000 lb. if filled to the 2ft. 6in. mark. Holes are drilled in the boxes at 4in. intervals sides and bottom.

Drying

The dryers used are the Samoan type with one hot-air flue and chimney. Firewood is collected by the members so that the society does not have to pay for it. When the beans are fermented the manager lights the fire in the dryer, and then puts the beans on the drying platform which measures 12ft. × 6ft. × 8ins. One fermenting box full of beans will fill it to a depth of 4 ins. If necessary, the dryer can take 1,500 lb. of wet beans, when the depth on the tray is 6 ins. A bamboo mat is placed on the dryer so that the beans heat slowly at first and do not stick to the metal net.

At the start the fire is kept low and the heat should never exceed 70°C. The beans are turned regularly. A normal ferment takes 56 hours to dry.

On completion of drying, defective and flat beans are taken out, and then the cocoa is bagged up and weighed to 140 lb. net per bag. It is stored above the dryer for a few days until shipping is available to carry the bags to Gizo.

A leaf wall shuts off the firing-room from the dryer so that no smoke gets onto the beans, and the flues are checked regularly for leaks. At the fire end the flue is 4ft. from the dryer net, and at the far end it rises so that there is 3ft. 3ins. between the flue and the net. The fire end and the far end of the flue are laid in walls of clay and stone.

Storage and Marketing

The dry cocoa is shipped to W.C.C.M.A.L. at Gizo as soon as possible. There it is reweighed and the member societies are paid 1s. 3d. per lb. for first grade, and 1s. 0d. per lb. for second grade (i.e. £140 and £112 per ton respectively). Before world prices fell the societies were paid 1s. 6d. per lb. for first grade and 1s. 3d. per lb. for second grade (i.e. £168 and £140 per ton respectively).

The cocoa is stored in Gizo and no mould has developed on cocoa dried below 7 per cent moisture content and shipped within three months of processing.

Dermestes ater has been found on cocoa bags stored in Gizo and awaiting shipment. These beetles may have been attracted to dirty bags, or they may have originated from the copra store, as they feed mainly on the remains of other insects.

W.C.C.M.A.L. has this year erected a new cocoa store at Gizo (pre-fabricated aluminium), measuring 60ft. × 25ft., together with an office and house for the secretary.

Case account of a typical society

The average cost of a cocoa processing unit is £65. The building was put up by the members without payment so that this figure represents materials only. Each ferment takes about nine days and deals with half-a-ton of wet beans producing 40 per cent by weight of dry beans. The average production of three C.P.C. in 1964 was 1½ tons dry beans per dryer. The labour involved is one manager at 6s. 0d. per day for nine days and one labourer at 5s. 0d. per day for three days; the labourer looks after the fire during drying.

Costing

	£ s. d.
Purchase price half-a-ton wet beans at 4d. per lb. ..	18 13 4
Manager 9 days at 6s. 0d.	2 14 0
Labourer 3 days at 5s. 0d.	15 0
	£22 2 4

Half-ton wet beans gives one-fifth ton dry beans:		£ s. d.
Cost to produce 1 ton of dry beans is $5 \times$ £22 2s. 4d. ..		110 11 8
Cost of empty bags (16 at 3s. 6d.)		2 16 0
Freight costs to Gizo from (say) Shortlands		6 0 0
Depreciation: Dryer—£65 at $33\frac{1}{3}$ per cent Equipment—£30 at 10 per cent	£25 p.a.	16 13 0
Other overheads		4 3 0
Total cost per ton		£140 4 0

The cost per ton of the manager, depreciation and other overheads will fall as production increases.

The societies during 1965 sold their dry cocoa at 1s. 3d. per lb. and 1s. 0d. per lb. for first and second grade cocoa respectively, i.e. £140 and £112 per ton. They made a net profit selling at these prices, so that their overall cost of production was therefore less than £140 4s. 0d. per ton quoted above.

Firewood

If firewood has to be paid for in the future when the quantity of cocoa increases, the cost has been worked out at 2 cords of wood at £3 per cord to dry 1 ton of cocoa or £6 per ton (1 cord=128 cubic feet). Average stick of firewood is 6ft. long and about 3in. in diameter. There are approximately 240 such sticks per cord.

Capacity of unit

The capacity of the unit is up to 1,500 lb. of wet beans at a time, equal to a production of 600 lb. of dry beans. It will dry this quantity of beans to a moisture content below 7 per cent in 56 hours.

With one ferment a week over the average 40-week processing period per annum, the annual capacity will be 10 tons.

With two ferments a week this could be doubled to 20 tons per annum.

Note on Contributor

H. Toxopeus L. I.

Born at Bogor (Buitenzorg), Indonesia in 1932. In the Netherlands as from 1946. Graduated at the Agricultural State University at Wageningen in January 1961. Major subjects: Plant Breeding, Tropical Crop Husbandry, Pathology (fungi/viruses) and Taxonomy. Worked in 1957–58 as scientific assistant to the Physiologist at the Citrus and Subtropical Horticultural Research Station at Nelspruit, Republic of South Africa. As from July 1961 with the Cocoa Research Institute of Nigeria.

Cocoa Abstracts

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

May 1968

Jiménez Sáenz, E. Relación entre el genotipo, productividad potencial y tolerancia del cacao al exceso de sales. Parte II. Estudio de la absorción y utilización del nitrógeno, fósforo, potasio, calcio y magnesio. (Relation between genotype, potential yield and salt tolerance of cacao. II. A study of absorption and utilization of nitrogen, phosphorus, potassium, calcium and magnesium). Turrialba, Rev. Interam. Ciencias Agr. 17, 4, p. 381–7 (1967).

In the trial described in the 1st part of this paper the 2 high-yielding cocoa progenies tended to absorb more N, P, K, Ca and Mg than the 2 low-yielding progenies, and to have a higher ratio of relative fresh-weight increment to net absorption of each of these nutrients. The differences were most pronounced in plants that had been grown on the stronger solution during the 2 initial months of the trial, and were particularly marked in the case of P absorption. English summary. Table. Graphs. 16 refs.

Opoku, A. A., and Jordan, D. Comparison of ground cover plants during establishment of cocoa on clear-felled land in Ghana. Exp. Agr. 4, 1, p. 77–86 (1968).

A trial on clear-felled forest land at Kade, Ghana, compared the effects of natural vegetation (mainly grasses) and 9 cover plants on cocoa seedlings planted 10 months later; temporary shade of *Manihot glaziovii* was planted 1 month after cocoa. The best growth of the cocoa was obtained with *Indigofera sumatrana*, a mixture of *Tephrosia hookeriana* and *T. villosa*, *Flemingia congesta*, and *Indigofera spicata*, by far the poorest growth with *Tithonia diversifolia*. However, *T. diversifolia* and *F. congesta* resulted in a greater height of primary branching than other covers. *F. congesta* had the best effect on the soil but is difficult to establish and requires much weeding. Covers of the *Tephrosia* mixture and of *I. sumatrana*, though less persistent, may therefore be the most profitable. Tables. 11 refs.

Legg, J. T., and Kenten, R. H. Some observations on cocoa trees tolerant to cocoa swollen shoot virus. Trop. Agr., Trinidad 45, 1, p. 61–5 (1968).

At Tafo, Ghana, Upper Amazon cocoa trees selected for tolerance to swollen shoot virus and artificially infected with a virulent strain of the virus were planted in 1950 and 1956. Some of these trees have continued to grow and produce normally up to the present time, showing only slight symptoms of the disease. Seedlings of the Upper Amazon type have been planted in the Eastern Region since 1954; because they are virus reservoirs, they are likely to preclude virus eradication in the region, where over 100 million diseased amelonado trees have been destroyed, by a continuation of this method. It may thus be better to replace cutting out diseased trees by the distribution of seed of tolerant Upper Amazon trees. Further breeding for tolerance of and resistance to swollen shoot within this type will be a necessary concomitant. Table. 18 refs.

June 1968

Sale, P. J. M. Effect of temperature on growth. Ann. Rep. Cacao Res 1965, p. 30–4 (1966); 1966, p. 33–8 (1967).

In Trinidad, 1-year-old cuttings of cocoa clone ICS 95 were grown under all combinations of day and night temperatures of 23·3, 26·7 and 30°C, at 90% relative humidity; artificial light was given from 8 a.m. to 8 p.m. Extension growth and numbers of flowers opened during a 273-day period increased, whereas leaf size and persistence of the leaves decreased, with an increase in temperature; day temperature had a greater effect than night temperature. Flushing occurred even at a constant temperature of 23·3°; this refutes some theories on factors inducing flushing. Cuttings grown in a greenhouse, at temperatures comparable with those of the trial rooms but in more intensive light and at a lower r.h., grew faster but flowered much less than the trial plants. Tables.

Murray, D. B. Soil moisture regimes. Ann. Rep. Cacao Res. 1965, p. 34–9 (1966; received 1967).

In Trinidad, cocoa cuttings were planted in containers in the wet season. During the next 18 months, the growth rate of plants receiving natural rainfall (1,800 mm a year) was reduced in the dry season, attaining a maximum only in the middle of the next wet season. The growth rate in pots watered with 150 mm of water every month was constant; that in pots watered with 75 mm every month was slightly reduced in the 2nd half of the dry season; that in pots receiving 1,800 mm a year so that the equivalent of the normal dry-season rainfall was applied in the wet season and vice versa was reduced in the dry season, showing that a dry atmosphere reduces growth even when the soil is wet. The plants with 150 mm of water each month had the largest number of leaves and were the only ones to flower profusely, showing that flower initiation does not depend on a dry atmosphere or on growth retardation. Table. Graphs.

Bartley, B. G. D. Plant breeding. Ann. Rep. Cacao Res. 1965, p. 10–29 (1966); 1966, p. 10–22, 25–32 (1967).

These reports of cocoa breeding in Trinidad include yields of progeny trials, results of testing trees from inbred progenies for their combining ability, data on susceptibility to diseases, results of genetic studies, and data on the introduction of Upper Amazon material into Nigeria. Several trials have been or will soon be discontinued because River Estate is to be closed as a research station in 1968. In the cross ICS 6 × SCA 6, the small seed size of SCA 6 was found to be dominant; varietal differences in the dry-to-wet-bean weight ratio proved to be larger than is generally thought, from 23% in SCA 6 to up to 50% in ICS 6. Selfed seed could be obtained from normally self-incompatible trees by pollination with their own pollen plus either *Herrania* pollen or pollen of a self-compatible cocoa tree carrying a marker gene. Tables.

Small, L. W. Ceratocystis resistance test. Ann. Rep. Cacao Res. 1966, p. 40–8 (1967).

The Delgado-Echandi test for resistance of cocoa trees to *Ceratocystis fimbriata* was introduced into Trinidad. It consists essentially of inoculating blocks of wood from 1 cm thick branches with a culture of the fungus and assessment of fungal growth after 4 days. Investigations were conducted on factors affecting the outcome of the test; a standardized procedure based on the findings is described. Consistent results were only obtained with highly resistant clones whereas minor differences in susceptibility were not easy to detect. A large number of clones was subjected to the test; a list is presented of highly resistant and moderately resistant clones. Tables. See also ibid. p. 49: Small, L. W. Chemical control of *Ceratocystis-Xyleborus* complex. Table. Mortality by *C. fimbriata* was not reduced by spraying the trunks with an insecticide.

Bartley, B. G. D., and Amponsah, J. D. Witches' broom. Ann. Rep. Cacao Res. 1966, p. 50–4 (1967).

The upper Amazon cocoa clones SCA 6 and SCA 12 have been used as sources of resistance to *Marasmius perniciosus* in the Trinidad breeding programme. It was soon found that SCA 12 progenies segregated for resistance in the field, and this was confirmed by artificial inoculation of seedlings. Progenies of crosses with SCA 6, however, remained unaffected in the field until 1965, after which up to 50% of the trees developed witchbrooms (see also Ann. Rep. Cacao Res. 1965, p. 13 and 21). Inoculation of seedling progenies of SCA 6 × ICS 8 and (SCA 6 × ICS 8) × ICS 8 clearly showed segregation as well; some back-cross progenies were 100% susceptible. Consequently, both SCA 6 and SCA 12 have to be regarded as heterozygous for resistance but having at least one dominant gene conferring resistance to their progenies. Tables.

Cruickshank, A. M., and Murray, D. B. Clonal trials, Grenada. Ann. Rep. Cacao Res. 1966, p. 23–5 (1967).

In Grenada, replicated trials comparing 79 cocoa clones locally selected in the early 1940s were planted in 1948 on 3 sites rather close to each other but showing fairly large differences in rainfall and soil properties. All trials were unshaded and regularly received fertilizers. Mean annual yields of dry beans over the 4 years 1961/62–1964/65 are given of 39 clones representing the 20 highest yielders and the lowest yielder of each trial. They ranged from 6,373 to 504 kg/ha at Mt. Horne, from 3,920 to 168 kg/ha at Ashenden, from 2,520 to 190 kg/ha at Maran. Whereas some clones were among the best yielders in all trials, many showed a remarkably large effect of environmental conditions; for instance, clone GS 18 ranked 5th, 27th and 1st, and clone GS 1 ranked 59th, 58th and 3rd, respectively. Table.

Turner, P. D. Cocoa dieback — a review of present knowledge. FAO Plant Prot. Bull. 15, 5, p. 81–101 (1967).

Literature on the symptoms and causes of dieback of cocoa trees is reviewed. The disorder, which has been reported from most cocoa-growing countries, and which may considerably reduce yields, can be brought about by a multitude of factors, but in general only 1 or a few of these are important. Consequently, control measures have to depend on the nature of the primary cause. Studies have been conducted on the role of inadequate moisture supply due to weather conditions, soil characteristics, exposure to sunlight and wind, and on the role of unbalanced nutrition, often with special reference to 1 or a few elements. Of the many pathogens and pests found to be associated with dieback, some are primary parasites initiating the phenomenon, but most of them are secondary parasites invading weakened tissue. 182 refs.

Iton, E. F. Ceratocystis wilt. Ann. Rep. Cacao Res. 1965, p. 44–50 (1966; received 1967).

Studies in Trinidad showed that *Ceratocystis fimbriata* forms 5 kinds of spores, partly in the wood and partly on the surface of *Xyleborus* tunnels. The latter category is carried by the beetles externally and in the gut, where they survive. Beetles are specially attracted by trees previously infected with *C. fimbriata*, not by trees that have only been wounded. Other possible vectors of the disease are: (1) windblown frass; (2) mites inhabiting the tunnels; (3) plant parasitic nematodes living in the tunnels and feeding on *Fusarium* cultivated by the beetle for its own food, the nematodes often attaching themselves to mites; (4) *Collembola* living in the tunnels. The existence of such an intricate biological complex may explain failures of attempts at controlling the disease with insecticides or by destruction of diseased trunks.

July 1968

Liabeuf, J. Deuxième conférence internationale sur les recherches cacaoyères, Salvador et Itabuna, Bahia, 19-25 novembre 1967. (Second international conference on cacao research, San Salvador and Itabuna, Bahia, November 19–25, 1967). Café, Cacao, Thé 12, 1, p. 3–12 (1968).

A preliminary report is presented on the cocoa conference mentioned in the title. The subject on which the largest number of papers were read was improvement of planting material; there appeared to be a tendency to replace clones with progenies from clonal crosses exhibiting hybrid vigour. Other subjects discussed included resistance to diseases (mainly *Phytophthora* and *Ceratocystis*), crop protection (mainly chemical control of *Phytophthora* and mirids), physiology and ecology, soil improvement, rehabilitation, mechanical pod-breaking, and pesticide residues. Reports of the 6 study groups are summarized. Excursions were held to a Catongo plantation, the quarantine station, and the CEPLAC research station. Photos.

Enríquez, G., and Soria, V. J. The variability of certain bean characteristics of cacao (Theobroma cacao L.). Euphytica 17, 1, p. 114–20 (1968).

The variability of length, width, thickness and weight of wet beans within trees of various cocoa cultivars was determined in Costa Rica. Highly significant differences in the means of these characters were shown to exist between clones. The most variable character is bean weight; a sufficiently accurate assessment requires weighing of 3 beans in each of 20 pods or of a larger number of beans in fewer pods; with only 14 or fewer pods all the beans have to be weighed. Other characters that can be used to distinguish between clones are percentages of shell and pulp, and seed shape; this last character, however, is difficult to describe. Cotyledon colour cannot be classified into discrete groups since it presents a series of gradations. Tables. 12 refs.

Toxopeus, H. Establishment of cacao clones in Nigeria. Euphytica 17, 1, p. 38–45 (1968).

Extensive deforestation in the cocoa belt of W. Nigeria has resulted in increased exposure to dry winds and high temperatures; consequently, commercial establishment of W. African amelonado cocoa has become almost impossible. Introduction of the F3 Amazon variety from Ghana around 1960 did not bring a sufficient improvement. Since then various cultivars have been tested for their establishment ability by planting them with only a little shade in the 1st dry season. This paper presents results of 2 trials with 40 clones. Most of the Upper Amazon clones tested survived better than did F3 Amazon seedlings and several were outstanding; clones of Trinitario parentage yielded highly variable results; among amelonado clones only 1 was satisfactory. Tables. Graphs. 16 refs.

Esquivel, O., and Soria V. J. Algunos datos sobre la variabilidad de algunos componentes del rendimiento en poblaciones de híbridos interclonales de cacao. (Some data on the variability of some yield components in populations of interclonal cacao hybrids). Cacao; Inst. Interam. Ciencias Agrícolas 12, 4, p. 1–8 (1967).

In Costa Rica, average yields of the cocoa hybrid progenies SCA 6 × ICS 1, SCA 6 × IMC 67, and SCA 12 × EET 62 up to the age of 5 years were found to be much higher than those of open-pollinated progenies of clones UF 613 and 650 and of the local Matina variety. The variability of yield and of pod index within all progenies was rather high. Coefficients of the correlation between number of pods and wet cocoa yield within progenies were all above $+0{\cdot}925$, showing that for a comparison of trees the number of pods provides a reliable estimate of relative yields. English summary. Tables. Graphs. 10 refs.

Newhall, A. G., and Salazar, G. Copper and organic fungicides for eradication of mosses on cacao trees. Cacao; Inst. Interam. Ciencias Agrícolas 12, 4, p. 15–6 (1967).

In an experiment conducted in Costa Rica, 18-year-old cocoa trees bearing a rich growth of mosses and ferns were sprayed with fungicides at 3-week intervals from Apr. to Jan., using a mistblower. Bordeaux mixture and a stabilized cupric hydroxide formulation, applied at a rate of 4·2 g Cu per tree, were highly effective against the epiphytes; captafol and mancozeb at a rate of 7·5 g per tree were less effective though they had a marked effect. In a 2nd trial, in which trees were sprayed during a whole year, cuprous oxide was more effective than mancozeb, but the effect of both treatments was relatively small because they were applied at half the rates used in the 1st trial. Spanish summary. Tables. 2 refs.

Soria, V. J., and Esquivel, O. Estudio preliminar sobre el periodo minimo y confiable de producción en cacao para su uso en experimentos de evaluación de cultivares. (Preliminary study on the minimum confidential period of cacao yields to be used in cultivar testing trials). Cacao; Inst. Interam. Ciencias Agrícolas 12, 4, p. 9–14 (1967).

Individual tree yields in numbers of pods per year from the 3rd to the 10th productive year for open-pollinated progenies of 6 UF cocoa clones and the local variety Matina were collected in a trial established at Turrialba, Costa Rica. Correlations between the total yields over 8 years and yields in any single year increased from about 0·70 to 0·95 with the age of the tree; correlations with yields over longer periods were not much higher. It is concluded that for a comparison of progenies average yields over 3 years suffice; if yield data are collected at a later age, 2 or even 1 year is enough. English summary. Tables. Ref.

Ornano, M. d', et al. Comparaison entre l'épreuve à la coupe et la densité optique des pigments pour l'estimation du degré de fermentation des fèves de cacao. (A comparison between the cutting test and the optical pigment density for estimating the degree of fermentation of cocoa beans). Café, Cacao, Thé 12, 1, p. 53–62 (1968).

Samples of cocoa beans were sent to 7 French laboratories for separation into slaty, violet, semi-violet and brown beans on the basis of the cutting test; the pigment density was then colorimetrically determined. As expected, pigment densities decreased from slaty to brown beans. However, the proportions of the 4 categories differed considerably between laboratories and this was reflected in the pigment densities, a low proportion of violet beans corresponding with a high pigment content and vice versa. A more objective method of classifying cocoa beans for colour is evidently required. English, German and Spanish summaries. Tables. Graphs.

August 1968

Ahenkorah, Y. Phosphorus-retention capacities of some cocoa-growing soils of Ghana and their relationship with soil properties. Soil Sci. 105, 1, p. 24–30 (1968).

P-retention and its relationship with the soil pH and with its organic C, Fe, Al, and clay contents was studied in 17 cocoa-growing soils in Ghana. In 13 latosolic soils (pH 5·3–7·8), P-retention was significantly related to organic C and Fe together with organic C, Fe, pH, and clay interactions. The relationship was closest for organic C and the interactions of pH × Fe, organic C × Fe, and organic C × pH. In 9 soils with pH 6·0–6·5, retention was mainly related to Fe and the interaction of pH × Fe. In both groups of soils, retention was not associated with clay content or Al. The dominant factors in P-retention in all these soils appear to be soil organic C, Fe, and their interaction with pH. Tables. Graph. 35 refs.

Hicks, P. G. Observations on the diseases and conditions of cacao pods in Papua and New Guinea — pod losses 1962-1965. Papua and New Guinea Agr. J. 19, 1, p. 5–9 (1967).

Losses of pods over 12 cm long from 312 cocoa trees at Keravat, Territory of Papua and New Guinea, were recorded according to their causes in 1962–65.

Total losses were 21·1%; the greatest losses were caused by birds and flying foxes (8·7%) and by lepidopterous pod borers. Pod rot (*Phytophthora palmivora*) caused a loss of only 1·2%; one-third of the trees were sprayed with Bordeaux mixture at 3-weekly intervals, and this reduced the incidence of pod rot, but its incidence in unsprayed plots was still surprisingly low. Minor causes of losses included mirids, rats, physiological factors inducing wilting or dry pulp, and knife wounds. Various types of damage are described. Pod borer infestation was found to increase with the number of pods per tree; it can be controlled by spraying with endrin. Table. Photos. 6 refs.

Emechebe, A., and Leakey, C. L. A Verticillium dahliae established as the cause of sudden death of cocoa. FAO Plant Prot. Bull. 16, 1, p. 13 (1968).

Sudden death disease of cocoa in Uganda was tentatively ascribed to *Verticillium dahliae* by Leakey in 1965. This has now been confirmed by inoculation experiments. Isolates of the fungus and cell-free filtrates of cultures induced wilting in cocoa seedlings and cuttings, control plants remaining healthy. After inoculation of roots with a conidial suspension, *V. dahliae* was recovered from surface-sterilized wilted shoots.

September 1968

Ibañez, M. L. The effect of cold on tropical seeds. Turrialba, Rev. Interam. Ciencias Agr. 18, 1, p. 73–5 (1968).

It is well known that cocoa seed is highly sensitive to cold. In the author's trials, the viability of seeds of all *Theobroma cacao* types studied and that of *Th. grandiflora* seeds was completely lost after exposure to a temperature of 4°C for 15 minutes. The rate of respiration of cocoa cotyledons being altered after chilling, whereas that of hypocotyls is not, indicated that the cotyledons are the sensitive part of the seed; accordingly, chilled beans show the formation of brown pigment indicating damage to cell membranes. Among seeds of other tropical plants exposed to the same treatment, those of *Momordica* sp. and *Annona* sp. were killed and those of *Ceiba pentandra* were damaged. Germination of *Inga edulis* and *Anacardium occidentale* seeds was stimulated by chilling. Spanish summary. Table. 9 refs.

Asomaning, E. J. A., and Kwakwa, R. S. A note on boron deficiency and fruit malformation in cocoa (Theobroma cacao L.). Ghana J. Sci. 7, 3–4, p. 126–9 (1967).

Upper Amazon cocoa trees at Tafo, Ghana, whose leaves showed symptoms of B deficiency, produced distorted pods with a constriction in the middle and a woody core instead of seeds; when seeds were present they were small and often lacked an embryo. That these symptoms were a direct effect of B deficiency was proved by withholding B from 14-month-old trees in sand culture; B deficiency symptoms in the leaves appeared after 10 weeks, asymmetrical cherelles, often with a constriction, were formed subsequently. The symptoms have previously been ascribed to attack by *Bathycoelia thalassina* but it could be shown that this insect, which feeds upon developing seeds, only produces premature ripening of the cortex and no distortion of the pods. Photos. 11 refs.

Newhall, A. G. To increase efficiency or lower the cost of the control of Phytophthora pod rot of cacao. Turrialba, Rev. Interam. Ciencias Agr. 18, 1, p. 79–82 (1968).

Under the conditions prevailing in Costa Rica, the best ways to keep costs of controlling *Phytophthora* pod rot of cocoa down include (1) doing whatever is needed to obtain the highest possible yield per tree, (2) spraying the canopy during new leaf flushes, (3) adding insecticide at suitable intervals, (4) spacing applications according to rainfall and number of pods per tree rather than by the calendar, and (5) after a year of thorough spıaying skipping the trees with very low yields at least part of the time. The value of a sticker is questionable. Author's summary. Spanish summary. Tables. 9 refs.

Lodos, N. Contribution to the biology of and damage caused by the cocoa coreid, Pseudotheraptus devastans Dist. (Hemiptera - Coreidae). Ghana J. Sci. 7, 3–4, p. 87–102 (1967).

The morphology, life-cycle and feeding habits of the coreid bug *Pseudotheraptus devastans* are described. Though it occurs widespread from Ghana to Congo-Kinshasa, serious damage to cocoa has only been observed since 1964 in trial fields, presumably because the amelonado type is not severely attacked whereas Upper Amazon cocoa is. Nymphs and adults feed and can survive on pods of all ages and on chupons; damage is similar to but much more serious than that of mirids, pods becoming deformed and seeds failing to develop. The main natural enemy appears to be the ant *Oecophylla longinoda;* good chemical control has been obtained with DDT and lindane but not with carbaryl. Other coreids associated with cacao in various parts of the world are listed. Tables. Figs. Photos. 15 refs.

October 1968

Sampayan, T. S. Flower biology, fruiting habit and compatibility, relationship in cacao. Philippine J. Plant Industry 31, 3, p. 193–201 (1966; received 1968). In the Philippines, anthesis in cocoa flowers was found to commence at 4 p.m. and to proceed during the night up to about 6 a.m. Anther dehiscence occurred from 6 to 10 a.m., stigma receptivity was highest from 10 a.m. to 1 p.m., and pollen viability lasted the day the flowers opened. In 10 seedling trees derived from a trinitario cocoa type tree, 3 were self-incompatible, while 5 seedlings of the Pamplona Red and as many of the Pamplona White types of criollo cocoa were all self-compatible. No fruit set resulted from crosses between the self-incompatible trinitario cocoa trees, while the highest percentage of fruit set was obtained with crosses between the self-compatible trees of this type. Cross-compatibility between trees of the trinitario type and the criollo type was very low. Tables. 8 refs.

Turner, P. D. Pod rot of cocoa in Malaysia caused by Phytophthora heveae. FAO Plant Prot. Bull. 16, 2, p. 33–4 (1968).

The incidence of cocoa pod rot caused by *Phytophthora* spp. in Malaya is extremely low though *Ph. palmivora* is a widespread pathogen of rubber and climatic conditions would be expected to favour the development of pod rot. Recently, a few pods from trinitario-type cocoa trees were found to be attacked by *Ph. heveae*, a species confined to Malaysia that occasionally produces black stripe in rubber; it had previously been found to cause rot of a single cocoa pod in Sabah. Artificial inoculation of pods with the isolate from the Malayan pods produced a rapidly spreading rot with lesions lighter brown in colour than those produced by *Ph. palmivora;* however, the fungus was unable to penetrate unwounded pods, and is probably of no economic importance for cocoa under local conditions. 2 refs.

Metzner, U. Die Kakaozone der Bahia. (The cacao zone of Bahia). Z. Ausländische Landwirtsch. 7, 2, p. 196–207 (1968).

This general account of the cocoa industry in the Brazilian State of Bahia briefly describes its history, the climate and soils of the cocoa zone, the economic importance of cocoa for the economy in comparison with other crops and mineral resources, size and tenure of the cocoa farms, methods of cultivation and processing of cocoa, the organization of the trade, local factories manufacturing products from cocoa beans, and the price policy of the government. Institutes created in the interest of cocoa planters and traders are discussed somewhat more comprehensively. Map.

Biehl, B. Fermentationsabhängige Rohkakao-Eigenschaften. (Fermentation-dependent properties of commercial cocoa beans). Gordian 68, 616, p. 260–3 (1968).

Chemical processes in fermenting cocoa beans are described from the relevant literature. Factors leading to a differentation of the beans into slaty, violet, and apparently well-fermented beans are discussed. Data from the author's experiments in Brazil show that this differentation is reduced but not eliminated when box-fermented beans are periodically turned. Reducing the proportion of slaty and violet beans by prolonged fermentation will result in a certain proportion of overfermented beans and in proliferation of fungi with a consequent deterioration of the quality. Unfortunately, the cutting test does not allow to detect all overfermented beans or those slightly damaged by fungal growth; moreover, the maximum permissible proportion of overfermented beans is not well known. Graphs. Figs. Photo. 25 refs.

Quesnel, V. Fermentation and drying of cocoa. J. Agr. Soc. Trinidad Tobago 67, 4, p. 527, 529, 531, 533, 535, 537, 539, 541–5 (1967).

In a lecture for cocoa planters in Trinidad, Dr. Quesnel gave a general account of the principles of cocoa fermentation and drying. Since Trinidad cocoa derives its value from its special flavour, and the pulp appears to contribute this, accelerated fermentation cannot be recommended. Experiments have indicated that, while openings in the bottom of a fermentation box are essential, an impermeable cover gives equally good results as a cover of banana leaves because CO_2 sinks to the bottom. Consequently, masses of up to 7 kg can be adequately fermented in a plastic box with a close-fitting lid if slits are cut in the bottom. A satisfactory fermenter for masses of 10–50 kg was made from an oil drum by punching holes into one end, inserting a slatted wooden floor above the perforated end, lining the drum with plastic and isolating it with a sheet of foam rubber.

INDEX of First Twelve Issues

AUTHOR INDEX

SUBJECT INDEX

Printed in England by the Hudson Buckler & Webb Group, Birmingham. 3.