COCOA GROWERS' BULLETIN

Number 2 February 1964

Contents

Cadbury Brothers Limited
Publication Department Bournville

Editorial

The first cocoa research scheme—study of cocoa-growing problems by a team of scientists—was started in Trinidad in 1930. It arose out of recommendations to the U.K. Government that there should be a series of research stations in the tropics, and was supported from the beginning by contributions from some U.K. manufacturers as well as Colonial Governments.

In 1938 the Gold Coast Government started the Central Cocoa Research Station at Tafo, and this became the West African Cocoa Research Institute in 1944.

Several other research stations have worked on cocoa, notably the Inter-American Cacao Centre at Turrialba, the WACRI Sub-Station at Ibadan, Nigeria, which has now become an independent research centre, and the stations in the Ivory Coast and Cameroon, but it is Trinidad and Tafo that have contributed most to basic knowledge of cocoa. It is these two stations that have undertaken long-term experiments of a fundamental nature, and it is from them that the improved planting material that is being used in many parts of the world, and the better understanding of shade and fertilisers, which can lead to higher yields, have come.

In 1960 there were 17 scientists working at Tafo, nine at Ibadan and eight in Trinidad. Now, at the end of 1963, there are only nine at Tafo, eight at Ibadan and four in Trinidad. The number of scientists at these three centres has been reduced from 34 to 21 and it is probable that the number will decline still further in 1964.

The need for continuing research requires no emphasis; apart from the problems that continue to arise with pests and diseases, breeding work and the studies on the various aspects of cocoa cultivation should not be interrupted, and there is a very real danger of this occurring if research staff is not increased.

Scientists have been leaving these research centres for a variety of reasons; in West Africa there has been a feeling of insecurity which has arisen from the various organisational changes that have taken place in recent years. At the same time the financial attraction of posts overseas has diminished. Salaries have improved in the U.K., and recent budgets in various overseas countries have raised personal taxation and the cost of living considerably. This undoubtedly explains why it has become very difficult to recruit staff for overseas research stations.

It is in this situation that manufacturers in the U.K. have been looking for ways in which to assist research. They have provided roughly half of the money for the scientific work in Trinidad for many years, but are now wishing to assist research in other parts of the tropics. For this reason a meeting was held in London in January 1964, at which U.K. manufacturers met manufacturers from other European countries in order to try to raise an international cocoa research fund.

G. A. R. Wood,
Cocoa Growers' Bulletin,
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Cocoa Price Stabilisation Scheme

S. L. Hale, Cadbury Brothers Limited

Reference was made in the first issue of the Cocoa Growers' Bulletin to the possibility of a Cocoa Price Stabilisation Scheme being agreed by producing and consuming countries in the hope that this would obviate excessive price fluctuations and provide producers with a reasonable and fair price for their cocoa while ensuring that world consumption of cocoa and chocolate would continue to expand.

The Negotiating Conference held in Geneva from the 26th September to the 24th October under the auspices of the United Nations failed to agree a scheme mainly because price ideas of producers and consumers were too far apart.

Consequently the Conference decided to adjourn and passed the following resolution:—

"RESOLUTION REGARDING ADJOURNMENT

The United Nations Cocoa Conference, 1963 convened by the Secretary General of the United Nations pursuant to a request by the F.A.O. Cocoa Study Group and attended by delegations from: Australia, Austria, Belgium, Brazil, Cameroun, Canada, Colombia, Congo (Leopoldville), Costa Rica, Ecuador, Federal Republic of Germany, France, Ghana, Israel, Italy, Ivory Coast, Jamaica, Japan, Luxembourg, Mexico, Netherlands, Nigeria, Norway, Spain, Sweden, Switzerland, Togo, Trinidad and Tobago, Turkey, United Kingdom, United States, Venezuela and Western Samoa.

Having met at Geneva from 26th September to 24th October, 1963.

Recognizing that differences of views exist among governments with regard to the terms of an agreement designed to take action to meet special difficulties which may exist or may be expected to arise concerning cocoa, and that further consideration by governments is required.

1. **Requests** the Secretary-General, acting in consultation with the Interim Co-ordinating Committee for International Commodity Arrangements in accordance with resolutions 296 (XI) and 557 (XVIII) of the Economic and Social Council,
   (a) to keep under review further discussions, including those which may take place within the F.A.O. Cocoa Study Group, and other developments which may make it desirable to resume the negotiating conference on cocoa, and
   (b) to invite States included in a list to be prepared for the purpose by the Interim Co-ordinating Committee for International Commodity Arrangements to come together for a further session of the Conference when satisfied that the conditions for a resumption exist and facilities are available.
2. **Decides** to adjourn"

A spokesman on behalf of consuming countries said in his concluding speech:—

> "Before we resume negotiations in the future, we must assure ourselves that the views of producers and consumers have come sufficiently close together. When this occurs we shall always be ready to take part in renewed discussions in the hope that a meaningful Agreement can be hammered out. At that time the work which we have done here in preparing the groundwork for an Agreement will, we are sure, prove of great value. Until that day we must continue, of course, to work together as producers, traders and consumers of cocoa, recognizing the mutuality of interest which must always bind us together".

Black-pod Disease

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Introduction

Black-pod disease, also known as brown-pod in some countries, is one of the most serious disorders of cocoa with which growers have to contend. The disease occurs to some extent in all the cocoa-producing countries of the world.

Losses due to the attacks of this disease vary greatly from country to country and from year to year, so that it is difficult to define its exact economic importance. McLaughlin and Bowman (5) estimated annual losses in Costa Rica at about 50 per cent; Miranda and da Cruz (6) placed them at 25 per cent for Bahia and Smith (8) suggested losses of up to 50 per cent in Western Samoa. In Ghana a recent estimate of losses puts them at between 10–15 per cent, while in Nigeria and the Cameroons they are much higher, and may account for almost the whole crop in areas where no control measures are applied. Watts Padwick (15) has suggested that a minimum of 10 per cent of the world production of cocoa is destroyed by the disease. This is probably a very conservative estimate.

Symptoms

Black-pod disease is caused by the fungus *Phytophthora palmivora*, which is one of the most common pathogenic fungi in the humid tropics. It infects hosts in over fifty genera (2) and, besides cocoa, is responsible for economically important diseases of rubber, citrus, and coconut and Palmyra palms.

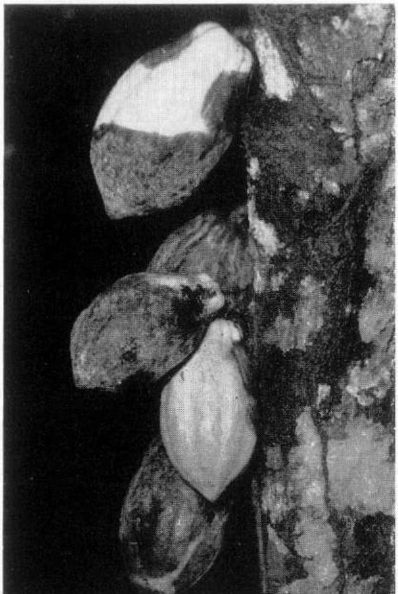

Fig. 1. *Pod rot caused by P. palmivora.* *Fig. 2.*

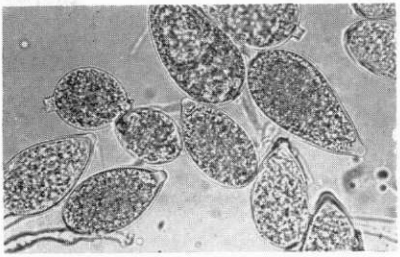

Fig. 3.—Sporangia of P. palmivora.

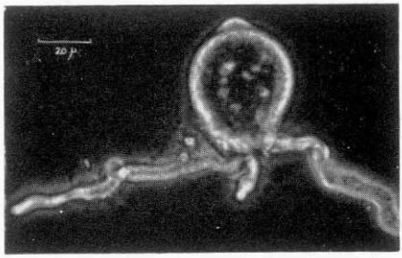

Fig. 4.—Sporangia showing germ tubes.

On cocoa, *P. palmivora* causes a pod-rot (illustrated in plates 1 and 2), stem and cushion canker, leaf fall and chupon and seedling wilt. The importance of canker has declined with the change from Criollo to Forastero types, and leaf infection appears to be of little importance in West Africa. Pod-rot is now the most important of these conditions.

On pods the first sign of infection is a minute translucent spot which soon turns chocolate brown. These spots expand rapidly so that the whole surface of a mature pod is discoloured within about 14 days. The fungus sporulates on the surface of the pod and has the appearance of a white or yellowish down. Internally the seeds are infected after about 15 days, and soon after they are rendered worthless. If diseased pods are left on the tree the fungus may grow back through the stalk into the cushion and this may result in the formation of a canker.

The fungus

The spores produced on the surface of infected pods are called sporangia (see plate 3) and measure approximately $60\mu \times 40\mu$ (1 micron "μ" $= 1/1000$ mm.) Sporangia germinate in a moist atmosphere to give one or more germ tubes (see plate 4), or if they are suspended in water they may release 15–30 small bodies called zoospores. These zoospores have two tail-like processes which lash back and forth and so allow the spore to move. When the zoospore comes to rest it germinates to form a germ tube in the same way as the sporangium.

Turner (13) examined many isolates of *P. palmivora* from ten cocoa-producing countries in West Africa and showed that there were two dominant strains. These differ in the type of lesion they produce, sporangial dimensions and geographical distribution. One strain is more or less confined to the westerly cocoa-producing countries of Sierra Leone, Ivory Coast and Ghana, while the other is dominant in Nigeria, Fernando Po and the Cameroun Republic. From an examination of isolates of *P. palmivora* from non-African countries Turner (14) found that most isolates were similar to those occurring in Ghana.

These two major strains will mate together in culture, and presumably in nature, to produce a third type of spore called an oospore. The importance of this spore is not known but it could be considerable by bringing about variation in the fungus and perhaps thereby allowing it to attack previously resistant types of cocoa.

The life cycle

Germ tubes from either zoospores or sporangia penetrate the pod surface at any point and at any age, and give rise to a mycelium which invades the host tissues. Infection can only occur when the humidity is very high or when there is free water on the pod surface. Since water tends to remain on the pod in the lip around the stalk, at the base of the pod from which it drips, and where pods touch one another or the tree, it is at these sites that infection usually occurs. At the beginning of the wet season, when there are no infected pods on the trees, initial infections may start with mycelium growing from previously infected flower cushions into young pods. In Ghana, Wharton (17) found that 6.2 per cent of the trunk crop was infected in this way. Early infections may also originate from infected debris in the soil, which is splashed onto pods near the ground by rain.

When conditions are suitable the build-up of the disease can be extremely rapid. However, Thorold (12) has shown that an epidemic will not occur until there are sufficient pods on the trees. Once this state has been reached the extent of the infection is largely determined by climatic conditions. In Nigeria, Thorold (9) demonstrated a close correlation between disease incidence and rainfall. In Ceylon, Orellana and Som (7) have shown that low temperatures of about 15°C. favour the development of the disease by causing dew formation. In Nigeria such low temperatures are rarely recorded in the cocoa areas, but it has been noted that during cool weather zoospore liberation is encouraged and that these zoospores have an extended period of motility.

Thorold (10) has shown that sporangia of *P. palmivora* can be carried by wind and has demonstrated the spread of the disease down-wind. Other workers have shown that various insects may carry spores from place to place and thus help the spread of the disease. However, rain is probably the most important of all the dispersal agents, spread over a distance being effected by secondary splash droplets.

Disease control

A. *Resistant varieties.* At the present time there are no acceptable varieties of cocoa resistant to *P. palmivora* being grown on any great scale. However, reports from various cocoa-growing countries indicate that a careful examination of existing material may well uncover selections which are either resistant or tolerant to the disease. The variety Lafi 7 from Samoa has shown a high degree of resistance in some countries, but recently in Ghana and Malaya this variety has not performed so well. Grimaldi (1) has demonstrated the value of clone B12 from the Cameroun Republic which, although not resistant to disease, bears much of its crop in the dry season and thereby escapes infection. In West Africa some of the new Amazon varieties, which show great promise with regard to yield and early production, also have an extended bearing period. Some of these selections have recently been examined in detail by Wharton (18), (19) who has demonstrated considerable differences in susceptibility to infection.

B. *Cultural practices.* Regular and frequent harvesting and removal of infected pods has been shown by Thorold (11) to reduce the severity of the disease by keeping the source of inoculum low. Frequent harvesting also appears to increase the average size of healthy pods which in turn leads to a considerable increase in yield (17). Furthermore, frequent harvesting means that beans can often be salvaged from ripe, recently-infected pods in which the seeds are still uninfected. Unfortunately most farmers with small areas of cocoa are not prepared to examine their trees often enough to make this method of disease-control work, and it is not practical for most large farms.

Heavy shade favours severe disease conditions, and closely-planted trees are more likely to be severely infected than those more widely spaced. Now that capsid pests can be controlled relatively easily, shade can be reduced and the cocoa more widely spaced and still form the good closed canopy essential for maximum production.

C. *Chemical control.* In many parts of the world existing cocoa is highly susceptible to attack by black-pod disease, and the only practical method of protecting the crop is by chemical means. As early as 1907 Von Faber succeeded in reducing black-pod losses in the Cameroons by more than 50 per cent after only three sprays of Bordeaux mixture. Regular sprays of Bordeaux mixture were applied to cocoa in Fernando Po in the early 1930s and soon after West (16) conducted experiments on the chemical control of black-pod disease in Nigeria. This work was followed up by Thorold (11) who showed that 1 per cent carbide Bordeaux mixture applied at three-weekly intervals during the wet season greatly reduced the incidence of the disease. The technique used was to spray only the pods and not the whole tree as is done in Fernando Po. In the early 1950s, when the world price of cocoa was high, the cost of these control measures was more than covered when the sprayed trees carried more than twelve pods, and when losses were potentially high. Similar results have been reported from many other countries where experiments have been carried out to determine the optimum frequency of spraying and the best fungicide to use.

Many fungicides for the control of black-pod disease have been examined in recent years, but with few exceptions the most effective have all been based on copper. Of the copper fungicides Bordeaux mixture still provides the best protection for the least cost, but to some extent they have been replaced by various cuprous oxide formulations which are rather easier to prepare (3). The reddish cuprous oxide fungicides appear to be more effective than the copper oxychloride formulations which are green in colour.

Fig. 5.—A typical pressurised knapsack sprayer.

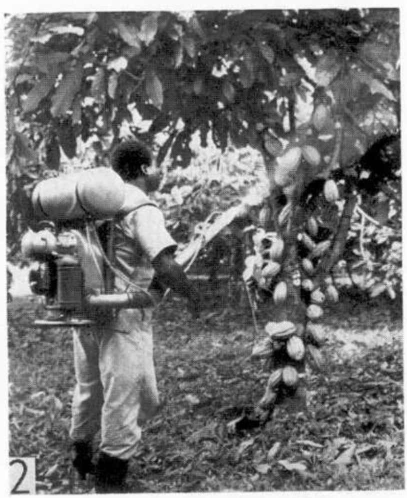

Fig. 6.—A mist-blower.

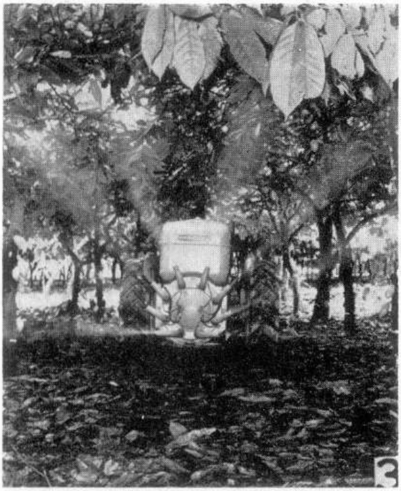

Fig. 7.—A tractor-mounted mist-blower.

The copper fungicides will not cure an infection on a pod once it has started; the first sprays therefore must be applied before the disease has a chance to build up. The fungicides act as protectants by killing spores, which are deposited on sprayed pods, before infection can take place. The amount and distribution of the fungicide on pods is continually being reduced by the action of wind and rain and by pod growth. For these reasons spraying has to be repeated fairly frequently to maintain a toxic deposit over the entire pod surface.

Until about 1950 almost all the cocoa was sprayed by high-volume methods, i.e. the sprayed areas were completely wetted. Bordeaux mixtures and cuprous oxide fungicides containing 0.2–0.5 per cent copper were applied at rates of up to 200 gallons per acre per application. More recently there has been a considerable acreage sprayed by an alternative technique known as mist-blowing. With this method of application no attempt is made to wet the sprayed surface completely but rather to cover it with a large number of small droplets containing a higher concentration of fungicide. The advantages of this technique are that only small volumes of water are required and spraying can usually be carried out more quickly.

Three different spraying machines which have been examined for black-pod disease control in Nigeria (4) are shown in plates 5, 6 and 7. The first machine is a simple high-volume apparatus which is in common use in Nigeria. The second is a small, motorized, shoulder-mounted mist-blower, and the third is a fully automatic tractor-mounted mist-blower. The machines were compared for efficacy in disease-control, speed of operation and cost of spraying. Although the results are rather complicated, because many factors have to be considered, it was found that the simple, cheap, high-volume machine gave the best disease-control for the least expenditure. The small mist-blower was quicker to use and gave good disease-control, but the cost of spraying was doubled and the machine did not prove to be completely reliable. Although the automatic sprayer was about 15 times quicker to use than the high-volume machine the cost of operation was high, and the level of disease-control poor. These results indicate that in areas where cocoa farms are small and where labour is relatively cheap the simple machine is still the most suitable. On the other hand, in areas where cocoa is grown on large estates, and where labour is expensive and water scarce, the mist-blower type of machine would have much to recommend it. This type of machine is also particularly useful for areas where leaf infection is a problem, e.g. Central America, since pods and leaves can be successfully treated at the same time.

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Planning and Layout in Relation to Labour Requirements on a Modern Cocoa Estate

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One of the first considerations in planning the establishment of a cocoa plantation is that of labour requirements before, during and after the period of establishment. The relevant factors are:—

(a) The planting rate and the building programme.
(b) The annual financial allowance for development.
(c) The annual budget after development.

It is also important to know whether there will be continuity of policy and management.

Once these basic factors have been considered the local management should be clear as to the jobs that have to be tackled, their priorities, the amount of labour that each requires and the time of year at which they should be done. The main jobs can be classified as follows:

Establishment Period

	Operation	*Man-days per acre*
1.	Underbrushing	12
2.	Staking	10
3.	Felling	26
4.	Shade planting	1
5.	Nursery seedlings	15
6.	Nursery shade material	—
7.	Holing	4
8.	Planting	5
9.	Weeding	66
10.	Pest control	6
11.	Pruning	1
12.	Shade adjustment	1
13.	Supplying	3

These are the tasks that will have to be done in the field, and the figures for man-days are based on our experience at Ikiliwindi. In addition labour will be required for building roads, houses and accommodation.

Maintenance and Production

1. Weeding.
2. Control of pests and diseases.
3. Pruning.
4. Harvesting.
5. Factory work including pod opening, fermenting, drying and grading.
6. Road and estate maintenance.

There are the main tasks that have to be performed in the cocoa fields and in harvesting and preparation. In addition there may be experimental work in the field, and there are inevitably many services that the estate has to provide;

these include: transport, workshop, office, hospital or dispensary, sanitation and various tradesmen.

It has been stated that the man-day figures are based on our experience in West Cameroon, and they are, therefore, merely a guide as the figures will vary greatly according to local conditions—the terrain, the type of forest and the skill and aptitudes of the labour force.

Organisation of Labour Force

Having established what is required in terms of manpower for the year, the priority and timing of the jobs assumes major importance. Priority of labour must be given to doing the right job at the right time. From the start labour must be trained to be able to do several jobs and not be classified as "weeder", "axeman", "roadman", etc.

On the assumption that cocoa is to be planted under thinned forest, and the best time for planting is during the three months April to June, then the labour gangs might be employed in the following way:—

Staking Gang:	Staking July to April Planting April to June.
Nursery Gang:	Nursery November to April Planting April to June.
Felling Gang:	Felling July to April Holing April to July.
Road Gang:	Road making July to April Loading seedlings and weeding in front of planting April to June.

This is just an example and shows clearly how everybody is allocated to the main job of 'Planting' for a short time of the year. Obviously finer adjustments are made throughout the year, and if one job falls behind, extra labour is allocated to keep the balance.

To give a further example, here is one for established cocoa.

Weeding Gangs:	Permanent, but available for harvesting pods at least one day a week.
Spraying Gang:	May to September black-pod spraying September to January harvesting and factory labour January to April pruning, extra sanitation, drainage, etc.
Road Gang:	Maintenance for most of the year September to January available for harvesting and pod opening.

The correct timing of operations and the allotment of priorities helps to achieve reasonable costs. A little extra labour in reserve is advisable in order to be able to cope with unexpected disease control, storm damage, breakdown of machines, strikes, etc. However, this reserve should be small.

Chain of Command

In order to be efficient it is important to give clear orders and instructions and to evolve a method by which they are conveyed to the labourers. Too long a chain of command will result in confusion; too short a one will put too great a strain on management. At Ikiliwindi the chain of command passes from the manager to the labourers through a Field Supervisor and three Section Overseers

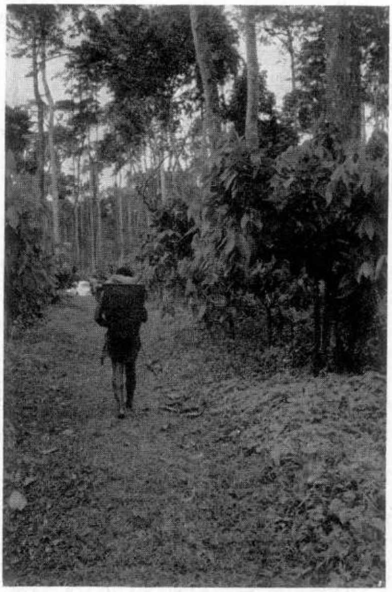

Fig. 8.—Ikiliwindi Estate. This shows the basket for carrying pods and a minor block road.

each of whom has under him two headmen. The Overseers look after 500 acres each and the headmen have gangs of about 22 labourers.*

The Field Supervisor and the Overseers come into the Manager's Office before the close of work to discuss problems that have arisen during the course of the day and to receive instructions for the next day's work. An Overseer's responsibility includes the state of his cocoa—disease, storm damage, state of crop—as well as the supervision of labour.

The Field Supervisor deals with all complaints from the labourers, passing on to the Manager those he cannot deal with himself. Labourers are entitled to see the Manager at all times, by making proper application through the office.

Plantation Layout

The layout of the plantation—the size and shape of blocks, position of the factory—will have a profound effect on efficiency and hence on the cost of production. In planning the layout the possibility of mechanisation must be considered, and this will affect the shape of the blocks and the spacing adopted. Harvesting is a major cost, so the methods employed must be carefully considered. There is a choice between taking the unopened pods to a central fermentary and opening them in the field. Whichever method is chosen the layout of the plantation will influence the labour requirements of harvesting, and any money spent on making the task easier will earn dividends later.

Another important consideration when planning lay-out is supervision. Management, and particularly senior management, is highly paid and should

* The meaning of the words manager, supervisor, etc. varies from country to country. At Ikiliwindi the Manager and Assistant Manager are from the U.K.; the rest of the supervisory staff are African.

Fig. 9.—Sorting and counting the pods.

not waste time walking from point A to B. It should spend the maximum number of hours on supervision and being on the spot at the right time. Managers must have time to look at cocoa, which probably needs more individual attention than any other tropical crop. They should be able to inspect every corner of their estates before breakfast and be free to cope with office, labour, and more field work afterwards.

To achieve both easy handling of produce and mobility of staff it is imperative that communications are good, and the aim should be to put in as many roads capable of carrying a tractor or Landrover as possible. At Ikiliwindi we have blocks half-a-mile or so long and 400 ft. wide, and there is a road between each block, and every second road is fortified. On the hilly sections we have put in as many as possible along the contours.

The following description of the method of harvesting being tried at Ikiliwindi will show the advantage of this type of layout.

The harvesters remove the ripe pods by means of a small knife and throw them over their shoulders into a basket which holds about 50 pods. When the basket is full, the harvester carries it to a collecting point. As the blocks are only 400 feet wide the labourers are never more than 200 feet from a road, though they may have to walk rather further than this in order to dump the harvested pods at a limited number of collecting points. At these collecting points hoppers are being built; these are raised off the ground and hold about 2,000 pods. The numbers are checked at this point and they are classified into healthy pods, black pods and rodent-damaged pods. They are all collected during the course of the day from the hoppers by tipping trailers which take them to the central fermentary.

The following morning the pods are opened by women—mostly labourers'

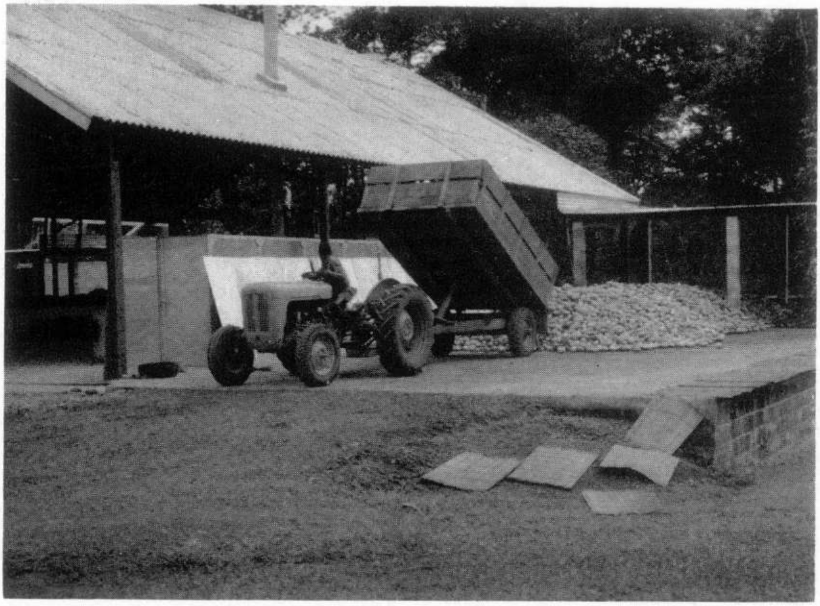

Fig. 10.—Pods being delivered to the central fermentary.

wives—working on contract. To complete the story, the husks and placenta are thrown into a hopper from which they are carried by the trailers to a ravine where they are dumped.

This method was adopted in preference to opening in the field because it makes it easier to supervise the whole task of harvesting and opening.

The transport of the pods is not expensive. The tractors are always moving and there is no chance of beans being left out or "conveniently forgotten to be picked up at night!"

Layout also plays an important part in planning spraying. In the Cameroons black-pod disease necessitates spraying over a period of five months. Good communications allow water to be carried easily, and the sprayer with his machine or knapsack spends the maximum time amongst the trees.

Overheads

On the briefest review of costings it becomes obvious that a great deal of money is spent under the heading "overheads". I do not propose to deal with material costs but will confine myself to overhead labour.

What overheads in this category do we have to carry? Let us consider the following list:—

1. Management, Senior
2. Management, Junior
3. Office
4. Building and maintenance men
5. Workshop labour
6. Medical and sanitation
7. Welfare

Field supervisory staff is becoming expensive, and maximum areas must be allocated to Overseers and maximum labour to each headman. Good supervision pays, but it must be good.

Office staff should fit into the general pattern of estate work. The office is there to help the efficient running of the estate and must be equally efficient; the number of returns should be kept to a minimum and the staff should be interchangeable. The office work requires a storekeeper, a costings clerk-typist, a wages clerk and possibly a junior clerk to understudy all three. In addition a 'dresser' is needed to look after the sick and wounded, real and imaginary; also someone to look after a canteen or shop.

In addition there are tradesmen in the workshop, besides carpenters and builders. The numbers employed will depend on the amount of machinery used and other local conditions.

Lastly, there is always an administration 'tail' comprised of yard boys, sanitation labour, watchmen and others. This 'tail' must be reviewed from time to time as it has a habit of growing, even on the best of plantations.

Many of the points I have made are obvious and elementary, and the object of this article is not to preach but to review or discuss certain aspects of labour management and requirements which in the "good old days", when labour was plentiful and cheap, were quite irrelevant, but which nowadays we shall have to begin to think of, and which in ten years' time will be of paramount importance!

It must have become all too noticeable that it is impossible to generalise and lay down rules, because these may apply in one country and not in another. Roads may be very cheap to build in one area and exceedingly expensive elsewhere due to lack of suitable material.

Finally, I must apologise for quoting Ikiliwindi so often. We are by no means perfect in layout, economy or any other aspect. We have, however, endeavoured to be modern. We are only seven years old and many points raised have yet to be proved.

Spacing

G. A. R. Wood, Cadbury Brothers Limited

The spacing at which trees are planted is one of the important factors affecting yield and, in the absence of clear evidence of the effect of spacing on yield, this subject has given rise to much controversy.

The optimum spacing is the distance which will give the greatest economic return of cocoa per acre. It will be influenced by various factors. In the first place it will depend on the type of cocoa planted, its vigour and its branching habit. A vigorous type, besides growing more quickly than others, will probably grow to a larger size at maturity, and could, therefore, be planted at a wider spacing. Branching habits vary from type to type: Amelonado cocoa tends to grow upwards and bears the bulk of its crop on the trunk; the proportion of the crop borne on the trunk varies with the spacing, but at a given spacing this proportion is higher with Amelonado than with Amazon.

Growing conditions will also vary the optimum spacing. It is arguable as to whether on poor shallow soils one should plant closer owing to lack of vigour on the part of the trees, or wider owing to lack of root-room. Shade conditions will influence the optimum spacing; cocoa grown with little or no shade has a much denser foliage and does not spread to the same extent as shaded cocoa. This is a generalisation as growth habits are dependent on light and temperature amongst other factors, and these will vary with climatic conditions as well as shade.

In deciding on the spacing at which to plant there are other considerations apart from yield. It may be wise to adopt a spacing which allows a tractor to move between the trees for spraying, or possibly for harvesting. This would mean a minimum of 10 ft. between the rows.

Another consideration is the effect of spacing on maintenance costs. Close spacing—less than 10 ft.—has the advantage that it leads to the rapid formation of a canopy, and hence the early suppression of weeds. This will reduce maintenance costs; on the other hand it costs more to plant cocoa at a close spacing; not only will more plants be needed but the cost of lining, holing and planting will be increased in proportion.

Spacing has a considerable influence on the effect of certain pests and diseases. There is clear evidence from Ghana (2) and Nigeria (5) that capsid attack is more severe on widely-spaced trees; in Nigeria the difference was considerable, 6 per cent of trees being affected at 5′×5′ rising to 100 per cent at 15′×15′.

The incidence of black-pod disease is affected by spacing, though the relationship is not clear-cut. The percentage of black-pod is usually greater at close spacings, presumably owing to higher humidity under the denser canopy, but these differences may be slight in a wet year (4). (The number of diseased pods per tree is usually greater at wide spacings because the trees carry a greater crop). Thorold (6) found that more healthy pods were produced at close spacings even where the black-pod percentage was higher.

The spacings used vary from country to country. In Trinidad 12′×12′ is generally favoured, and this spacing is commonly used throughout the West Indies and Central America; Urquhart (7) mentions that in Ceylon, New Guinea and Samoa the spacing is usually 15′×15′, and in the Congo a spacing of 4m×4m has been superseded by 3m×3m. In West Africa very close spacing has been the common practice, the farmers planting the seeds 3½–4 ft. apart in an irregular pattern. Many of these trees die and others are cut out deliberately, but the final stand is still fairly dense at roughly 500 trees per acre, equivalent to 9′×9′.

Experiments on spacing have been conducted in Trinidad, Ghana, Nigeria and New Guinea, and they have been fully reported. Most of the experimental evidence points to close spacing as giving the highest yields. There is no doubt that close spacing will give a higher yield in the first years of bearing, but when the canopy forms and the soil becomes fully exploited, the difference between close and wide spacing narrows.

At River Estate in Trinidad there is a large shade, spacing and fertiliser trial which was planted in 1949. In this trial two spacings—8′×8′ and 12′×12′—were used. The close spacing outyielded the wide spacing in the early years, but the difference decreased as the trees matured as the following figures show:—

Shade and Spacing Trial: River Estate

(*Yields in lb. per acre*)

	8′×8′	12′×12′
1952–53	341	188
1953–54	421	348
1954–55	1202	934
1955–56	1253	985
1956–57	1358	1177
1957–58	1048	1152

(Figures from a *Report of Cacao Research* 1957–58, p. 83).

These yield figures apply to the plots without shade; on the shaded plots the yields were similar but the differences between close and wide spacing were less.

In Ghana, two spacing trials have been planted at Tafo (1), one using Amelonado cocoa, the other Amazon. The Amelonado spacing trial was planted in 1947, using eight spacings from 4′×4′ up to 15′×15′. A spacing of 7½′×7½′ (774 trees per acre) has given the highest overall yield, the aggrerate for seven years to 1960–61 being:—

15′ ×15′	5470 lb.
12′ ×12′	7420 lb.
10′ ×10′	8640 lb.
7½′× 7½′	9420 lb.
7½′× 6′	8530 lb.
6′ × 6′	8310 lb.
5′ × 5′	8940 lb.
4′ × 4′	8620 lb.

Although the yield at 7½′×7½′ is outstanding, all the other spacings at 10′×10′ or closer gave similar yields.

The Amazon spacing trial using 8′×8′, 10′×10′ and 12′×12′ has given different results; the 8′×8′ plots gave slightly higher yields in the first three years of bearing, since when the wider spacings have given the greater yield, the aggregate yields for the ten crops up to 1961–62 being:—

8′× 8′	8006 lb. per acre
10′×10′	8904 lb. per acre
12′×12′	8789 lb. per acre

In Nigeria a spacing trial was planted at Gambari in 1942; this compared seven spacings from $5' \times 5'$ up to $15' \times 15'$ and compared Amelonado with Trinitario. Kowal (5) has discussed this trial in detail and concludes that the optimum density for Amelonado is about 800 trees per acre and that "a stand density below 580 trees per acre for both Trinitario and Amelonado cocoa in Nigeria is disadvantageous in relation to health and management, and uneconomical in relation to yield".

In New Guinea the usual practice has been to plant cocoa at a spacing of $15' \times 15'$ and this has been the recommended distance. Charles (3) has reported that in trials at Keravat comparing a spacing of $12' \times 12'$ with $15' \times 15'$, the closer spacing has yielded 17 per cent more cocoa over a period of eight years, and that casualties were lower at $12' \times 12'$. Closer spacings than $12' \times 12'$ have not been tested, but it is clear that the recommended spacing "should be changed to 12 ft. on the triangle".

The results of most of these trials points to a spacing of between $7\frac{1}{2}' \times 7\frac{1}{2}'$ and $10' \times 10'$ as giving the highest yield with Amelonado cocoa, with some indication that $10' \times 10'$ or even $12' \times 12'$ gives better yields with the more vigorous Amazon type. On cocoa estates $10' \times 10'$ is possibly the best compromise. It allows easy access between the rows of trees and a canopy forms fairly quickly at this spacing. If a closer spacing is required, then $10' \times 8'$ might give slightly higher yields while still giving easy access.

From time to time it is suggested that cocoa should be planted close and thinned later, with the object of achieving an early yield and of reducing maintenance costs. This has not yet been tried in experiments so there is no evidence to show the financial gain or loss. The major disadvantage would seem to be a psychological one in that it becomes difficult for estate managers or farmers to thin out trees once they start bearing and, where a regular stand of trees is the aim, thinning is bound to involve the removal of some vigorous trees, leaving some less vigorous ones.

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5. Kowal, J. M. L. *Emp. J. Exp. Ag.* 27. 105. 27 (1959).
6. Thorold, C. A. *Ann. Appl. Biol.* 47. 4. 708 (1959).
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Notes

Cocoa Research Institute of Ghana

The West African Cocoa Research Institute became the Cocoa Research Institute of Ghana following the dissolution of the West African Research Organisation in October 1962. The Institute is organised by the Ghana Academy of Sciences.

The second half-yearly progress report from C.R.I.G. was issued in July 1963 and covers the period July–December 1962. The following items are of particular interest:—

Root Infection by Phytophthora palmivora

Evidence of root infection of cocoa by black-pod fungus, *P. palmivora*, has been given in WACRI Annual Report for 1961–62 and in an article in Tropical Agriculture (Turner and Asomaning. *Trop. Agric.* 39. 339. 1962).

Root infection retards the growth of seedlings but it has been found that there are considerable clonal differences indicating resistance to root infection. There is some evidence that clones resistant to root infection are also less susceptible to black-pod, so that a test of resistance to root infection may prove a quick test of black-pod susceptibility.

Capsid Studies

Much work is now being done on the control of the capsid *Distantiella theobroma*, which has become resistant to lindane (BHC) in some parts of Ghana. This resistance was first evident at Pankese Cocoa Station in mid-1961, and since then resistant capsids have been found at a few other widely-scattered places. Clearly there is grave danger of the capsid population becoming generally resistant to the present insecticide, which is based on lindane.

Resistance to lindane involves resistance to other chlorinated hydrocarbon insecticides such as aldrin, chlordane, heptachlor, endrin and dieldrin. This cross-resistance does not extend to D.D.T., organophosphorous compounds or the carbamate compound, Sevin.

Extensive trials are being conducted with alternative insecticides, notably Sumithion, an organophosphorous compound, and Sevin, and it is expected that recommendations for a new insecticide will be made in 1964.

Swollen Shoot Disease

In answer to a question in Parliament, the Deputy Minister of Agriculture in Ghana stated that the total number of diseased trees cut since the appearance of swollen shoot disease in Ghana was 113,535,831, made up as follows:—

Trees cut by the Government up to March 31st, 1963	113,447,071
Trees cut by farmers up to August 25th, 1963	88,760
	113,535,831

A total of £11,376,136 12s. 10d. has been paid as compensation to cocoa farmers.

New Cadbury Plantation

Cadbury Brothers Ltd. have started work on a 2,000-acre plantation in the Labuk Valley in Sabah (formerly North Borneo). This is situated in a new area for cocoa, and it is hoped that in a few years' time smallholdings will be established in the neighbourhood.

Pests of Cocoa in Sabah

The report of the Department of Agriculture for 1962 devotes several pages to the entomologist's report on pests that have occurred at the Cocoa Research Station at Quoin Hill.

When fairly large areas of forest were thinned and cocoa planted in 1959 and 1960, the young trees were attacked by a number of pests of which two borers were the most important. One of these is a ring bark borer, identified as *Phassus hosei*, which attacks young trees at the collar, often killing them. Two-year-old trees appear to be the most susceptible to attack. The other is a branch borer, of the genus *Zeuzera*, which tunnels into twigs and branches of trees of all ages. The affected branches are killed, and damage has been quite serious. In 1960 and 1961 frequent and expensive spraying routines were being done on estates in an attempt to control these pests.

The entomologist has concluded that when cocoa was planted on a wide scale these pests had an opportunity to multiply rapidly and their natural parasites and predators were unable to exert the normal level of control. "There is in theory a time lag before a control balance is re-established". There is a possibility that the insecticides killed off some parasites and predators and prolonged the time lag.

At the end of 1961 routine spraying was stopped at the Cocoa Research Station, and these two borers have been brought under control by natural parasites supplemented by application of insecticide to the burrows made by the ring bark borer.

Pest attacks in new areas are not uncommon, and there are obvious morals to be drawn from this experience at Quoin Hill.

Notes on Contributors

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Born in London in 1934 and graduated from London University 1955. Studied plant pathology and crop protection at Bristol University for one year as a Colonial Research Service student. Joined the Colonial Pesticides Research Unit, Arusha, Tanganyika late 1956 and was seconded to Nigeria in 1958 to work on black-pod disease control. Joined the staff of the West African Cocoa Research Institute, Ibadan, Nigeria, in 1959 and continued to work on black-pod disease control until March 1963. Now engaged in work on the copper fungicides at the University of Bristol Research Station, Long Ashton.

O. E. K. Laband

After war service worked on farms in U.K. in a managerial capacity and then went to Ghana as an Agricultural Survey Officer. Joined the Cadbury and Fry buying organisation in 1954 and moved to the Cameroons to manage the plantation at Ikiliwindi which was started in 1956.

Cocoa Abstracts

The following abstracts are reprinted from *Tropical Abstracts*, a monthly publication issued by the Royal Tropical Institute, Amsterdam. The dates refer to the issues of the publication.

September 1963.

Cocoa. Nigeria Trade J. 11, 2, p. 69–73 (1963).

Apart from a few young plantations totalling about 4,000 ha it is estimated that cacao is cultivated in Nigeria by more than 300,000 farmers in the Western Region, Eastern Region and part of the Northern Region, on small farms occupying some 240,000 ha. The cocoa produced by the farmers is bought by the Cocoa Marketing Board, which also supports the activities of the West African Cocoa Research Institute with regard to crop protection and breeding. Each season the Marketing Boards publish a list of licensed buying agents (in Western Nigeria also co-operative unions). The Boards indicate the official buying stations to which cocoa must be delivered for inspection and grading. Almost the whole of the cocoa crop passes through the port of Lagos, where the overseas sale is negotiated by the Nigerian Produce Marketing Company Ltd. Coloured illus.

Note on estimation of leaf areas of cocoa from leaf length data. Canadian J. Plant Sci. 43, 2, p. 243–5 (1963).

According to growth-analysis studies on young cocoa seedlings in West Africa it became necessary to develop a rapid non-destructive method for estimating leaf areas. In this note a method is described based on the relationship between leaf length and leaf area. It was found that the area of the cocoa leaf can be described accurately in terms of length. The maximum width of the cocoa leaf may also bear a definite relationship to the area. However, leaf width is less readily determined in cocoa than leaf length and its measurement is subject to bias. While the relationship of leaf area to leaf length described was determined only for cocoa of the variety in question (Amelonado), it is expected that similar relationships would hold for other cocoa varieties. Fig. 4 refs.

Hunter, J. R. Estado del trabajo referente al mejoramiento de variedades de cacao en el hemisfério occidental. (The present state of the work directed towards the improvement of cacao varieties in the Western Hemisphere). Cacao. Inter-Am. Cacao Centre 6, 4, p. 1–17 (1961; received 1963).

The introduction summarizes the history of cacao breeding and selection in the Americas since its inception around 1930, when the Imperial College of Tropical Agriculture in Trinidad and the United Fruit Company in Central America started the systematic selection of mother trees; it emphasizes the role of the Cacao Centre at Turrialba, Costa Rica, in co-ordinating this work and in promoting the adoption of well-planned selection programmes in various countries. The main part reviews, for each of 16 countries in Central and South America including the West Indies, the present state of the breeding and selection work, its aims, the clones and progenies included in field trials, and the main results. Tables. Fig. Photo. 23 refs.

Smith, R. W., and Acquaye, D. K. Fertilizer responses on peasant cocoa farms in Ghana: a factorial experiment. Emp. J. Exp. Agr. 31, 122, p. 115–23 (1963).

Similar fertilizer trials were conducted on 6 farms in the Ashanti region of Ghana. The following treatments were applied in each of the 4 years 1957–58 to 1960–61: (1) no fertilizer; (2) 112 kg N + 85 kg P_2O_5 per ha; (3) 50 kg K_2O + 250 kg dolomitic limestone containing 42% $MgCO_3$ and 53% $CaCO_3$ per ha; (4) a combination of (2) and (3). The NP treatment elicited yield responses ranging from —26 to +33% and would have yielded a profit in some cases; responses due to the KMgCa treatment were much smaller and unprofitable in all cases. The combined treatment was no or only slightly better than the NP treatment except in one case where it increased the yield by 61%. These results were correlated with soil analytical data. The response to KMgCa fertilizers appeared to increase during the course of the trial period. Tables. Graphs. 12 refs.

Eloja, A. L., and Gandia, I. M. A new threat to cacao. Coffee and Cacao J. 6, 2, p. 40 (1963).

A cacao disease reported in the Philippines in 1962 (see Trop. Abstr. k574 was tentatively identified with the disease caused by *Ceratostomella fimbriata*. A *Ceratostomella* sp. was isolated from the bark of diseased trees infested by shot-hole borers (*Xyleborus* sp.).

Catley, A. Tiracola plagiata Walk. (Lepidoptera Noctuidae), a serious pest of cacao in Papua. Papua and New Guinea Agr. J. 15, 1–2 p. 15–22 (1962).

Damage to cacao by the polyphagous caterpillars of the noctuid moth *Tiracola plagiata*, in the Territory of Papua and New Guinea was first recorded in 1938. The pest was considered a minor one until a serious outbreak occurred in 1960 as the result of the felling of a large area of virgin forest for cacao planting. Several weed species, and the *Crotalaria* and *Leucaena* used as shade plants, were attacked first: afterwards the caterpillars moved on to the cacao. The severity of the attack has since then subsided. The caterpillars feed only on soft tissues such as flush growth, flowers and young fruits; older cacao leaves are not attacked. Natural control by parasites, predators and fungal diseases proved insufficient to keep the pest in check. Table of host plants. Photos. 26 refs.

October 1963.

Hall, T. H. R. The cuttings production and rooting potential of some W.A.C.R.I. cocoa clones. Trop. Agr., Trinidad 40, 3, p. 223–8 (1963).

Thirty cocoa clones were examined in Ghana for the production of cuttings and for their rooting potential. Upper Amazon and trinitario type clones were shown to be the highest producers of cuttings and the best rooting subjects while amelonado type clones were the poorest. Local non-amelonado types were intermediate in performance. It was also shown that, in the long term, the taking of cuttings at weekly intervals did not provide as many cuttings as monthly collections. The effect and implications of these differing responses by clonal parents on the production of hybrid seed are discussed. Author's summary. Table. Graph. 9 refs.

Dupont de Dinechin, B. Régénération des cacaoyères en Côte d'Ivoire. (Rehabilitation of cacao plantations in the Ivory Coast). Café, Cacao, Thé 7, 2, p. 87–107 (1963).

The average yields of cacao in various regions of the Ivory Coast Rep. are discussed in their relation to climatic and soil conditions. Cultural practices applied by the farmers are reviewed, and the economics of cacao growing are outlined. Examples are given of old plantations which have been rehabilitated by various methods including the removal of excess shade, disease and pest control, fertilizer application, replanting, and budding. A campaign directed at promoting the farmers' interest in the rehabilitation of old fields would be desirable; conversion of coffee and banana plantings into cacao should be included in the programme. Though rehabilitation in marginal cacao areas should not be wholly neglected, the effort should be concentrated on the regions most suitable for the crop. English, German and Spanish summaries. Tables. Figs. Photos. Maps.

Blencowe, J. W., et al. A new virus disease of cocoa in Sierra Leone. Trop. Agr., Trinidad 40, 3, p. 233–6 (1963).

Swollen-shoot disease of cacao, caused by a mild strain of the swollen-shoot virus, was first recorded from Sierra Leone in 1958. A subsequent survey revealed, besides several more cases of swollen-shoot disease, the occurrence of a second virus disease of cacao different from all previously described virus diseases. Leaves of affected trees showed large necrotic blotches, a chlorotic mosaic, or almost complete chlorosis, with occasional vein necrosis. The new virus proved to be readily transmissible by mechanical means but not by mealybugs. Its effect is relatively mild. Photos. 3 refs. See also ibid. p. 229–32: Attafuah, A., et al. Swollen-shoot disease of cocoa in Sierra Leone. Tables. Photos. 7 refs.

Wilbaux, R. Observations sur la préparation du cacao criollo à Madagascar et à l'Archipel des Comores. (Observations on the processing of criollo cocoa in Madagascar and the Comoro Islands). Café, Cacao, Thé 7, 2, p. 119–30 (1963).

Fermentation and drying trials were conducted using cocoa beans from pure or almost pure criollo plantations in the Comores and on the West coast of Madagascar. The optimum fermentation period was found to be 5–6 days when the cocoa was harvested in the rainy season, and 6–7 days when it was harvested in the dry season; 2 or 3 turnings proved sufficient. Immersion in water during 24 hours following fermentation improved the quality but rendered the shells very brittle. Washing was indispensable to obtain a good quality commercial cocoa. The only reliable criterion for assessing the relative merits of different fermentation and drying methods was the cut test applied to the dried beans. English and Spanish summaries. Tables. 5 refs.

Allison, H. W. S., and Kenten, R. H. Seasonal variation in the fermentation of West African amelonado cocoa. Trop. Agr., Trinidad 40, 3, p. 217–21 (1963).

Observations made in Ghana over the 4-year period 1958–61 showed that the mean weight of commercial cocoa with a moisture content of 5–6% obtained from 100 kg of wet beans drops sharply from about 46 kg in April to a minimum of 40 kg in June–July when the bulk of the mid-crop is harvested, and thereafter increases steadily to its former level of 46 kg, which is reached in Dec.–Jan. at the end of the main-crop season. Temperatures attained in tray or heap fermentations after 24 hours show a similar annual periodicity. The practice followed by many farmers, of shortening the fermentation period in the mid-crop season, is condemned. Tables. Graphs. 10 refs.

November 1963.

Hansen, A. J. The role of Fusarium decemcellulare and Fusarium roseum in the greenpoint cushion gall complex of cacao. Turrialba, Rev. Interam. Ciencias Agr. 13, 2, p. 80–7 (1963).

Investigations on the cause of greenpoint cushion gall of cacao were conducted at Turrialba, Costa Rica. *Fusarium decemcellulare* was isolated from galls in Costa Rica and Venezuela, and *F. roseum* from similar galls in Nicaragua. Cacao seeds inoculated with these fungi and with *Calonectria rigidiuscula* (of which *F. decemcellulare* is the imperfect form) from W. Africa developed into seedlings bearing typical greenpoint galls. Mature cacao trees developed galls after infection with *D. decemcellulare; Theobroma bicolor* could be systemically infected but did not form galls. No resistance to the disease was observed in progenies of 4 UF cacao clones, 2 of which have been reported to be resistant to flowery gall. Spanish summary. Tables. Photos. 26 refs.

Delgado, J. C. Efecto de diversas dosis de óxido cuproso y zineb aplicados a bajo volumen en el control de la Monilia en el cacao. (Effect of different levels of low-volume application of cuprous oxide and zineb for the control of *Monilia* in cacao). Turrialba, Rev. Interam. Ciencias Agr. 13, 2, p. 130–2 (1963).

Plots of 30-year-old trees in a shaded cacao field in Ecuador were sprayed at 2-weekly intervals, during the periods Feb.–July 1959 and Dec. 1959–April 1960, with fungicide suspensions at a rate of 18 l/ha. The percentage of *Monilia*-diseased pods was reduced from 35 in the unsprayed control plots to 20 by cuprous oxide applied at a rate of 2 kg/ha, to 22 by cuprous oxide at 3 kg/ha, to 30 by zineb at 1.5 kg/ha, and to 23 by zineb at 2.25 kg/ha. No effect of the treatments on flowering or fruit-setting was observed. Tables. 6 refs.

December 1963.

Bartolome, R. Coffee and cacao development and the socio-economic program in Northern Luzon. Coffee Cacao J. 6, 5, p. 105, 115, 126–7 (1963).

The social and economic development programme for the Philippines envisages a coffee production of 56,000 tons by 1967; since the 1963 crop forecast is 44,000 tons, this goal will be easily attained. The programme does not set a goal for cocoa, though barely one half of the domestic requirements of cocoa are met by local production. Since, however, the market outlook is bright, cocoa production should be promoted. The northern part of Luzon, which in 1963 produced only 200 tons of cocoa, or 6% of the national production, offers ample scope for expansion, whereas areas suitable for arabica coffee are limited. New cacao plantings should be established on land not suitable for the permanent cultivation of subsistence crops and lucrative cash crops such as tobacco. Clearings on hillsides offer good prospects if the cultivation of upland rice, which lasts only a few years, is followed by a banana crop, and cacao is planted between the bananas. Photo.

Ruinard, J. A contribution to the technique of hand-pollination in cacao. Trop. Agr., Trinidad 40, 4, p. 285–6 (1963).

Cacao flowers used for controlled hand-pollinations in W. New Guinea since 1958 were protected against all insects by means of conical hoods of stiff nylon cloth attached to the bark with a couple of pins. This method obviates the difficulty that plasticine-attached tubes or coverings cannot be used on wet bark or on thin branches. Table. Photos.

Acquaye, D. K. Some significance of soil organic phosphorus mineralisation in the phosphorus nutrition of cocoa in Ghana. Plant and Soil 19, 1, p. 65–80 (1963).

Analyses of topsoil samples from 4 identical NP x KMg cacao fertilizer trials conducted in Ghana showed that 46–70% of their total P content was present as organic P. Application of NP fertilizers increased the organic P content only in those trial fields where cacao yields responded to the NP treatment. Incubation trials demonstrated that mineralization of soil organic P, which makes the element available to the crop, was rather slow, only 10% of the total content being mineralized after 70 days at 27° C. Addition of urea and triple superphosphate to the soil increased the rate of mineralization, the effect of P being greater than and independent of the effect of N. This increase in the rate of mineralization explains the correlation between cacao yield responses to NP fertilizers and the organic P content of the soil. Tables. 34 refs.

Longworth, J. F. The effect of swollen-shoot disease on mature cocoa in Nigeria. Trop. Agr., Trinidad 40, 4, p. 275–83 (1963).

Observations made on naturally infected cacao farms in W. Nigeria showed that duration of infection with the swollen-shoot virus had no effect on yield. The principal factor affecting yield was the condition of the crown as influenced by mirid damage and *Calonectria* die-back. Regular spraying with BHC checked and reversed the degeneration of farms when infection was not widespread. Recovery of a heavily infected farm in an advanced stage of degeneration was assisted by additional cultural operations. In a field experiment with mature amelonado cacao, infection with 2 virulent isolates of swollen-shoot virus was without effect on yield over a 3-year period. It is suggested that with careful maintenance, the effects of most virus isolates in Nigeria would become no more important than other major environmental factors influencing yield. From author's summary. Tables. 10 refs.

Dunn, J. A. Insecticide resistance in the cocoa capsid. Distantiella theobroma (Dist.). Nature 199, 4899, p. 1207 (1963).

Several years ago *Sahlbergella singularis* was the most important capsid pest of cacao in Ghana, whereas *Distantiella theobromae* was far less numerous. As a result of the control campaign initiated in 1954, *S. singularis* is now uncommon and *D. theobromae* has become the most abundant species, probably because nymphs and adults of *S. singularis* are more active than those of *D. theobromae* and, consequently, pick up more insecticide during their movement over the trees. In 1961, *D. theobromae* at Pankese was found to have developed resistance to BHC; even spraying with more than 70 g gamma-BHC/ha failed to control the pest. Laboratory tests showed that their LD_{50} of gamma-BHC had increased 40-fold and that they had also become resistant to aldrin. At present the distribution of insecticide-resistant capsids in Ghana is probably not yet widespread. 6 refs.

Publications on Cocoa Growing

The following publications on cocoa growing are available and can be obtained by writing to:

B.W.A. (Publications), Cadbury Brothers Ltd., Bournville.

Reports on Cocoa-Growing Countries

1. Report on a Visit to the Caribbean Area. DAVID GILLETT. 1949
11. Report on a Visit to the Cocoa Zone of Bahia, Brazil. D. H. URQUHART AND G. A. R. WOOD. 1954
12. Report on the Cocoa Industry in Sierra Leone, with notes on the Cocoa Industry of the Gold Coast. D. H. URQUHART. 1955
13. Report on the Cocoa Industry in the French Ivory Coast. D. H. URQUHART. 1955
14. Report on a Visit to the Gold Coast. PAUL S. CADBURY. 1956
15. The Expansion of the Cocoa Industry in Jamaica. D. H. URQUHART. 1956
17. Cocoa-Growing in the Dominican Republic, Mexico, Guatemala and Costa Rica. G. A. R. WOOD. 1957
25. Report on the Possibilities of Growing Cocoa in the Protectorate of Nyasaland. D. H. URQUHART. 1958
26. Prospects for Cocoa-Growing in Uganda and Zanzibar. D. H. URQUHART. 1958
28. Report on an investigation into the Prospects for Growing Cocoa and Oil Palms in India. D. H. URQUHART. 1959
29. Cocoa-Growing in Venezuela, Colombia and Ecuador, with notes on three Cocoa Diseases. G. A. R. WOOD. 1959
30. British North Borneo: A Review of the Colony with special reference to Agricultural Development and opportunities for investment in Agricultural Enterprise. D. H. URQUHART. 1959
33. Cocoa-Growing in Venezuela, Colombia and Ecuador, with notes on three Cocoa Diseases (Spanish Translation). G. A. R. WOOD. 1960

Preparation, Storage and Quality

19. The Quality of Raw Cocoa as it affects the Manufacturer (Reprint from "Tropical Agriculture", January 1955). R. V. WADSWORTH. 1955
20. Experiments on Cocoa Fermentation in West Africa (Reprint from the "Journal of the Science of Food and Agriculture", 1957). G. R. HOWAT, B. D. POWELL AND G. A. R. WOOD. 1957
23. The Samoan Cocoa Drier. 1957
24. Experiments on Cocoa Drying and Fermentation in West Africa (Reprint from "Tropical Agriculture", October 1957). G. R. HOWAT, B. D. POWELL AND G. A. R. WOOD. 1957
27. The Rapid Artificial Drying of Cocoa Beans and Chocolate Flavour (Reprint from "Tropical Agriculture", July 1958). B. D. POWELL. 1958
31. Raw Cocoa: Manufacturers' Quality Requirements (Issued by the Cocoa, Chocolate and Confectionery Alliance). 1959
32. The Storage of Cocoa and the Prevention of Moulding (Reprint from "World Crops", September, October, 1959). B. D. POWELL AND G. A. R. WOOD. 1959
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