Editorial

The Freedom from Hunger Campaign

The population of the world is increasing at the rate of 1·8 per cent per annum. This may seem a small enough amount but it is easy to forget that this is a compound rate of growth. Put another way, if the population were merely increasing at the rate of 1·8 per cent of the *present* numbers each year it would double in 55 years, but at the compound rate doubling will take only 40 years. To emphasise, this rate of increase—the surplus of births over deaths—means one million more people in the world each week.

The fact that a large proportion of the world's population is not properly fed and that some go hungry is well known, and indeed may be obvious to readers of the *Bulletin* in some countries. Considerable efforts are being made to increase food production, and over the world as a whole it has more than kept pace with population growth. But as the F.A.O. has stated, the rate of increase has slowed down and the general increase conceals great variations among the different regions. Food production has been rising more slowly in those countries where population is increasing fastest.

Much more must be done to increase food production. Many measures are available to us. Some involve heavy capital expenditure, others research. Practically all require a strenuous extension effort to get them adopted.

Whatever success is attained by these efforts, the pressure on land will increase as time goes by, and extensive methods of production must be replaced by intensive methods. This applies to cocoa as much as to any other agricultural product, and it is the purpose of this *Bulletin* to pass on information which will help growers to increase their yields and lower their costs.

Chocolate Manufacturers

In this issue we open a series of articles on the larger cocoa and chocolate manufacturers and begin with Cadbury Brothers Limited. The object is not to recount the history and achievements of the firms concerned—this information is generally available elsewhere—but to discuss their links with the cocoa-growing industry. By and large it is true—regrettably so—that in the past there has been less contact between chocolate manufacturers and cocoa growers than is desirable, less than there is between manufacturers and growers of other tropical crops, rubber and oil palms, for example. This contact with the cocoa-growing industry is becoming closer, and although it does not seem likely that chocolate manufacturers will become plantation owners on a large scale, there are other ways—through research for instance—by which manufacturers can understand and help the cocoa grower. These various approaches will be described in later articles.

G. A. R. Wood.

Cadbury Brothers Limited

and the prospects of expansion in the cocoa industry

In his annual statement to shareholders in May, the Chairman of Cadbury Brothers Limited, Mr. Paul S. Cadbury, referred to a static home market in which home sales for 1963 remained at the same level as in 1962. The imposition of a purchase tax on chocolate and confectionery and the consequent increase in prices to the public is one of the factors which have led to a fall in the sales of all U.K. chocolate manufacturers, but as the decline for Cadbury Brothers Limited and J. S. Fry and Sons Limited was less than for the industry as a whole, the company slightly increased its share of the total market.

The U.K. has a higher *per capita* consumption of chocolate and confectionery than any other country, and it seems unrealistic to anticipate any further rise. Total sales will, however, probably move upwards, keeping pace with the growth of population.

The cocoa grower, however, is concerned with the levels of consumption and the prospects for expansion over the whole world. Here the picture is very different. The total of raw cocoa production for 1963/64 was maintained at a high level and world consumption continued to rise. The indications are that this trend will be maintained as living standards throughout the world continue to improve.

Confident in the prospects for the industry over the next ten to twenty years, Cadburys are committed to a large-scale expansion programme.

The Cadbury group of companies is a world-wide organisation with considerable export business and factories in Australia, Canada, New Zealand, Ireland, South Africa, India, and Western Germany. The total overseas business of the company has been steadily increasing for some years.

Cadbury Brothers Limited of Bournville is the largest manufacturing unit in the British Cocoa and Chocolate Company, which was formed in 1919 by the fusion of interests between J. S. Fry and Sons Limited of Bristol (founded 1728) and Cadbury Brothers Limited (founded 1831). Bournville is the headquarters of the group and the centre of research and development, although, in fact, there is a constant interchange of information and ideas between all the factories.

British Cocoa and Chocolate shares are bought and sold on the Stock Exchange, but Cadburys is still, essentially, a family business, and of the fourteen Directors, eight are members of the Cadbury family whose management has extended over five generations.

The Founder was John Cadbury who opened a grocer's shop in Birmingham in 1824, and began manufacture in 1831. Two of his sons, Richard and George, transferred the business to Bournville in 1879. The number of employees at that time was 230. Today about 11,000 people work at Bournville and the total employed by the Cadbury group of companies is about 25,000.

The process of expansion has been almost continuous for a hundred years although since 1945 many of the major developments have taken place away from Bournville—notably at Moreton in Cheshire (chocolate biscuits, moulded chocolate and confectionery; 3,000 employees), in India where a new factory is under construction, and in Western Germany where a new company for the manufacture of Cadbury-Fry goods was formed in 1961. In the U.K. Cadburys have, in the past few years, built new factories and depots and added considerably

to their productive capacity at Bournville.

The continued development of the industry depends on an assured supply of raw cocoa which will be profitable to the grower and enable the manufacturer to sell his products at competitive prices.

The Cadbury policy has been to lift cocoa products out of the restricted range of high-priced luxuries and, within the limitations imposed by large-scale manufacture, to widen their appeal by novelty and diversification. A turning point in the Firm's history, and indeed in the history of the industry, was the introduction of the famous C.D.M. chocolate in 1905. The success of this line was even greater than had been anticipated, and Cadburys had to deal with a supply problem.

Shortly after Cadbury's Dairy Milk had been launched a new cocoa appeared —Bournville Cocoa (1906)—and was acclaimed by the public. By this time the Firm was hard-pressed in its attempts to ensure adequate supplies of raw cocoa. The main sources at that time were the West Indies (chiefly Trinidad and Grenada), South America (Ecuador and Venezuela), Portuguese West Africa and Brazil. Ceylon and Java made a very small contribution and there was a trickle of inferior cocoa from West Africa.

In 1907 Cadburys asked a member of Trinidad's agricultural teaching staff, William Leslie, to go to the Gold Coast and survey the prospects for cocoa-growing. The first shipment (eight tons) was made in 1908. In the following year William Cadbury went out to the Coast to enlist the support of imaginative and progressive African leaders. He ensured that they would be given all the help they needed in the establishment of the new industry and that all the farmers understood that they would receive a fair price for good-quality beans.

From this beginning a buying agency was built up which covered the whole cocoa-growing area of Ghana and handled roughly 15 per cent of this crop. Originally it bought on behalf of the parent company and arranged shipment to its factories; later, when the Marketing Boards were set up, the organisation became one of the Licensed Buying Agents buying cocoa from farmers on behalf of the Cocoa Marketing Board. This continued until 1961 when the Ghana Farmers' Co-operatives became the sole buyer of cocoa from the farmers. In addition to its buying activities the Cadbury organisation has played an influential part in matters concerning cocoa grading and inspection and also research.

The cocoa research work at the Imperial College of Tropical Agriculture in Trinidad started in 1930 and from the beginning received financial assistance from the Cadbury and Fry firms. This has continued ever since and is now arranged on a tonnage basis through the Cocoa, Chocolate and Confectionery Alliance, whose contributions have been approximately £20,000 per annum in recent years.

It was in Trinidad that the Firm owned its first cocoa estates. William Cadbury bought two small estates in 1897 and these were held until 1949 when they were handed over to the Trinidad Government, which in turn made River Estate available to I.C.T.A. for cocoa research.

More recently the Firm has taken a more extensive interest in cocoa planting in new areas and countries where extra capital would give encouragement to farmers. The first of these ventures was in Malaya where Malayan Cocoa Limited was founded in conjunction with the Colonial Development Corporation and Harrisons and Crosfield Limited. This company owns Jerangau Estate and nearby is Landas Estate owned by United Cocoa Development Company in which a large number of cocoa and chocolate companies have shares.

In the Cameroun Republic Cadbury Brothers started a plantation at Ikiliwindi in 1956. This has a total area of 1,500 acres of which over 1,300 have been planted; the earlier plantings have started to produce.

In 1963 work was started on a plantation at Rumidi in Sabah (North Borneo). This will be a larger plantation of over 2,000 acres but it will be some years before the trees are bearing.

The production of these estates at maturity will be 1,500 tons or more, which is only a small fraction of the Firm's requirements. These plantations have not been started with the idea of supplying the Company's factories, but the investment of £800,000 which will be incurred indicates the Firm's faith in the future of cocoa as a crop.

To conclude this account of Cadbury Brothers' interests in cocoa-growing, mention should be made of the many journeys undertaken by D. H. Urquhart and G. A. R. Wood to practically every existing and potential cocoa area. The main object of these journeys has been to gather information and give encouragement to countries initiating a cocoa programme.

Review of Production, Consumption and Prices

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Consumption

In the first issue of this *Bulletin* the increase in consumption between 1958 and 1962 was noted, together with the forecast that consumption would continue to increase at the rate of 4 per cent per annum. This has been borne out by the figures given in the latest issue of *F.A.O. Cocoa Statistics* (July 1964).

1962	1100 thousand metric tons.
1963	1140 ,, ,, ,,
1964 (estimate) ..	1194 ,, ,, ,,

The increase in 1963 over 1962 was 40,000 tons or 3·6 per cent and the estimated consumption for 1964 represents a further increase of over 4·7 per cent.

In the following table the countries with the largest individual increases are given:—

	Grindings (thousand m. tons)		
	1962	1963	1964 (estimate)
U.S.S.R. ..	45	50	55
Japan	21	26	32
Ghana	20	23	38

These three countries account for nearly half of the increase in consumption; in the U.S.S.R. and Japan the increase will be in the form of cocoa and chocolate, but in Ghana it will be largely cocoa butter, which will have to be converted into cocoa and chocolate elsewhere.

Production

Fifteen months ago, the 1962-63 crop was forecast by F.A.O. at 1,109,000 tons, but in fact it was in excess of this figure, and the most recent calculation is 1,166,000 tons. The difference is largely accounted for by the crops from Ghana, Nigeria and the Ivory Coast being heavier than was estimated, the largest single factor being the mid-crop in Ghana, which was estimated at 15-20,000 tons, but achieved a record level of nearly 40,000 tons.

The F.A.O. forecast for the 1963-64 crop was 1,158,000 tons in the April 1964 issue of *Cocoa Statistics*, but this has been increased to an estimated 1,217,000 tons in the July issue. This is again largely due to heavier than estimated crops in Ghana and Nigeria. Production is, therefore, increasing, but not at the rate it rose during 1959, 1960 and 1961.

According to the F.A.O. estimates there should be a surplus of production over consumption of some 23,000 tons.

Prices

In the last issue we referred to the failure of the Geneva Conference to agree a price stabilisation scheme. Since then there have been various discussions by the Cocoa Producers' Alliance, the members of which are Ghana, Nigeria, Brazil, Ivory Coast, Cameroun and Togo, and after a recent meeting in London the following communiqué was issued.

*Draft Cocoa Producers' Agreement

"The technical committee of the Cocoa Producers' Alliance has completed work on the drawing-up of an International Cocoa Agreement for Producers. The decision of the Cocoa Producers' Alliance to seek an agreement among producers is a sequel to the failure of last year's cocoa conference which was organised by the United Nations to negotiate an agreement embracing both producing countries and consuming countries. The producing countries were unable then to get the consuming countries either to agree to a range of prices which they considered reasonable or to contribute materially to the working of an international agreement. The trends in the cocoa market since the Geneva meeting have confirmed the need to regulate the cocoa market and strengthen the resolve of the producing countries to take all requisite action to this end. The technical committee of the Alliance has based its work on the realisation that the increase in the supply of cocoa at a rate considerably out of line with the rise in consumption has been the cause of the continuing depression in the cocoa market. The draft agreement accordingly seeks to regulate the market by strict control of the supplies of cocoa reaching the international market.

"The members of the Alliance already provide about 82 per cent of the world supply of cocoa. It is therefore confidently expected that the workings of the proposed agreement will provide an adequate control of cocoa supplies. At the same time the draft agreement is designed to facilitate the accession of other cocoa-producing countries which are not now members of the Alliance. It is envisaged that the proposed agreement will be used to halt the present decline in cocoa prices and restore them to a level more acceptable in producing countries.

"The draft agreement leaves the door open for the co-operation of the consuming countries in the management of the cocoa market through a resumption of the negotiations under the United Nations or as a result of the current world conference in trade and development or through some other auspices.

"The draft agreement will now be submitted to the member countries of the Cocoa Alliance. It is expected to become operative in the 1964-65 cocoa year".

A further meeting of the Producers' Alliance was held in July in Lomé and it is believed that the draft agreement referred to in the above communiqué has been agreed and may be adopted at a meeting to be held in Rio de Janeiro in September.

WORLD COCOA PRODUCTION AND GRINDING FIGURES— July 1964

These figures have been taken from F.A.O. Cocoa Statistics and are expressed in thousand metric tons

1. PRODUCTION

	Average 1955/60	1960/61	1961/62	1962/63	Forecast 1963/64
Ghana	258	439	416	428	415
Nigeria	121	189	194	179	218
Ivory Coast	61	94	81	103	98
Cameroons	66	82	75	82	88
Rest of Africa ..	50	62	62	66	71
Total Africa	556	866	828	858	890
Brazil	173	122	118	111	125
Rest of S. America..	69	73	75	76	76
Central America ..	26	33	39	42	42
Caribbean	51	51	52	53	54
Total America ..	319	279	284	282	297
Asia and Oceania ..	15	19	22	26	30
World Total	890	1164	1134	1166	1217

**Extracted from "West Africa" dated 30th May, 1964.*

2. GRINDINGS

	Average 1956/60	1961	1962	1963	Forecast 1964
NON-PRODUCING COUNTRIES					
Germany & Fed. Rep.	98	116	124	129	132
Netherlands	73	98	103	105	101
U.K.	90	82	95	95	94
France	54	61	65	66	67
Italy	26	36	37	39	40
Spain	20	23	24	29	29
Rest of Europe ..	117	115	121	129	139
Total Europe ..	478	531	569	592	602
U.S.A.	219	245	255	255	267
U.S.S.R.	23	40	45	50	55
Others	20	60	68	85	85
Total Non-Producing Countries	740	876	937	982	1009
PRODUCING COUNTRIES					
Brazil	53	46	53	42	51
Rest of America ..	58	77	74	73	76
Africa	12	18	31	37	52
Asia	4	6	6	6	6
Total in Producing Countries	127	147	164	158	185
Total World Grindings	868	1023	1101	1140	1194

3. WORLD SURPLUS OR DEFICIT

Average 1956/60	1961	1962	1963	Forecast 1964
+22	+141	+33	+26	+23

Environmental Factors and the Growth of Cocoa

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In times past it was fashionable to argue the claims of nature versus nurture in the development of an individual. Today it is realised that the two are not exclusive, and any living organism develops according to both its genetic make-up and the environment in which it grows. And this is true for cocoa as much as for any other growing thing.

The cocoa grower wants high yields, and these must be achieved both by nature and by nurture. To begin with he must plant material which by selection and/or breeding has the genetic potential for high yield. Too often, however, he thinks that this is enough; he plants rooted cuttings, seedlings or seed with high-yield potential but does not appreciate that this potential will only be realised if the environment under which the plant grows is as good as it can be made. The very best planting material, if grown in too dry a climate, or on an unsuitable soil, if never weeded nor pruned, never receiving manure nor fertiliser, will probably give no higher yields than unselected material.

This point having been made, what then are the environmental factors that affect the growth and cropping of cocoa? It is, of course, very difficult to disentangle all the factors in the environment independently, for a change in one factor can affect one or more of the others (3, 7). Thus, for example, rain will affect not only such an obvious factor as soil moisture but also atmospheric humidity, temperature and amount of sunlight. For convenience the environment will be considered under two heads—the soil and the climate.

Soil

Clearly it is only possible to deal very superficially with the factors that differentiate good and bad cocoa soils (4, 5). Plant roots need water, oxygen and mineral nutrients, and the first two of these are determined by the physical structure of the soil. A very sandy soil will provide the aeration necessary but will lack the capacity to hold water if rainfall is not well distributed. Clay soils, on the other hand, though having better water retention properties, tend to become waterlogged in the wet season so that the roots are unable to secure the necessary aeration. As a result, root development on heavy clay soils is confined to a shallow surface layer. Clay loams of good structure support the best growth of cocoa since the aggregates of sand, silt and clay provide large pore spaces for aeration and drainage, while at the same time retaining moisture. This matter of good physical structure emphasises the importance of root room for cocoa. The better the soil structure the deeper the root penetration, and hence the greater the volume of soil exploited by the roots for moisture and nutrient uptake.

Of great importance in a good cocoa soil is the amount of organic matter in the surface layer. It is the loss of this organic layer that is closely associated with soil degeneration and falling yields in cocoa. It is also an important factor in the problem of replanting cocoa in areas where the old cocoa has died out through disease and neglect. To preserve this organic layer it is essential for the soil to be well shaded to slow the speed of natural breakdown of leaf litter.

Mention must be made of the soil pH. Soils for cocoa must be slightly acidic, or problems will arise with induced deficiencies, particularly of iron and zinc. On the other hand, too acid a soil may lead to problems of aluminium and manganese toxicity.

Turning to the supply of mineral nutrients, although a soil well supplied with both the major and minor plant nutrients is obviously highly desirable, a deficiency of any one is probably the least important factor in the soil environment since it can be corrected fairly easily, certainly in any country where the agronomy of the crop is at a fairly high level. A deficiency of phosphate in a soil would not rule it out for successful cocoa growing, whereas a pH of over seven most certainly would.

In this very brief account of the soil environment, final mention must be made of the great difficulty in measuring many of the soil properties that affect the growth of cocoa. And this, too, increases the difficulties of field experimentation. The fact that within a small area trees of exactly the same genetic make-up, i.e., rooted cuttings, are found to give yields that vary by 100 per cent or more, poses the problem of just what soil factors are responsible for this great sensitivity in the tree.

Climate

The climatic environmental factors are temperature, rainfall, humidity, wind and light intensity (1, 7). In dealing with the effect of these factors on growth and yield it is of importance also to discuss possible ways of amending unfavourable environmental conditions.

As a tropical crop, the cold limit of cocoa has been set at 21°C. for the average annual temperature with a mean daily minimum in the coldest month not lower than 15°C. and an absolute minimum of 10°C. Low temperature may be determined either by latitude, i.e., distance from the Equator, or by altitude. As regards the hot limit, opinions tend to vary. Hardy (4) suggests 30°C., whereas Voelcker (9) has put it much higher at 38°C. Recent work in Trinidad (8), however, indicates that growth is abnormal at a constant temperature above 31°C., though with a fluctuating temperature between day and night good growth can ensue at temperatures up to 35°C. The fact that temperatures fluctuate in the field complicates the problem. Shade trees reduce the air and soil temperatures below them by several degrees, but the significance of this as compared with the reduced light intensity is difficult to interpret. It may be fairly confidently stated, however, that provided other factors, particularly rainfall, are optimal, high temperature would never be limiting to growth.

The most important single factor influencing both the area in which cocoa may be grown, and also the yield that it will give, is rainfall. And even more important than the annual total is the distribution. In another tree crop, citrus, high yields are associated with a sharp, dry season which triggers off flowering and crop production. Cocoa, however, does best with little or no dry season, and the pattern of rainfall also determines the distribution of the crop. In general, the main crop is produced at the end of the wet season, with a light crop following 4-6 months later, maturing during the dry season. In countries where the dry season is very mild the monthly distribution of the crop is far more uniform. This is of practical importance, for processing facilities which must be able to cope with the peak crop may be inadequately utilised for most of the rest of the year.

In the tropics, monthly evapotranspiration, i.e. the total loss of water by transpiration from the plant, together with evaporation from the soil, lies between four and five inches. If the monthly rainfall drops below four inches per month the cocoa will suffer water strain. This is of course subject to the nature of the soil. Where, however, several months may pass with dry season conditions the cocoa will suffer, one of the first danger signals being accentuated leaf fall.

There is not a great deal known yet about the effects of irrigation on yield of cocoa, and, moreover, not only is the equipment expensive but also sources of water where it is most needed may be severely limited. However, as cocoa becomes more of an intensively grown orchard tree, rather than a semi-cultivated forest crop, irrigation must play a part in increasing yields. In general, sprinkler irrigation is more effective than furrow irrigation.

With rainfall and soil moisture must be linked atmospheric humidity. And this also brings up the question of shade trees. Although normally thought of as a very sensitive crop, cocoa will grow under exposed conditions at quite low humidities. If grown under hard conditions cocoa will become adapted to them, but what it is sensitive to is change in its environment. Thus the soft, thin cuticled leaves that develop under shade and high humidity are lost rapidly when the shade is removed and humidity falls. The leaves that develop under exposed conditions are better adapted, however, to stand such conditions. The objective, therefore, with cocoa-growing is not so much to produce an ideal environment as a constant environment.

This brings us to the role of shade in cocoa-growing. The past decade has brought a great deal of new knowledge to bear on the intricate relationship of shade to the crop (2, 6, 7). We know that higher yields can be secured without shade provided that the soil is very fertile or if fertilisers are used. The position is, however, that a far higher level of agronomy is needed in growth without shade, and, moreover, the efficient control of certain pests and diseases becomes more important. Shade acts as a buffer against changes in the environment, and makes the crop rather easier to maintain in the field, albeit at a lower level of yield.

Conclusion

As compared with most other tropical tree crops, cocoa appears to be particularly sensitive to changes in its environment. It is of special importance to ensure that all the factors concerned in growth are correctly balanced, but this ideal is seldom possible and it therefore becomes important to recognise which factor is the limiting one. Unless the effect of this limiting factor, which may be soil moisture, nutrition, over-exposure or any other, can be eliminated or reduced, improvement in other factors will have no effect. Moreover the limiting factor or factors will vary with season. The agronomy of the crop must, therefore, almost invariably require a series of compromises to minimise unfavourable aspects of the environment.

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Nursery Practices

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Introduction

Planting of cocoa is normally from seed, but other methods of propagation are also employed. These include rooted cuttings and, in special cases, bud grafting and marcottage. The need for planting vegetatively-propagated material is gradually giving way to the use of clonal or hybrid seed which would produce an upright or chupon, as opposed to the low-branching and spreading type of tree. The chupon or seedling type of tree is more convenient for the farmer or planter to work under.

As good seed from freshly harvested pods may not be available at the time when weather conditions are favourable for the major plantings in the field, a nursery may be found desirable for raising seedlings when seed is available, thus allowing transplanting into the field under favourable conditions. For seed which is transported long distances and arrives when field conditions are not ideal for planting at stake, a nursery also serves a useful purpose. More care and attention can be given to seedlings in the nursery.

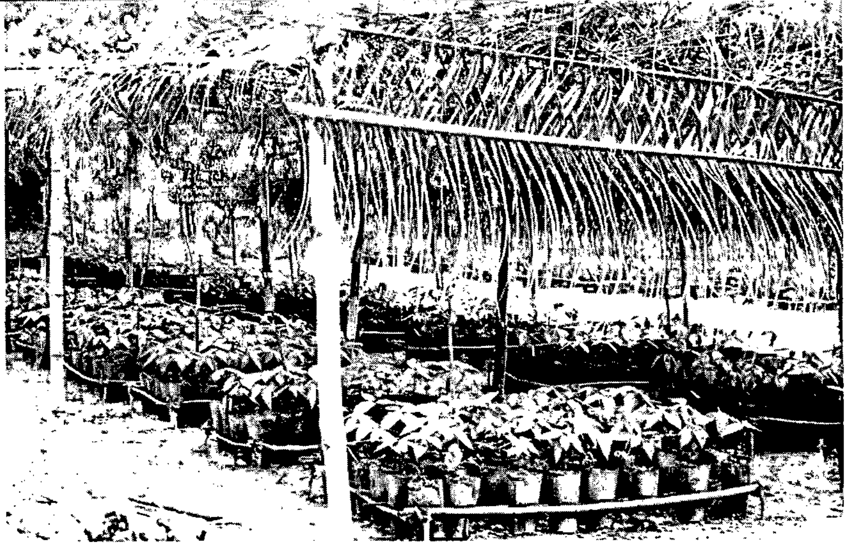
Choice of Site

The use of containers for propagation has made the choice of nursery site less dependent on the prime condition of good, fertile, deep and friable soil. This soil factor is, however, very important if seed is to be raised on beds made at the site of the nursery. Other factors to be considered in the choice of a nursery site include proximity to the farm where the seedlings are required, the presence of natural shade and very often the availability of shelter, and good water for irrigation. In general, water is the most expensive item to provide, and nearness to a stream may decide the location of the nursery.

Plant Material for Transplanting

Nursery Beds: Where farmers do not plant beans at stake, the seed may be planted on nursery beds of various shapes and sizes. The beds should be about six inches high to permit of free drainage, and the soil should be worked to a fine tilth and be free of grass roots. In order to allow hand-weeding, hand-forking and efficient watering, the beds should be reasonably narrow, about four feet, but can be of any convenient length. The sides should be compacted to prevent washing away.

Containers: Several types of containers for raising seedlings such as cans, bamboo baskets, pots made of banana sheaths, paper or whale-hide, plastic bags and similar receptacles, have been in use for a considerable number of years in cocoa-growing countries. Some of these are falling into disfavour with the production and acceptance of more convenient types. It is desirable for the farmer to select the potting container that best meets his special requirements at reasonable cost. The containers must be durable if seedlings are to be stored for a long time in the nursery before transplanting, or if they are to be transported some distance to the field site. They must permit free drainage, and be of a fair size to eliminate the necessity for re-potting. Seedlings intended for



Cocoa seedlings in whale-hide pots with palm-frond overhead shade.

transplanting in three months' time may be raised in pots about three inches in diameter and four inches deep. The longer the seedlings remain in the nursery the larger and more durable should the container be. For seedlings to be transplanted after six months, containers of a diameter of five inches and depth of six inches should be used. Rooted cuttings are better nursed in baskets about seven inches in diameter and about eight inches high. In general the larger the container the better. When seedlings cannot be planted with the container, it must be easy to remove them with little disturbance to the roots.

Tin cans in the Philippines and banana sheaths in the Dominican Republic may be giving way to polythene bags. In most tropical countries bamboo is available and is used, a hole being made at the bottom of the pots and pebbles or fibre placed in them before use. Pieces of wood held together by wire form

Rooting cuttings in baskets under polythene sheet.

Cocoa seedlings in whale-hide pots with palm-frond overhead shade.

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suitable containers for budded seedlings in Tanganyika. Baskets woven from vegetable material, chiefly palm fronds, are in more general use because they possess most of the qualities required.

The pots, of whatever material, are filled with good top soil and placed at the nursery site.

Planting the Seed

Young cocoa seedlings need a certain amount of shade in thc early stages, and where natural shade is not available, artificial overhead shade may be provided by palm fronds placed on uprights. Seedlings, however, harden off better if, in their later nursery stages, they are introduced to more and more sunlight by reduction of the overhead shade.

Seed is planted fresh on nursery beds a few inches apart and about one foot between the rows. Planting may be done with the thicker or germ end downwards, but in cases of doubt as to which is the thicker end, seed may be placed on its side. Several pre-treatment practices, mainly to remove the sweet mucilage, are employed in various places; these include washing, rubbing the seed with sawdust, soil, sand, charcoal, wood ash, or removing the testa completely. The last practice has been found to hasten germination but it is expensive and time-consuming and has little practical advantage. Seed is planted singly in containers. Whether seedlings are raised in containers or on nursery beds, about 30 per cent more than the number required should be produced in order to enable the choice of the healthiest for transplanting, and also to provide spares for filling vacancies during the first three months in the field.

Leaf and stem cuttings are rooted in specially constructed bins, or in baskets or other containers placed under polythene sheets (1). The cuttings are given a quick dip in a rooting hormone of beta-indole-butyric acid or a mixture of this and alpha-naphthalene-acetic acid (2) and planted either in the bins filled with sand or a mixture of sand and palm fibre overlying some pebbles to facilitate drainage, or planted in baskets or other containers filled with a rooting medium of chopped palm or coconut fibre mixed with sand. Composted sawdust also gives satisfactory results, but composting has to be thorough in order to avoid adverse effects on the cuttings.

The technique employed in, and the attention that should be given to, rooting of cuttings makes the practice more suitable for central propagating stations than for the average farmer.

Propagation by approach grafting, budding and marcottage has been employed on a small scale.

Post-Planting Operations

Mulching of nursery beds, baskets or other containers used for seedlings and rooted cuttings with wilted grass, bamboo leaves or other suitable vegetable material may be found advantageous, especially in dry situations. The nursery beds and containers must be kept free of weeds and judiciously watered.

In general, top soils used for nursery potting are reasonably rich and need no manuring. However, based on the progress of the seedlings, application of compost, pen manure or the appropriate fertilizer or fertilizer combinations may be given.

Cocoa seedlings on beds.

Diseases and Pests

One of the most important diseases to be encountered in the nursery is damping-off (3). This is caused by a fungus which attacks the base of the seedlings, and is usually brought about by too much watering, poor drainage or adverse growing conditions. The disease condition may be controlled by the application of a fungicide. A copper fungicide is generally effective. In serious attacks, steps should be taken to ameliorate the adverse growing conditions, e.g. by improving drainage and by aeration of the soil or by reduction of shade.

Seedlings in the nursery may also be attacked by virus diseases, capsids, mole crickets and larvae of various insects. Virus-infected seedlings should be rogued out, and in mild cases of caterpillar attack, hand-picking should be sufficient. With the exception of virus diseases, the diseases and insect pests can be controlled by the application of fungicides and insecticides.

Cocoa seedlings in polythene bags under natural shade.

Cocoa seedlings on beds.

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Cocoa seedlings in polythene bags under natural shade.

Transplanting

The healthiest seedlings are transplanted, preferably when they are still very young. In any given situation, the most useful guide is the progress they have made in the nursery. Some farmers transplant seedlings when they are two feet high, whilst others transplant them between four and six months old. The operation is best done in the morning or late in the evening. Transplanting of seedlings from nursery beds is facilitated if the beds are given a good watering the previous evening. When bare-root seedlings have to be transported over some distance, care should be taken not to injure the roots. It might be advisable to transport them in hampers, bundles or suitable containers. Bamboo pots and polythene bags are better slit open and removed before the seedlings are planted with their ball of earth. Basketed seedlings may be planted with the baskets, the bottom of which must be removed to allow the tap roots to grow without obstruction. Hardened rooted cuttings in baskets must be held in the nursery for not less than six months, preferably nine to twelve months, before they will be ready for transplanting to the field. Successful establishment has also been obtained with plants stored for much longer periods.

Seedlings should be transplanted to the field at the beginning of the rains, but in a few cocoa-growing countries with no pronounced dry season, this can be done almost throughout the year. Holes to receive the seedlings can be made at the time of transplanting, and the soil around the plants should be made firm.

Conclusion

There is no doubt that seedlings which are not given a good start make poor subsequent growth until they have overcome the initial weakness. Efficient nursery work is apt to be less expensive than inefficient work. Seedlings should therefore be given the best treatment possible in the nursery, and such efforts should not be relaxed until transplanted seedlings are well established in the field.

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The Operation of Central Cocoa Fermentaries in Jamaica

David Dow, Manager, Cocoa Industry Board, Jamaica

Cocoa has been grown in Jamaica since the 16th century, and the area under cultivation today is approximately 12,000 acres of old seedling trees and 17,000 of new clonal plantings; a total of 30,000 acres. 90 per cent of the cocoa produced from this area is from small farms of two acres or less. The quality of the dry cocoa has always been poor and has, in the past, been sold abroad at a considerable discount on West African cocoas. Not only do the farmers lack the facilities for producing a well-fermented cocoa, but with such small holdings, they do not have a large enough quantity of cocoa at one reaping to carry out proper fermentation.

In 1957, the Cocoa Industry Board was set up to promote the interests and efficiency of the industry, and to raise the quality of the cocoa produced. The first small central fermentary was built in the centre of the main cocoa-growing area of the island as an experiment. The results were very successful, and the number and size of the fermentaries have steadily expanded. There are now four situated in the cocoa areas of the island, and farmers have benefited considerably from the better prices obtained for the high-quality fermented cocoa produced. The system involves the collection of wet cocoa from an area of approximately 25 miles radius from each of the central fermentaries. The wet beans are transported from the collecting centres by truck, and the fermenting and drying is carried out under strict supervision at the fermentary before the dried cocoa is sent to Kingston for final cleaning and export.

Collection: The farmers in each district or village surrounding the central fermentary are organised into groups. There are approximately 100 such groups around each of the two larger central fermentaries, and each group has up to four collectors who are responsible for receiving and measuring the wet beans and delivering them to the trucks.

Within a 25-mile radius of each fermentary, licences for the purchase of cocoa from farmers by dealers are not issued. This ensures that as much cocoa as possible passes through the fermentary.

The farmer brings his wet cocoa to the nearest collecting centre (usually not more than two miles away), and is given a voucher for the good cocoa supplied. The wet beans are measured in a standard box of approximately one cubic foot capacity, and all purchases are based on this measurement. The minimum quantity accepted is one-twelfth of the measuring box, which is the equivalent of approximately 25 ripe pods. All cocoa supplied by the farmers is stacked in the measuring boxes and protected from the sun and rain until the arrival of the truck transporting it to the fermentary. It is collected on the same day each week in any one area. At the beginning and end of the crop, collection is made fortnightly.

Each cocoa group is paid 1s. 0d. per box for collection expenses—6d. of which is paid to the collector for his services.

Transportation: The Manager of each fermentary despatches hired trucks on the day of collection to pick up the wet cocoa from the numerous buying stations. The truck operators are paid a flat rate per mile and are also given a small commission for each box of wet beans collected. On arrival at the buying station, the truck driver checks the quantity as well as the quality, since he is responsible to the Manager of the fermentary for buying only wet cocoa in good condition. Any sub-standard cocoa delivered to the fermentary is rejected and has to be paid for by the truck driver, together with any shortage over 1½ per cent in volume. The trucks are covered with tarpaulins, and the wet cocoa is transported in bulk from the buying station to the fermentary as quickly as possible. There it is weighed and measured. Each load is accompanied by signed delivery receipts from each buying station.

Payment to Growers: Two systems are in operation:—

(a) The farmer receives a voucher from the collector for cocoa supplied. The truck driver carries with him enough cash for a load of wet beans and pays the collector for all cocoa supplied at each buying station. The collector, in turn, distributes this money to farmers in accordance with the vouchers issued. This system, which operates at three fermentaries, enables the farmer to receive his money without delay, but necessitates the handling of fairly large sums by the truck drivers and collectors.

(b) In the second method, each group is paid by cheque issued in accordance with the delivery receipts brought in by the truck driver. These cheques are mailed on the day after collection to the secretary of each group, who then pays the farmers in accordance with the vouchers issued to them on the day of collection.

In this system, there is greater delay in payment, but the handling of cash by truck operators and collectors is eliminated.

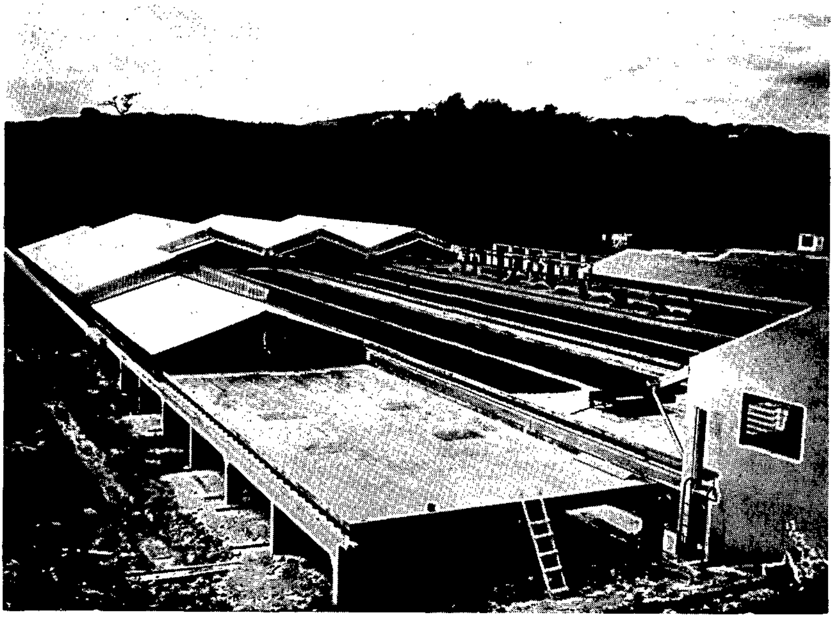
Processing: At the fermentary, the wet cocoa is placed in fermenting bins, each with a capacity of 1½ tons. It is fermented for a period of seven days, during which time it is turned every other day. At the two larger fermentaries, the bins are arranged in tiers of five, and at each turning the cocoa is moved down the slope, ending up at the bottom row of bins when fermentation is complete.

The initial cost of this arrangement of the bins is higher than construction on one level, but it is offset to a certain extent by a saving of labour in turning. In the two most recently built fermenting houses, the bins are on one level, and taking all things into consideration, this arrangement is preferable.

The fermentaries are equipped with sun-drying trays as well as mechanical rotary driers. The sun-drying is done either on nests of small movable trays or on fixed trays with movable roofs. The movable trays are stored under the fixed trays when not in use. The sun-drying period lasts from seven to ten days. Cocoa that is dried mechanically is prepared for two days on the sun-drying trays in order to get rid of the mucilage before being loaded into the rotary drums. Each batch of cocoa in the mechanical driers is fully dry in 24 hours. All cocoa, whether dried by sun or mechanically, is stored in the fermentary warehouse prior to shipment to Kingston for final cleaning, bulking and exporting.

The bulking of the cocoa from each area results in more uniformity, and affords a better opportunity to standardise shipments.

Costs: Cocoa produced under this system is uniformly good in quality, and enjoys a premium of between £50–£80 per ton over bulk West African cocoas. The total cost of processing, including labour, materials, management and all overheads, is £56 per ton (6d. per lb.). These costs are broken down as follows:—



Sun-drying trays, Morgan's Valley Fermentary, Jamaica.

Photos: Wally Allan

Haughton Court, Central Cocoa Fermentary, Jamaica.

Sun-drying trays, Morgan's Valley Fermentary, Jamaica.

Photos: Wally Allan

Haughton Court, Central Cocoa Fermentary, Jamaica.

(1) Transportation charges to fermentaries	=	£16 per ton.
(2) Processing and overhead expenses at fermentaries	=	£23 „ „
(3) Grading, bulking, shipping and warehouse expenses	=	£8 „ „
(4) Administration and general overhead expenses ..	=	£9 „ „
		£56 „ „

Labour is paid 13s. 6d. to 17s. 6d. per day.

The capacity of the four central fermentaries is about 4,000 tons per annum, and these costs should be reduced when our present production of 2,000 tons of high-grade cocoa increases.

Premiums obtained for Jamaican Grade "A" fermented cocoa have enabled the Board to pay higher prices to farmers for cocoa supplied to the fermentaries than for cocoa prepared by farmers in the traditional manner without any fermentation at all. The net difference realised in the price for the two grades is approximately £100 per ton, and this differential, less the processing costs, is paid back to the farmer. The initial payment to the farmer is equivalent to 1s. 3d. per lb. of dry cocoa.

The farmer is paid 28s. 0d. for a box of wet cocoa, which weighs approximately 58 lb., and yields about 22½ lb. of dry cocoa.

At the end of the season a bonus is paid from any trading surplus on the crop. Last year's bonus was 3s. 0d. per box, bringing the total grower's price to 31s. 0d. per box or 1s. 4½d. per lb. This compares with 1s. 0d. per lb. paid to growers for unfermented cocoa. It will be seen, therefore, that the central fermentaries have given considerable financial benefit to farmers by way of increased prices. They have also made it possible for them to sell their crop straight off the trees without the trouble of processing and the risk of theft. They also do not have to transport their product further than their own village.

The main problem of the central fermentaries in maintaining a high-quality cocoa is the difficulty in providing proper supervision of the handling of the wet beans prior to their delivery to the collecting centres. There is some variation between the time of harvesting and breaking of the pods, and there can be variation also in the time between breaking and supplying to the collecting centres. There is also variation in the degree of ripeness of the pods reaped.

It is sometimes difficult to overcome these problems, but through field training and written advice, farmers are realising that it is to their benefit to aim for high quality.

The operation of central fermentaries is well suited to the needs of the cocoa industry in Jamaica, where most farms are small and the network of roadways for easy transport is good, with the cocoa plantings concentrated in well-defined areas.

Above all, the cocoa farmer benefits from the better prices obtained for a high-grade fermented cocoa.

The Selection of Spraying Equipment

A. E. H. Higgins, Imperial College Field Station, Silwood Park

PART I

In the past 15 years, considerable interest has been shown in the pests and diseases of cocoa affecting production. With the discovery of many new pesticidal* chemicals, it has been shown that the majority of these pests and diseases can be controlled or even eradicated. This led to the need for equipment and techniques to be developed for the chemical to be directed on to the crop with accuracy, economy and ease.

Spraying equipment now available is extremely diverse and covers a wide range of application. Some is specialised but most of it is capable of being used for many purposes. The number of sprayers designed for use in specific control problems is extremely limited, and it is common practice to choose equipment considered suitable and then to adapt or modify it to the particular requirements of the user. This presupposes detailed information of the various kinds of sprayer available, with extensive knowledge of practical use of such equipment and its limitations. This kind of information is not always readily available, and in consequence disappointment in the performance of the equipment often results, or even complete control programmes may fail as a result of choosing unsuitable equipment.

The usual requirement foremost in the mind of a purchaser is the cost involved, and on this he therefore bases his first priority. A compromise is often made on what appears to be the cheapest equipment likely to do the job, irrespective of the basic requirements for the application of the pesticidal material. For this reason the first priority should be based on the requirements for the pesticidal material and the formulation, with particular attention to the kind of deposit or coverage which will be required. The accuracy of both the dosage and its location is often the main factor in the success or otherwise of many programmes in not only achieving effective control but also economic costs.

Many of the pesticidal chemicals possess corrosive or other undesirable chemical or physical properties, which must be taken into account when considering the materials used for the construction of equipment. Some of the pesticidal chemicals also have various toxicity hazards, and where these are present it is important to ensure that there is no possibility of "slopping" or leaking occurring during the normal operation of the equipment; also portions of the sprayer which are under pressure during use must be constructed of materials which are not likely to burst or fail. The materials are equally important in the life of the equipment in relation to the amount of rough usage likely to be met with.

Simplicity in the design and the operation of the sprayer is of the utmost importance. Complexity should be avoided wherever possible, even though skilled resources may be available for maintenance and repair. The more items

*The word pesticide (and hence pesticidal) may sound like a synonym for insecticide. In fact it is coming into vogue as a blanket term which covers all agricultural chemicals used in control of pests and diseases, i.e. fungicides, insecticides, herbicides, etc.

of the equipment capable of being taken apart or removed, the greater the likelihood of accidental loss or damage occurring. Simplicity of operation is equally important in that the easier the task for the user in the field the more likely he is to co-operate, and the better the results obtained. Closely associated with simplicity of operation is the question of comfort. This is extremely important in relation to any equipment designed to be carried by the operator during use. It must be remembered that field personnel often have to work under arduous and unpleasant conditions and that they may not be under constant supervision. Therefore, when choosing equipment, the prospective purchaser should always make a simple trial under conditions as near as possible to those likely to be met with in the field, and judge the effort required for operation, and also the comfort during use. It is useful to have some standard for comparison, and it has been found that continuous operation for a period of 15 minutes under simulated conditions enables a satisfactory assessment to be made. During this trial, particular attention should be given to ensure that there are no rough surfaces on items such as operating handles or harness straps likely to cause chafing or blistering of the operator's skin during use. Sharp edges or projections should be looked for to ensure that they are not liable to cause damage, especially in the event of a trip or fall. Weight and balance are important and, in general, it can be stated that the lighter the equipment the better, taking into account the liquid capacity and sturdiness of construction. A good balance is essential with knapsack equipment, as quite heavy loads can be carried comfortably if properly positioned high on the shoulders. When trying a knapsack sprayer for balance, it should first be filled with its normal contents and then careful adjustment made to the harness to ensure that a comfortable and firm carrying position is achieved. The body of the wearer should then be rocked to and fro from the hips and similarly sideways to test balance and also to ensure that there is no serious movement or swaying of the sprayer on the back. Ease of cleaning and maintenance are factors to be considered. Filler holes should be of a size such as to permit filling direct from a bucket without the use of a funnel, and similarly to permit the hand and arm to enter to facilitate the proper cleaning of the container. Worn or damaged parts should be easily replaceable without extensive dismantling. This can easily be checked by asking for a demonstration in which the sprayer is dismantled into its component parts, at the same time recording the number and time, and also any special tools needed. The availability of spares should be checked in addition to any supplied with the sprayer. The versatility of the equipment should be considered in the event of other possible uses, and enquiries should be made about alternative nozzles or fittings.

The essential component

The nozzle is the essential component in determining the character of the spray, irrespective of the type of sprayer employed. The various kinds of nozzle available can best be grouped according to the nature of the energy which is used to break the liquid into drops. For the control of cocoa pests and diseases three basic categories of nozzle have been employed.

1. Nozzles in which hydraulic energy is used to force the liquid through an orifice or orifices. (*Hydraulic energy*).
2. Nozzles in which the energy from an airstream is used to produce the drops by a shearing action on the liquid (*Gaseous energy*).

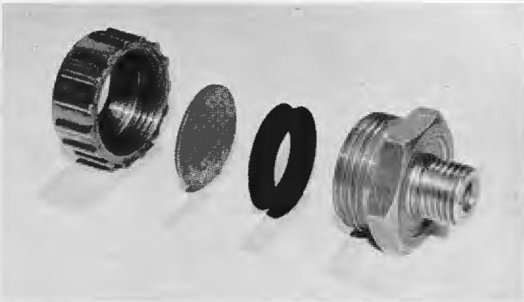


Fig. 1. Plain jet showing cap, orifice plate, washer and body.

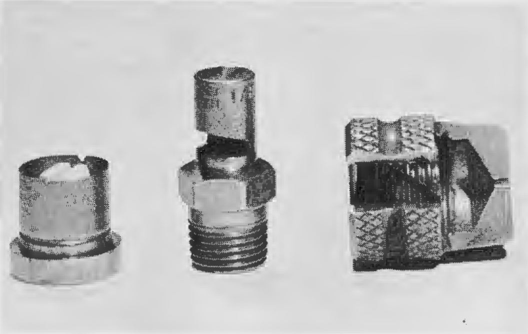


Fig. 2. (Left to right): *Ceramic fan jet; deflector nozzle; hollow cone or swirl nozzle.*

Fig. 3. Hollow cone or swirl nozzle—(left to right) *cap, orifice plate, spacing washer, swirl plate, strainer and body.*

Fig. 4. Adjustable nozzle.

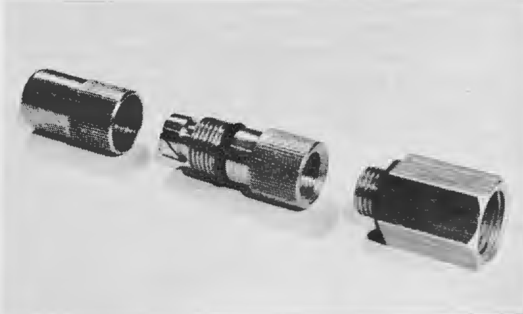


Fig. 5. Rotating disc nozzle.

Fig. 6. Rotating disc nozzle in air discharge tube.

3. Nozzles with a rotating disc, cup, brush or basket, on or into which the liquid is fed and then flung off at the periphery in the form of drops. (*Centrifugal energy*).

These basic categories of nozzle are further sub-divided, depending upon the type. The simplest type of hydraulic nozzle is the plain jet (Fig. 1) which is often employed to give maximum carry or throw to project liquid. This is often important in the spraying of tall crops. The plain jet is directed in such a manner that it will strike solid surfaces, such as branches or twigs, and then be broken into coarse drops on impact. This same effect is employed in other types of hydraulic nozzle such as the anvil, deflector or slot nozzles (Fig. 2) in which the liquid jet strikes a smooth solid surface at a high angle of incidence within the nozzle itself. Such nozzles produce coarse drops which emerge and travel short distances at a wide angle, also giving a heavy deposit of the full coverage or run-off character. The more commonly used hydraulic nozzles are known as the cone or swirl type and the fan jet (Figs. 2 and 3). In the cone or swirl nozzle, the liquid emerges with a spinning motion as the result of its passage through one or more tangential or helical passages before reaching the orifice. These nozzles are sometimes made so that they can be taken apart and separated into their basic components of swirl plate, spacing washer or seal, and the disc with the hole from which the spray emerges. The respective functions of these component parts are: (a) the swirl plate mainly governs the angle of the cone of spray, (b) the spacing washer or seal determines the size and depth of the swirl chamber, (c) the size of the orifice in the disc determines the rate of flow through the nozzle at any given pressure. Both the swirl plate and the disc are interchangeable so that varying cone angles can be obtained. With the appropriate swirl plate, hollow or solid cones of spray can be obtained and, equally, the flow rate can be altered by the size of the hole in the disc. The spacing washer or seal is not interchangeable, as it determines the fundamental performance of any particular nozzle, and for this reason both size and thickness are important if a replacement is necessary, and only the spacing washer supplied by the manufacturer should be used, otherwise the nozzle performance will be affected. It is equally important to ensure that the components are reassembled in their correct order. Frequently a seal between metal and metal, or plastic and metal or other material, is used in the construction of these nozzles. This eliminates the separate spacing washer and the disc sometimes becomes an integral part of the nozzle and is not interchangeable. It is important that the small swirl plates of these nozzles are not lost when clearing a blocked nozzle, otherwise a plain jet results instead of the cone-type spray. This effect is sometimes deliberately made use of to give the plain jet advantage of carry, as has already been mentioned. The character of the spray drops produced by cone or swirl nozzles varies from coarse to fine, being governed to some extent by the pressure at which they are operated.

There are adjustable nozzles (Fig. 4) which can give either a plain jet or a hollow cone spray but they are not generally as satisfactory as fixed nozzles.

The uses of fan jets

The fan jets (Fig. 2) are nozzles in which there are no interchangeable parts and are characterised by the fact that the spray pattern produced is a flat sheet as opposed to a cone. These nozzles have specially shaped bores and the orifice may be rectangular in shape, or more frequently it is lenticular in shape. The orifice of these nozzles will be ruined if attempts are made to clear blockages with pieces of wire or a pin, and it is therefore important that any obstruction is removed by gentle tapping or by a blast of air from a bicycle- or car-type pump, applied in the opposite direction to the normal flow. A range of these nozzles is available to give different fan angles and flow rates, the latter usually being lower than with the cone-type nozzles. They are also often operated at lower pressures than the cone type and do not give the same amount of carry or throw of the spray, and for this reason should be regarded as being most suitable for use at close range. The spray drops are usually finer than those from the cone jets at comparable pressures. For these reasons the fan jets are mostly used when even coverage is required over large surfaces at low flow rates.

Air-blast nozzles

The gaseous-energy, or the air-blast nozzles (Fig. 7) as they are often more popularly known, rely on an air blast to form the drops and convey them to the target. The liquid is fed into the air stream passing inside a discharge tube, and upon meeting an air blast, usually within the nozzle itself, is sheared into spray drops by the velocity of the air. The air blast required for the operation of these nozzles is provided from a fan or blower, and the liquid is fed to the nozzle under slight air pressure obtained from the fan, or occasionally by a small pump. The drops produced by this method are generally small, and range from mists to fine sprays. The flow is governed by the rate at which the liquid is fed to the nozzle, and this is usually controlled by various sizes of metering jet inserted at a convenient point of the liquid flow to the nozzle. Good carry or throw of the spray is achieved, and depends very largely upon the amount of air issuing from the nozzle, and not so much upon its velocity. Generally speaking, these nozzles should be regarded as best suited for long-range

The equipment illustrated in this article was made by the following manufacturers:

Allman & Co., Chichester, Sussex; Cooper, Pegler & Co., Burgess Hill, Sussex; Evers & Wall Ltd., Newbury, Berks; W. T. French & Sons, Birmingham; Kent Engineering Foundry Ltd.; Spraying Systems, Illinois, U.S.A.

Fig. 7. Air-blast nozzle showing metering jet.

applications, although it must be realised that at long range the deposits obtained are typically light. For close-range work, diffusers which broaden the beam of spray, or deflectors which turn the spray upwards or sideways, can be added to the normal nozzle. They also tend to coarsen the spray drops.

In the centrifugal or rotary nozzles (Figs. 5 and 6), an air blast is again employed, initially to rotate the centrifugal device by means of a simple windmill or other contrivance, and finally to convey the drops formed to the target. The flow rate of the liquid to the nozzle is more critical, and is therefore generally fixed by the manufacturer, and the application rates tend to be low. The spray drops produced are small and range from fine sprays to mists, with the main tendency toward mists. The nozzle performance is similar to the air-blast type in that good throw can be achieved, but the deposits attained are frequently lighter. A special application technique known as drift spraying is sometimes employed with these nozzles. In this, advantage is taken of the prevailing wind conditions to carry the spray into the crop.

Notes

"Tafo Hybrid Cocoa"

The breeding work at the Cocoa Research Institute, Tafo, has evolved a number of new types, most of them crosses between Amazons and Amelonado, which come into bearing early and yield more heavily than either of the parent varieties. Seed gardens to produce these new types have been planted in various parts of Ghana and are coming into bearing. At a press conference at Tafo, the Director of the Institute, Mr. S. T. Quansah, stated that there would be sufficient seed to plant 2,000 acres this year, and this would increase to sufficient for 40,000 acres or more per annum. D. R. Glendinning, the plant breeder, hopes that "Tafo Hybrid Cocoa" will increase Ghana's exports by £9 m. per annum in the 1980s.

Resistance by Capsids to Lindane (BHC)

In the last issue of this *Bulletin* it was noted that resistance to lindane has developed in the capsid population in some parts of Ghana. The first evidence of this was found in 1961; during 1963 a team of four Canadian scientists were engaged in determining the extent of the problem and carrying out trials of alternative insecticides. The grave danger that this resistance represents has led to the problem being studied in other West African countries, and an important outcome has been the initiation of a series of Mirid Conferences. (The family name Capsidae has been replaced by Miridae so that capsids are now called mirids). The first of these conferences was held at Tafo in August 1963, and the second at Ibadan in March 1964. A third is to be held in the Ivory Coast.

In papers presented at the second conference it was revealed that in Ghana resistant mirids were to be found in a fairly large area on the borders of Ashanti and the Eastern Region and in small isolated areas as well. This resistance is confined to the species *Distantiella theobroma*. In Nigeria this species is confined to a comparatively small area, the other species, *Sahlbergella singularis*, being widely distributed. Surveys have revealed signs of resistance among *S. singularis* in one area.

Trials with alternative insecticides continue and show promise, but no recommendations have been made.

Die-Back in New Guinea

Recent cocoa market reports have mentioned the rapid spread of die-back in New Guinea caused by the fungus *Botryodiplodia theobromae*. This disease has been present for some time in the Gazelle Peninsula, but has recently been spreading rapidly.

Miss Dorothy Shaw, Principal Plant Pathologist of the Department of Agriculture, New Guinea, describes this disease in a recent issue of the *Papua and New Guinea Agricultural Journal*. This fungus is found throughout the tropics, usually on dead or dying tissue. "There is no evidence that it can attack healthy undamaged cacao wood" but "once it gains entry the fungus can proceed down the inside of the branch in the wood without difficulty".

There is no indication as to any insect damage or other predisposing factor which allows the fungus to enter. Growers are recommended to prune affected parts and adopt "any practice which promotes the health and vigour of the trees".

A further note on spacing

In the paper on spacing in our second issue, the yields were given as aggregates for a number of years. This may have confused some readers and it conceals the way in which yields have increased over the years. Further data are given here and the opportunity is taken to correct some of the figures. These were taken from *WACRI Annual Reports*, but in one case an erratum was unfortunately ignored.

SPACING TRIALS AT TAFO

(*Yields in lb. per acre*)

1. Amelonado spacing trial planted 1947

Spacing	15′×15′	12′×12′	10′×10′	7½′×7½′	7½′×6′	6′×6′	5′×5′	4′×4′
Trees per acre	193	302	435	774	968	1210	1742	2722
Dry cocoa per acre								
1955-56	109	128	145	187	145	161	189	113
1956-57	441	433	522	816	657	613	757	601
1957-58	890	1005	1215	1375	1200	1015	1190	1035
1958-59	1465	1570	1925	2080	1790	1650	1905	1835
1959-60	795	1487	1969	2007	1828	1877	1912	1997
1960-61	1623	2588	2765	2878	2765	2897	2894	2929
1961-62	1436	2063	2350	2543	2225	2319	2333	2288
	6759	9274	10891	11886	10610	10532	11180	10798

2. Amazon spacing trial planted in 1949

(*Yields for unpruned plots*)

	8′×8′	10′×10′	12′×12′
1952/53	21	35	10
1953/54	264	288	182
1954/55	299	255	245
1955/56	235	226	215
1956/57	322	318	262
1957/58	591	697	705
1958/59	1071	1486	1339
1959/60	1423	1581	1388
1960/61	1818	1936	2308
1961/62	1810	1840	1966
	7854	8662	8620

The considerable increases in yield that took place after 1956/57 must have been due to reduction of shade. The *Annual Report* for that year noted that shade reduction of the Amazon trial was started. In 1958-59 shade was completely removed from the Amelonado spacing trial.

Notes on Contributors

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Went to Ottawa, Canada, after graduating to work as Research Assistant, Central Experimental Farms. Assistant Manager, later Manager, Nonpareil Estates, Trinidad, 1953-55. Joined the Agronomy Division, Ministry of Agriculture, Jamaica 1956 as cocoa agronomist, working on the production of new planting material for the Cocoa Expansion Scheme. Became Manager, Cocoa Industry Board, Jamaica, 1962.

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Graduated from the Imperial College in 1937. During the war he was concerned with the spraying operations and the equipment for the protection of stored foodstuffs carried out by the Infestation Division of the Ministry of Food and later with the equipment requirements of the Armed Forces for the control of insect vectors of disease. He joined the Staff of the Imperial College in 1947, teaching and working on various aspects of pesticidal application where he is the Senior Lecturer on the field use and application of insecticides. He is also the Officer-in-Charge of the Overseas Spraying Machinery Centre whose function is to provide information and instruction for Overseas Officers and also maintain liaison between British manufacturers and the users in all fields of application.

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Cocoa Abstracts

January 1964.

Sampayan, T. S. Flower structure and biology in cacao. Coffee Cacao J 6, 6, p. 131, 144-5 (1963).

Studies of the flower biology of criollo and trinitario cacao trees in the Philippines showed that anthesis starts at 4 p.m. and that the sepals and petals are already unfolded at 6 p.m. Anther dehiscence starts at 6 a.m. of the following morning; pollen is accessible to insects from 8-8.30 a.m. onwards. In a series of hand-pollinations made at hourly intervals on the same day, the percentage of fruit set was fairly high at all hours from 6 a.m.-5 p.m., reaching a maximum when pollinations were made between 10 a.m. and 1 p.m. Self-compatible × self-incompatible crossings yielded a higher percentage of fruit set than their reciprocals. Table. Photo. 4 refs.

March 1964.

Lems, G. Resultaten van een cacao-klonen experiment. (Results of a clonal trial with cacao). Surinaamse Landbouw 11, 4, p. 138-45 (1963).

A clonal trial experiment with 10 ICS cacao clones was started in Surinam in 1953. Records were kept of number of pods, yields of dry beans, percentages of black pods due to *Phytophthora*, and number of witchbrooms due to *Marasmius perniciosus* during the period from 1955 until September 1962, when the trees had to be felled on account of a heavy attack of witchbroom. In 1957 clones ICS 45 and 49 were eliminated on account of their high sensitivity to *Phytophthora*. No data are presented of clone ICS 89 as the planting material of this clone was found to be heterogeneous. The highest producing clones, ICS 40, 46, 48 and 60, proved to be very susceptible to witches' broom, and their pods to *Phytophthora*, despite regular sprayings with copper oxychloride. Clones ICS 84 and 100 were eliminated in January 1962 because of their low yields. The best results were obtained from the remaining clone ICS 95. English summary. Tables. Graphs. 11 refs.

Lavabre, E. M. et al. Etude de l'évelation régionale et saisonnière des populations de mirides (capsides) en Côte d'Ivoire. (Study of the regional and seasonal development or mirid populations in the Ivory Coast). Café, Cacao Thé 7, 3, p. 267-89 (1963).

A detailed account is presented of the results of periodical assessments of mirid incidence in cacao plantings, conducted in several regions of the Ivory Coast since 1960. In most of the country the population shows a minimum in Mch.-June, a maximum in Sept.-Oct., and sometimes a secondary maximum in Jan.; in the coastal zone it is rather low and constant throughout the year. A control scheme based on these data recommends spraying in July-Aug., spraying plus sucker removal in Dec. Generally speaking, *Sahlbergella singularis* is the predominant species; however, the proportion of *Distantiella theobroma*, a species favoured by drier conditions, varied between 0 and 93%. A list of insects attacking cacao in the Ivory Coast is appended. English, German and Spanish summaries. Tables. Graphs. Figs. Photos. Maps. 8 refs.

The capsid control scheme, Ghana. Rep. Techn. Conf. Dir. Agr. Senior Officers Overseas Dep. Agr. and Agr. Inst. Wye College, Kent, Sept, 1961, Misc. 2, p. 69-73 (1962). B.

After swollen shoot disease, capsids are the most serious problem of cacao in Ghana. The development of the knapsack mistblower in 1954 opened new possibilities; promising results were obtained with gamma BHC. In 1956 a saturation spraying scheme was started on 37,000 ha of cacao with outstanding success. This led to the adoption of a mature cacao extension spraying scheme for 300,000 ha, which was completed in 1958, but which was afterwards extended to 400,000 ha. All this work was free of cost to the farmers. In 1959 a new capsid-control scheme became effective; it placed the responsibility on the farmer. An extensive advisory, distribution and maintenance organisation was created; in 1961 40,000 mistblowers, 27,000 hand sprayers and 2·7 million 1 of concentrated insecticides were sold. The important production increase of the last two years is credited to a large extent to the capsid-control scheme. Fig.

Dow, D. The outlook for cocoa. Farmer, Jamaica 68, 7-8, p. 194-6 (1963).

After a brief analysis of the world cocoa situation, the author points out the favourable conditions for this crop in Jamaica. With a comparatively small production, Jamaica has, of course, very little influence on world prices, but it is in a position to produce a high-flavoured, top-quality cocoa bean. Cocoa as a crop is ideally suited to Jamaica with its good soils, favourable climate and easy access to a local market. Central fermentaries, strategically placed in the cocoa areas, enable the farmer to market his cocoa straight from the field without having to ferment or dry his beans. Photo.

April 1964.

Freeman, G. H. Nursery trial. Ann. Rep. W.Afr. Cocoa Res. Inst. 1961-1962, p. 123-6 (1963).

A cacao nursery trial conducted in Nigeria comprised all combinations of the treatments: (1) planting of seeds in Nov. 1960 (start of dry season), Dec. 1960, Jan. 1961 (peak of the harmattan), or Feb. 1961; (2) no, light or heavy shade; (3) frequent or infrequent watering. Seedling development was most rapid under light shade irrespective of the planting date; frequent watering was markedly beneficial only in unshaded plots planted in Nov. and Dec., and in light-shade plots planted in Dec. Trees from all plots were transplanted to the field in June 1961 and treated in the same way. Tree size in Mch. 1962 in general showed the same pattern as at the time of transplanting, the main exception being that trees planted in Feb. under heavy shade and watered only twice a week had developed unexpectedly well and were bigger than any sown in Dec. or Jan. Another nursery trial was started in Oct. 1961. Tables.

Hall, T. H. R. Spacing experiments. Ann. Rep. W.Afr. Cocoa Res. Inst. 1961-1962, p. 33-6 (1963).

In the 14th year of the unshaded amelonado spacing trial at Tafo, Ghana, all treatments with densities between 755 and 6,805 trees per ha yielded over 2,300 kg of dry cocoa per ha; plots with 482 trees/ha yielded only 1,608 kg. Due to dry weather all yields were lower than in the previous year, the disturbance of nutrient uptake affecting the close-spaced plots more than those with a wider spacing; the percentage of trunk-borne pods increased in the close-spaced plots and decreased in wide-spaced plots. Cessation of pruning in the old Amazon spacing × pruning trial caused the yields of the formerly pruned plots to drop considerably below those of the unpruned plots because of the formation of new chupons. Yields in this trial decreased with increasing densities of 755, 1,087 and 1,700 trees per ha; in a parallel trial with the same densities, however, they increased with the planting density. Tables.

Smith, R. W., and Akrofi, G. S. Cover crops and mulches. Ann. Rep. W.Afr. Cocoa Res. Inst. 1961-1962, p. 72-3 (1963).

Further results from the cacao establishment trial A6 at Tafo, Ghana, referred to in Trop. Abstr. 1852, showed that the deleterious effects of cover crops continued though the treatments were discontinued in 1958. The cacao established with elephant grass mulch or bare soil significantly outyielded all other treatments. In a younger trial (H5), the mean stem diameter 1 year after planting was smallest in plots with natural regeneration and largest in the treatments with a grass mulch or a *Crotalaria striata* cover, the treatment with bare soil and those with covers of Guatemala grass, *Stylosanthes gracilis* or *Zebrina pendula* forming a middle group. Yields of the 1st crop year reflected this pattern; in the 2nd crop year, however, yields of the bare-soil treatment were as low as those of the plots with natural regeneration, i.e. about half of those of the five remaining treatments. Table.

Freeman, G. H., and Wessel, M. Shade observation trial. Ann. Rep. W.Afr. Cocoa Res. Inst. 1961-1962, p. 126-8 (1963).

The effect of shade and soil covers on the growth of young cacao was studied in Nigeria. Amazon seedlings were planted in June 1961; the field was kept free of weeds. At the end of the first year, no differences in development were found between plots with tree cassava, plantain and pigeon-pea shade, or between plots with plastic soil covers between the rows laid either in June or in Oct. Soil moisture was highest under a plastic cover, but cacao development was best and the percentage of dead plants by far the lowest under artificial shade of palm fronds. Unshaded plots with bare soil did not differ much from those covered with plastic though soil moisture in them was much lower. The living-shade plots showed the lowest soil moisture content and by far the highest percentage of dead trees; the height of the remaining trees was equal to that in the bare-soil plots. Table.

Smith, R. W., and Akrofi, G. S. Amelonado shade, fertilizer and irrigation experiment. Ann. Rep. W.Afr. Cocoa Res. Inst. 1961-1962, p. 69-70 (1963).

One-third of the cacao trial field K1 at Tafo, Ghana, was irrigated in 1960/61 and 1961/62. The yields of the four treatments over these two years, adjusted so as to eliminate the effect of irrigation, were, in kg dry cocoa per ha: shaded without fertilizer 786 and 553; shaded with fertilizer 1,085 and 760; unshaded without fertilizer 2,742 and 1,698; unshaded with fertilizer 3,891 and 2,727. The relatively falling yields of the third treatment demonstrate that fertilizer application is indispensable to maintain a high yield level in unshaded fields. Irrigation in 1960/61 increased the yields of all treatments by about 20%; in the drier year 1961/62 the yield level of the no-fertilizer treatments was increased by about 50% and that of the treatments with fertilizers by only about 30%. Table.

Shaw, D. E. Diseases of cacao in Papua and New Guinea. Papua and New Guinea Agr. J. 15, 3-4, p. 79-90 (1962-1963).

Serious diseases, like witches' broom (*Marasmius perniciosus*), do not occur in the Territory of Papua and New Guinea. This is attributed to a strict quarantine. The paper reviews the diseases of cacao in Papua and New Guinea. Symptoms, causal organisms, environment, and control methods are described of: black pod, canker, chupon wilt (*Phytophthora palmivora*), die-back, pod disease (*Botryodiplodia theobromae*), root rots (*Fomes noxius*, *F. lignosus* and *Ganoderma* sp.) and pink disease (*Corticium salmonicolor*). Some data are presented on white thread blights, horse-hair blight, sooty moulds, algal spot, lichens and entomogenous fungi. Photos.

Blencowe, J. W., et al. The effect of viruses on growth and yield of cocoa. Ann. Rep. W.Afr. Cocoa Res. Inst. 1961-1962, p. 17-9 (1963).

Results of three experiments on swollen shoot virus disease of cacao, conducted in Ghana. Artificial infection of young amelonado trees with one of five virus isolates showed large differences in virulence between these strains, the most virulent isolates causing progressive deterioration of the canopy and a reduction of yields from the second year onwards, the mildest strain showing no apparent effect during three years. In a second trial, shade had no effect on the rate of infection with a virulent strain; amelonado cacao proved once more to have a higher susceptibility to the virus than Upper Amazon types. A comparison between plots of peasant cacao regularly sprayed with gamma BHC and similar unsprayed plots, situated in regions with a high incidence of swollen shoot, demonstrated that the elimination of capsids delayed but did not prevent the deterioration and subsequent death of the trees. Table.

Hislop, E. C. Black-pod control. Ann. Rep. W.Afr. Cocoa Res. Inst. 1961-1962, p. 90-100 (1963).

A trial conducted to compare the effect of different fungicides against black pod disease of cacao, applying 10 sprayings at three-weekly intervals, was superimposed upon a spacing experiment at Gambari, Nigeria. Spraying with 0·04 or 0·06% triphenyl tin acetate or with 1% carbide Bordeaux mixture reduced the percentage of *Phytophthora*-diseased pods to about one-half of that in the unsprayed control plots (35·5%); 1% ordinary Bordeaux mixture and 0·16% Cu as copper oxychloride were somewhat less effective. A series of tests was initiated to examine the performance of various spraying machines; the first two implements tested were both mist sprayers. A shoulder-mounted motor sprayer yielded droplets with a smaller average size than an automatic tractor-mounted sprayer, but the strong directional effect of the portable machine resulted in a less even covering of the pods. Tables.

Entwistle, P. F. Entomology. Ann. Rep. W.Afr. Cocoa Res. Inst. 1961-1962, p. 100-13 (1963).

Entomological research conducted in Nigeria showed that the incidence of the shot-hole borer *Xyleborus morstatti* on cacao varies considerably between different regions of W. Africa, indicating the presence of local races. This would make intrational quarantine precautions advisable. Observations on the mating behaviour and sex ratio of the beetle suggested that the males hatch from unfertilized eggs and are haploid. Investigations into the biology of the noctuid moth *Earias biplaga*, the only species of this genus whose caterpillars attack the buds and young leaves of cacao, put the duration of its pre-adult life at about four weeks; adults may live for up to 48 days depending on their diet. Two population peaks were observed within one year; exposed sites are preferred to shaded sites. The several other pests observed on cacao were all of only minor importance in the period under review. Tables.

Catley, A. Observations of the biology and control of the armyworm Tiracola plagiata Walk. (Lepidoptera: Noctuidae). Papua and New Guinea Agr. J. 15, 3-4, p. 105-9 (1962-1963).

Biological data are presented of all the stages of the armyworm (*Tiracola plagiata*), collected by the author during an outbreak of the pest in cacao in the northern district of Papua. Field trials conducted at Popondetta showed that satisfactory control of the caterpillars could be obtained by spraying the tops and undersides of cacao flush leaves with endrin, DDT or sevin. High volume spraying with 0·25 % DDT is recommended. Satisfactory control was also obtained in low volume spraying trials using 2·5 % DDT. However, the treatment was rather wasteful and the use of low volume apparatus required skilled operators. Table. Photos. Five refs.

May 1964.

Amson, F. W. v., and Lems, G. De invloed van de bodem op de kolf-produktie in een cacaoklonen-experiment. (Effect of soil factors on pod yield in a clonal trial with cacao). Meded. Landbouwproefstat. Suriname 33, p. 1-31 (1963).

A trial to compare the performance of cuttings of 8 ICS cacao clones was established on a clay soil in the coastal strip of Surinam in 1955. The 1958-62 yield data indicated a marked inhomogeneity of the soil; detailed studies showed that pod yields per tree increased with the organic-matter content and were inversely related with the pH and the degree of base saturation of the soil. Relatively high yields were obtained where the pH was not higher than 4·5, while the top 20 cm of soil had to contain 4% or more of organic matter and less than 10 maeq./100 g dry soil of exchangeable bases. The highest yielding clone (ICS 95) proved to react much less to differences in soil properties than the second highest yielder (ICS 40). English summary. Tables. Graphs. Maps. Four refs.

Hall, T. H. R., and Smith, R. W. The performance of randomly planted West African amelonado cocoa at Tafo from 1938 to 1960. Ghana J. Sci. 3, 1, p. 35-43 (1963).

A survey is presented of the performance of an area of 40 ha of old cacao trees under observation at the cocoa research station at Tafo, Ghana, since 1938. Between 1914 and 1920, the area was planted in the customary manner of small African farms between food crops after selective felling of the forest. The density varied from 750 to 1,750 trees/ha. No decline of yield due to senility was noted; however, regular losses of trees only partially compensated by natural rejuvenation by basal chupons were responsible for a general reduction in yield from 1,100 kg/ha in 1938 to 576 kg/ha in 1960. There was no indication of yield decline per tree up to 40 years of age. Tables. Graphs. Photos. Maps. 14 refs.

Cunningham, R. K. Micro-nutrient deficiency in cacao in Ghana. Emp. J. Exp. Agr. 32, 125, p. 42-50 (1964).

Observations made in Ghana demonstrated that cacao showing symptoms of both Fe and Zn deficiency and containing little Mn, yielded less than half as much as symptomless trees. Zn deficiency showed when Zn in leaves was less than 15 p.p.m. Whether low leaf Mn concentrations affected yield is not certain; cacao tolerates a wide range of Mn concentrations without showing deficiency or toxicity symptoms. Soil pH above 7·6 was the main cause of decreased availability of Fe, Zn, and Mn. Reducing soil pH corrected Zn deficiency and increased Mn concentrations in the presence of much organic matter; only foliar spraying with Fe corrected Fe deficiency. Foliar sprays of micronutrients included in insecticide sprays are the best way of correcting deficiencies. Micro-nutrient deficiencies are not widespread in Ghana when cacao is grown under forest; they could be serious when cacao is planted after clearing and burning. From author's summary. Tables. 30 refs.

Gerard, B. M. Cocoa mirid control. Nature 201, 4917, p. 353-4 (1964).

A report on a conference held at Tafo, Ghana, in Aug. 1963, to discuss the recent discovery that cacao mirids had developed resistance to insecticides. Resistance has not yet been observed in Cameroun and the Ivory Coast. In Ghana, however, *Distantiella theobroma* in several locations survived spraying with 0·5% gamma BHC at a rate of 56 l/ha, whereas in Nigeria resistance of *Sahlbergella singularis* has been observed in one small area. *D. theobroma* resistant to gamma BHC proved to exhibit no resistance to DDT, organophosphorus compounds, and carbamates. Other subjects discussed included taints imparted to commercial cocoa as the result of spraying with insecticides, increases in noxious insect populations due to spraying with insecticides other than gamma BHC, and shifts in the relative abundance of *D. theobroma* and *S. singularis*. The proceedings of the conference are available from the Cocoa Research Station of Ghana.

Vernon, A. J. Cocoa yield increase by control of capsids (Miridae). Chemistry and Industry 8, p. 320-1 (1964).

Results are presented of 12 trials conducted in Ghana to investigate the effect of spraying against capsids on the yield of cacao. During the six-year period 1957/58-1962/63, treated plots were sprayed with gamma BHC four times annually, twice at a rate of 280 g/ha (active ingredient) and twice at 70 g/ha. Control plots were left unsprayed during 1957/58-1959/60 and were sprayed four times annually at a rate of 70 g/ha during the next three years. The mean yields of the sprayed plots during these two periods were 194 and 171% of those of the control plots, respectively. Since the trial sites were probably selected because they showed more than average capsid damage, the national increase in cacao yields due to spraying against capsids may well be somewhat below that indicated by the trials. Tables. Four refs.

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