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Editorial

The Farmers' Price

In an early issue of the Bulletin we stated that it was our purpose "to pass on information which will help growers to increase their yields and lower their costs". This is still our purpose and is, of course, the object of extension services everywhere. Farmers will not, however, make use of this information unless they feel it is worth while. If they do not consider that the extra expense or effort involved will be definitely repaid in extra crop, then the information and advice will be ignored. This is obvious and is, of course, a perfectly logical attitude.

There is another factor involved, namely the farmers' price. The higher the price, the more profitable his cocoa farm should be, and a price that is satisfactory to the farmer is as good as a dose of fertiliser. Is this so today in those countries that pay a fixed price? World prices during the past crop season have been between £350 and £480 per ton, but the prices paid to farmers in the four main cocoa producing countries in West Africa have been between £107 and £120 per ton. Admittedly the sellers of these crops—about 65 per cent of the world's cocoa—will have sold much of the crop before prices rose, but, nevertheless, there remains a large gap between farmers' price and the price realised. This is a form of taxation but the rights and wrongs of this are not in question here. Prices should not, however, be kept so low that farmers lose interest in their farms, and there has been a danger of this occurring. Farmers prices in West Africa are low, not only in relation to world prices, but also in buying power, compared with prices some years ago. An increase in price seems due, and is needed in order to maintain a healthy cocoa-growing industry—one that will undertake the sort of rehabilitation that is described in Dr. Are's article, that will actively maintain healthy farms, and will remain competitive with other crops.

G. A. R. WOOD.

Review of Production and Consumption

(September 1969)

A. P. Williamson, Cadbury Group Limited

Production

In one or two countries harvesting of the main crop continued at a rather better rate than was expected at the time of our last Bulletin, and in addition the summer crops have been above average, particularly in Bahia and Ghana. As a result, the latest 1968-69 production estimate shows an increase of 28,000 tons over the figure forecast eight months ago.

It is too early to forecast the size of the forthcoming main crops, but what reports are heard from West Africa tend to be pessimistic.

Consumption

The grinding figures from the leading consumers for the first half of 1969 were rather disappointing, particularly from the United States, West Germany and France. The detailed figures were:

	per cent		per cent
U.S.A.	—8·6	U.K.	+0·6
West Germany	—8·0	France	—7·1
Netherlands	+0·2		

No figures are published of the usage in the U.S.S.R. and Eastern Europe but from the level of their purchases it would appear that they are continuing to expand, although at a slower rate, despite the rise in prices.

Overall, the forecast of world grindings for the whole of 1969 has been reduced from 1,358,000 tons to 1,332,000 tons, a decrease of 4 per cent on 1968.

Stocks and Prices

The increased production and reduced consumption estimates have reduced the nominal 1969 deficit by over 50,000 tons. Nevertheless, the basic stock position, at the end of this year, measured in terms of month usage, will still be at its lowest level since the war.

Prices have continued to reflect this physical shortage of cocoa and the price for spot Ghana has fluctuated around £425 per ton. For a considerable period of the year, however, the market remained hopeful about the prospects for the coming season and shipment prices for new crop cocoas ranged between £370 and £390 per ton. Recently, with the pessimistic crop reports coming from West Africa, these prices rose to £425 per ton before falling back to around £400 per ton.

International Cocoa Agreement

It is some time since we referred to the progress with the negotiations on an International Cocoa Agreement. Consultations took place in Geneva in June 1968 and, while progress was made on a number of points, some important issues remained outstanding and it was not felt that they were such as could be resolved at a negotiating conference.

In June this year a further meeting took place in Geneva to try and isolate these areas of disagreement. During the discussions the whole structure of the proposed agreement was questioned and so was the price range that had been negotiated in October 1967. As a result it was not possible to put out an agreed statement at the end of the meeting and the Secretary-General of U.N.C.T.A.D. will be visiting individual producers and consumers before considering further action.

WORLD COCOA PRODUCTION AND GRINDING DATA

Reproduced from Gill and Duffus Market Report dated 15th August 1969

(Thousand long tons)

Production

	1966-67	1967-68	1968-69 (forecast)
Africa	953	961	839
America	308	295	294
West Indies	43	48	39
Asia and Oceania	34	38	41
World Total	1,338	1,342	1,213
Principal Countries			
Ghana	376	415	330
Nigeria	263	235	187
Ivory Coast	147	144	140
Cameroon	84	90	100
Guinea (Spanish)	38	33	37
Brazil	173	143	154
Ecuador	53	68	55
Dominican Republic	28	30	22
Mexico	25	26	25
New Guinea	21	24	27

Grindings

	1967	1968	1969 (forecast)
Western Europe	554	546	524
Eastern Europe and U.S.S.R. ..	170	178	173
North America	307	304	282
Australia and New Zealand ..	17	17	17
Central and South America ..	163	156	151
Asia	54	50	48
Africa	105	137	137
World Total	1,370	1,388	1,332
Principal Countries			
United States	289	286	265
Germany (Federal Republic) ..	142	137	127
Netherlands	110	110	110
United Kingdom	94	92	90
U.S.S.R.	83	95	95
France	51	49	45
NOMINAL DEFICIT	–32	–48	–119

Nutritional Aspects of Cocoa and Chocolate

P. H. Wiggall, Research and Development, Confectionery Group, Cadbury Schweppes Limited, Bournville

General Introduction

Before considering cocoa and chocolate specifically it is desirable to consider the composition of foods generally. The major classes of nutrients that go to make up foods are—carbohydrates, fats, proteins, minerals and vitamins.

Nutrients

Carbohydrates include the sugars and starches, and although a variety of carbohydrates such as starch, lactose (milk sugar) and sucrose may be used by the body, the most important body sugar is the monosaccharide glucose, into which the other utilizable sugars can be converted. Carbohydrates are broken down preferentially in the body to provide energy, and any excess may be either stored as glycogen or converted into fats. Glucose is the principle food for brain and nerve tissue. Carbohydrates are not good "body-building" materials but they do spare the use of those materials which are, when used as an energy source. Carbohydrates also include the celluloses, gums and pectins, not all of which can be used by the human body although they are of use to some animals. However, such substances do supply bulk, which is necessary for the normal functioning of the digestive system.

Fats form a ready source of body fat, a concentrated form of energy, and are composed of various fatty acids combined with glycerol. Everybody needs a proportion of fat in his diet. Fat is required in certain parts of the body to act as a reserve food material, as insulation against loss of body heat and as protection for some organs. Some components of fats, certain unsaturated fatty acids (e.g. linoleic acid) are known to be essential inasmuch as the body is unable to synthesise them from other materials. Fats also act as carriers of fat-soluble vitamins and phosopholipids.

Proteins are required mainly as body-building materials and are essential for growth and production of scar tissue, although excess may be used as a source of energy. Even the compounds known as enzymes, which are involved in the many metabolic reactions in the body, are themselves composed mainly of proteins. Proteins are composed of amino acids and the body builds its own proteins by breaking down the proteins in the food into the constituent amino acids and reassembling these in a complex way to build up the proteins required. Any "excess" amino acids may be broken down, thereby providing energy. Some of the 22 amino acids of which proteins are composed cannot be synthesised by man from other materials and they are therefore "essential". Eight are known to be essential for adults and probably ten for children. Most animal proteins contain a mixture of the various essential amino acids, whereas some vegetable proteins are deficient in some of these constituents and are thus in some respects inferior. However, the consumption of both animal and vegetable proteins allows the maximum benefit and use to be made of each. Whilst proteins may be used as an energy source, normally in this respect the fats and carbohydrates eaten have a protein "sparing" action.

Various *vitamins*, such as the fat-soluble vitamins A, D, E and K and water-soluble vitamins, including those of the B group and vitamin C, are also essential for health, as well as a number of minerals and trace elements (1, 6). Calcium, iron and iodine are those most likely to be in a critical state of supply.

It is important that everyone should receive a properly balanced diet, and this is normally achieved by the consumption of a wide variety of foods.

Calculating calorific values

A number of slightly differing factors in terms of the Calories that one gram of protein, fat, or available carbohydrate provides for calculating the calorific value of food from its composition have been proposed. Generally used values are 4·1 Calories per gram of protein, 9·3 Calories per gram of fat and 3·75 Calories per gram of available carbohydrate as glucose (this factor varies with the type of carbohydrate) (4). From a knowledge of the composition of the food and with the aid of such factors the calorific value can be calculated.

The number of Calories required daily varies according to sex—women requiring slightly less than men unless they are pregnant, or nursing mothers; type of work, age and other factors. However, an average man of 25 years of age engaged in light work requires in the region of 3,200 Calories per day.

Cocoa and chocolate

Having considered a few general aspects of foodstuffs we can now consider more specifically cocoa and chocolate.

It is probably true to say that cocoa and chocolate are consumed primarily for pleasure rather than for their nutritional value. Nevertheless they have an important role to play as a supplement to a balanced diet. The fat content of cocoa means that it is able to provide more energy than an equivalent weight of coffee or tea. Linoleic acid, one of the essential fatty acids, is present to about 3 per cent of the component fatty acids of cocoa butter, the main constituent fatty acids of cocoa butter being palmitic, stearic and oleic acid, although traces of other fatty acids are also found.

Cocoa also contains certain vitamins, and McCance and Widdowson give values in mg/100 g of nicotinic acid 1·7, riboflavine 0·30, thiamine 0·08 compared with daily requirements in mg of approximately 10, 1·6 and 1 respectively.

Proteins are sometimes assessed on the basis of their ability to provide all the types of amino acids required by the body and thus may have either a high or a low "Biological Value". Not all of the protein present in cocoa is apparently used by the body, and Mitchell, Beadles and Keith (5) have given the biological value of cocoa protein as 37 per cent compared with 84 per cent for milk protein and a digestibility coefficient of 38 per cent based on feeding experiments with young rats (2).

Cocoa, when taken with milk and sugar, forms a highly nutritious beverage and also has a mild stimulatory action due to the theobromine and traces of caffeine that it contains (approx. 2 per cent and 0·1 per cent of the cocoa powder respectively) (3), apart from being a pleasant warm drink. It has also been stated that the digestibility of the milk is improved by the presence of the cocoa which helps to break up the milk clot formed in the stomach.

McCance and Widdowson (4) give the following analytical data for cocoa powder:—

Table I Analytical data for cocoa powder (mean of three varieties)

Nutrients		g/100 g	Elements	mg/100 g
Protein		20·4	Sodium	650*
Fat		25·6	Potassium	534*
Available carbohydrate as monosaccharide..		35·0	Calcium	51·2
			Magnesium	192
Calories per 100 g ..	452		Iron	14·3
			Copper	3·40
			Phosphorus	685 (15% of which is in the form of phytic acid phosphorus and not readily available).
			Sulphur	160
			Chlorine	199

*These values would be expected to vary with the manufacturing process used.
100 grams = 3·53 ounces.

The following data have been reported for chocolates of British manufacture:—

Table II Average composition of plain and milk chocolate given by McCance and Widdowson.

No. of well-known varieties analysed		4 Plain	2 Milk
Total available carbohydrate†, calculated as monosaccharide ..	g/100 g	52·5	54·5
Fat*	g/100 g	35·2	37·6
Protein* (N x 6·25) ..	g/100 g	5·6	8·7
Elements Present:	mg/100 g		
Sodium		143	275
Potassium		257	349
Calcium		63·0	246
Magnesium		131·0	58·9
Iron		2·90	1·71
Copper		0·81	0·49
Phosphorus		138·0	218·0
Chlorine		4·8	170·0
Calories per 100 g. ..		544	588

†Total available carbohydrate will consist of sugar, cocoa starch and also lactose in the case of milk chocolate.

*The total fat and protein in milk chocolate will include a proportion of milk fat (the other fat normally being cocoa butter), and of milk protein.

Although, as stated earlier, chocolate is also normally eaten for the pleasure it gives, rather than because it is considered nutritious, it does nevertheless contain a proportion of the main classes of nutrients, carbohydrates, fats and protein, and milk chocolate includes a proportion of valuable milk solids, among them butter fat, milk protein, calcium and other minerals and vitamins. Nuts—a further rich source of vegetable oil and protein—may also of course sometimes be included, as may dried fruit, in some moulded chocolate.

Some vitamins, such as vitamin C, are rather unstable, and any present tend to be destroyed during processing, but some of the more stable are present in chocolate. McCance and Widdowson (4) quote values of 0·04 mg carotene, 0·03 mg thiamine, 0·35 mg riboflavine and 1·0 mg nicotinic acid per 100 grams of chocolate. These values are equivalent to approximately one tenth of a man's daily requirements of nicotinic acid and one fifth of riboflavine.

The proportions of sugar, milk and roasted ground cocoa nibs used in the production of chocolate will clearly vary from manufacturer to manufacturer.

The fat content of chocolate renders it of higher calorific value than many other kinds of sugar confectionery, making it a good energy-producing food. Despite the similarity in calorific value of plain and milk chocolate, milk chocolate is probably better nutritionally because of the inclusion of the proportion of milk protein, which is of high biological value, notwithstanding the slight deterioration that unavoidably may occur in drying the milk. Also, as can be seen from Table II, the milk makes a valuable contribution of calcium and phosphorus.

In survival rations

In summary, chocolate, with its low moisture content, bacteriological safety and excellent keeping properties, forms a safe, concentrated food of high energy content which contributes to the main classes of nutrients. For these reasons it is usually included in survival rations and is taken on expeditions as a source of readily available energy requiring no preparation, and is widely used as a snack food when it helps to replenish blood-sugar levels. Whilst it has a definitely advantageous role to play in these respects, obviously it should not be eaten to such an extent that the appetite is depressed for the main meals. A well-balanced diet is essential, but as a nutritional supplement chocolate has its place. The world would certainly be a more austere place without it!

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Dr. C. J. J. van Hall, Amsterdam 1875–1947

Ir. H. Toxopeus, Cocoa Research Institute of Nigeria

Dr. C. J. J. van Hall

Photo: Royal Tropical Institute, Amsterdam.

Born in Amsterdam on 21st April 1875, Dr. C. J. J. van Hall received his secondary education at the Gymnasium of Amsterdam and studied botany and zoology at the University of the County of Amsterdam from where he graduated *summa cum laude* with a thesis on "Bacterial Plant Diseases". In 1903 he entered the service of the Surinam Ministry of Agriculture to deal with the Witches' Broom disease of cocoa. This had been first observed in 1895 and had all but wiped out the cocoa industry of Surinam. He was appointed Inspector of Agriculture in the West Indies, and simultaneously as Director of the Surinam Agricultural Station which he started.

During these years van Hall's great and lasting interest in the husbandry and improvement of tropical crops, particularly cocoa, developed, and he was in close touch with other specialists in Latin America and the West Indies. In 1909 he moved to the then Dutch East Indies, where he became Director of the Institute for Plant Diseases and Plantation Crops. He paid special attention to the publications of the Institute, many of which were written in the native tongue as extension pamphlets. During this period he took an active interest in cocoa selection work, and he wrote the first edition of his book *Cocoa.*

He returned to the Netherlands in 1926 and became Head of the Library of the Colonial Institute, now The Royal Tropical Institute at Amsterdam. It was here that he wrote the second and revised edition of the book *Cocoa* which appeared in 1932. In the mid-'thirties he played an important role in the promotion of the elaborate research programme on the curing of Java cocoa, which subsequently (1935-38) was conducted by P. A. Roelofsen and G. Giesberger (4). After his retirement in 1941 he remained active in the Colonial Institute, where he edited a series of books called "Insulinde", a fanciful name for the Indonesian archipelago, often used by people who, like van Hall, had acquired a deep and genuine love for these islands where they had worked for so long, and for their peoples. He was senior editor of a handbook of "Agriculture in the Indonesian Archipelago" which by and large presented a complete picture of agricultural production and the activities of the joint agricultural services and research in the area up to the early 1940s (3, 5).

Cocoa Work

On the basis of his experience in Surinam, van Hall began active cocoa selection work soon after his arrival in Indonesia. The small exports of cocoa from Indonesia were mainly produced on plantations located in Central Java from a variety called "Java Criollo", probably derived from plants introduced by the Spanish into the Phillipines in the 17th century. "Java Criollo" has white beans with a weak flavour, is slow-growing and is very susceptible to diseases, in particular bark canker caused by *Phytophthora palmivora* and to attack by *Helopeltis* bugs (*Miridae*). To improve the cocoa crop, the manager of Djati Roenggo estate introduced plants from Venezuela in 1888 to give his cocoa the famous flavour of the Venezuelan Criollo. To his great disappointment the plants turned out to be a Trinitario variety which was considered in those days to have an inferior flavour.

However, seeds from these trees gave very vigorous progeny, which were presumably the product of cross-pollination of the Venezuelan Trinitario with Java Criollo pollen, with a resultant hybrid vigour effect. Although very little was known about heterosis in those days, van Hall recognised this phenomenon as such, and he selected the best trees in the existing hybrid population. These were propagated as budded plants and seedlings. From his previous experience van Hall knew that cocoa was outbreeding, although the pollinating agent was unknown. To get seed by self-pollination he completely covered each selected tree with mosquito gauze to prevent insects or wind from carrying pollen from other trees. In most cases only a few pods were produced but he was lucky to get these few pods because 40 years later it was found that many of these trees were in fact self-incompatible (2).

At this stage, however, van Hall's other work allowed him too little time for further selection work on cocoa and he handed the task over to other workers. In 1946 three of his original selections: DR1, DR2 and DR38 (DR for Djati Roenggo) were finally selected as high-yielding, commercially valuable clones. Buddings of these clones on specially selected rootstocks were extensively used on plantations, and a high proportion of the 1,000 tons of cocoa exported annually from Indonesia now comes from the DR clones (6). Plantings of these three DR clones have now also been established in Tanzania on an estate initiated by Dutch companies.

Van Hall's main contribution to cocoa research and production is embodied in his book *Cocoa*. No other technical work on cocoa published so far is so well balanced, contains so much information useful to the planter and presents such a complete review of up-to-date scientific information (1).

With the present re-examination of the shade requirements of cocoa, van Hall's summary of the basic need of shade is remarkably up-to-date. He says on page 137 of his book: "We may conclude that the use of the shade trees is in the first place *the improvement or at any rate the conservation of the good qualities of the soil*". Shade is not necessary for cocoa plants and "the close planting of cocoa trees where shade trees are not used is simply a means of obtaining a shade otherwise afforded by the shade trees". He goes on to say, however, that the effects of pests, such as thrips, and die-back, will be much more serious where there is no shade.

Van Hall was very anxious that the information in his publications should be useful to the reader, and the first sentence in the preface to his book is: "In writing this handbook, I have done my best to make it practical".

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Rehabilitation of Cocoa Farms

PART I

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Introduction

Rehabilitation of a cocoa farm implies the replacement of the existing moribund or old variety of cocoa trees by younger or improved stock. In cocoa-producing countries, most cocoa trees which contribute to the average annual crop of 1·3 million metric tons are over 30 years old. Many trees have therefore become a wasteful asset owing to old age, lack of fertilizer application, poor maintenance, severe attack by pest or disease. A combination of these factors have rendered many cocoa farms derelict. In addition, rehabilitation might be necessary where improved varieties are being used to replace those less productive. The problem of rehabilitation is common to all cocoa-producing areas, hence the following detailed survey.

Methods used for rehabilitating cocoa farms:

Complete farm replanting

This is done by cutting out all the old cocoa and replanting under newly-established nurse shade trees. This permits the use of improved, more vigorous, highly tolerant and higher yielding cocoa material. This system is used in Nigeria where it is particularly suitable, since the size of the average holding is about 2 to 3 acres (1). Growers receive grants in cash and kind in Western Nigeria to encourage them to replant (13). Originally, F_3 Amazon seedlings were supplied for the replanting scheme, but the more promising hybrids from the bi-clonal seed-gardens, which are just coming into production, will now be used.

The cocoa seedlings are planted at a spacing of 5 feet by 10 feet on clear-felled land. Shade plants are established 4 months to one year before the cocoa is planted. Later, the cocoa is thinned to a final spacing of 10 feet by 10 feet. Close spacing initially increases yield per acre and helps the canopy to close fairly quickly. Weed control is achieved by hand and chemical weeding. Plantain is used as temporary shade because of its economic value and importance in the Nigerian diet, and is spaced at 20 feet by 20 feet.

This method permits orderly replanting, but it is expensive and cannot, therefore, be successfully undertaken by the peasant farmer without some subsidy or financing, particularly where the farm exceeds the usual 2-3 acres, especially as the farmer gets little income while the young cocoa trees are being established. In addition, the sudden exposure of the soil after clear-felling encourages more weeds to grow and possibly more soil erosion and pest attack.

Phased farm replanting

This method is used wherever the farm is large. A given percentage of the acreage is completely replanted annually until the whole area is restocked. Phasing is commonly practised in Brazil and Colombia, and in the Areas of Mass Infection (AMI) in Nigeria.

In Brazil, farmers are encouraged to replant 10 per cent of old farms (up to a maximum of 10 hectares per farm) having trees over 40 years old, under a prescribed scheme of operations, including fertilizer applications and pest control. The precocious, high-yielding, white-seeded Catongo variety is used as planting material, but this will be gradually replaced by hybrids (11).

In Colombia, rehabilitation is achieved by replanting the entire farm over a period of eight years, thus replanting one-eighth of the area at a time. The minimum size of old farms to be replanted at any one season is 10 hectares. Wherever funds and assistance in the form of improved planting materials and agricultural advice are available, replanting could be spread over four years. In both of the above schemes, all the old trees in a section are cut down and replanted that season (Gutierrez, personal communication).

In the Area of Mass Infection, in Western Nigeria, trees affected by swollen shoot are removed and replanted by the Extension workers of the Ministry of Agriculture and Natural Resources. F_3 Amazon seedlings are usually planted in place of the diseased Amelonado trees, but hybrids which are tolerant to the disease are being introduced. In the AMI, the young cocoa plants might be planted close to old virus-infected trees with a consequent risk of re-infection. Therefore, farmers wishing to replant their old farms in the AMI have to establish a 30-foot cordon around replanted farms. They must also agree to periodic inspection by the Cocoa Survey section of the Ministry of Agriculture, and the removal of diseased and contact trees without compensation, other than replanting of the areas cleared by the Cocoa Survey section (13).

This system enables the farmer to remove his old cocoa in stages thereby permitting him to get some income while the replacements are becoming established. By the time the last old cocoa is being removed, most of the new trees have started to yield fairly steadily.

Selective tree replanting

This method involves the replacement of not less than 35 per cent of the old, unthrifty cocoa trees from all over the farm. It was until recently commonly used in Trinidad, but is fast becoming unpopular because the scattered, newly-planted trees do not get adequate attention, and overhead shade is not uniform over the rehabilitated farm. The Cocoa Board, established about 20 years ago with the primary aim of rehabilitating old cocoa farms in Trinidad, supplies the improved plant materials and gave a cash subsidy of £60 per acre for each replanted farm until the subsidy stopped in 1968. After an inspector of the Cocoa Board has found the land and shade of the farm to be satisfactory, the farmer applies for improved seedlings a year before they are needed (Freeman, personal communication). Complete replanting is now favoured, as experience has shown that it gives uniform shade, better growth and easier management.

Growing young cocoa under old cocoa trees

This method is favoured in Colombia, Costa Rica and Nigeria, and with slight modifications, from place to place as discussed below:

In Nigeria, potentially good old cocoa trees are retained as shade plants, and young improved seedlings (F_3 Amazon) are planted at a spacing of 5 feet by 10 feet under them. The canopy of the old cocoa trees is progressively thinned and they are eventually stumped, thus leaving a pure stand of F_3 Amazon at a final spacing of 10 feet by 10 feet.

In Colombia, the first phase is the removal of the bigger shade trees in the farm, leaving 20 to 30 per cent, consisting mainly of *Erythrina glauca*, *E. poepigiana*, *Gliricidia sepium* (giant variety), *Inga spectabilis*, *I. acuminata* and *I. edulis*. These eventually provide the only shade over the young cocoa. The old cocoa trees are first heavily pruned to allow adequate light penetration, and the improved young cocoa is then planted. Two spacings are used: 4 m × 4 m for hybrid seedlings and 3·6 m × 3·6 m for clonal material (cuttings). Eighty per cent of the planting materials used for rehabilitation are hybrid seedlings, while the remaining 20 per cent are clonal cuttings. Removal of the old cocoa trees begins during the second year and they are completely removed by the end of the fourth year.

In Costa Rica (10) the old farm is staked, lined and holes are dug for the young cocoa to be planted. Six months before the planting, the permanent shade trees in the old farm are either poisoned or cut down. Temporary shade, such as bananas, are then planted in the spaces left. Six-months-old hybrid seedlings (Catongo × P12, the best yielder, and UF677 × P12, having good-sized pods and seeds) are transplanted into the field from October to December. Fertilizer is applied to the planting holes at a rate of 2 oz. NPK per plant a week before the hybrid seedlings are planted. Permanent shade trees such as the fast-growing types of *Ingas*, *Erythrina glauca* and *E. velutina* may be planted at a spacing of 12 m × 12 m or 15 m × 15 m, depending on the species used, during the first year of the hybrid seedlings in the field. Further fertilizer application at the rate of 0·55 lb. NPK is given to each plant after six months in the field and every six months thereafter. At that time, the old cocoa trees are also pruned to admit about half of the sunlight. When the hybrid seedlings are about $1\frac{1}{2}$ years old in the field, 50 per cent of the old cocoa trees are removed, while the remainder are removed at the end of the third year. At this stage, the hybrids are beginning to bear pods, and if planted at a close spacing of 2 m × 2 m or 3 m × 3 m their canopy would have closed. The permanent shade trees planted during the first year start to give the desired overhead shade for the hybrid cocoa plants, and all the provisional temporary shade trees are then removed.

Some advantages

This method is likely to prove attractive and acceptable to farmers since they are assured of reasonable income from their old cocoa while the young areas are being established. In addition, the weed problem is not as bad as in complete-farm or selective-tree replanting. It also helps to reduce considerably the cost of re-establishing cocoa on an old farm, as there is some revenue from the old cocoa during the first two years. It would appear, however, that this method can only be used where the old canopy cocoa is poor, otherwise some of the branches would have to be pruned to admit sufficient sunlight for good development and growth of the new plantings.

In Nigeria, where the trees are irregularly spaced, some of the old stock would have to be removed to make for orderly replanting of the young seedlings. In all areas the old cocoa may not give uniform overhead shade to the young trees, hence this may be supplemented by planting a few temporary nurse shade plants.

Hybrid Seed-Gardens

Some practical considerations

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There are two methods by which the seeds of high-yielding hybrid varieties can be produced for commercial scale plantings. The first of these, by hand-pollination, has been described in a recent article (5) for comparatively small-scale production on the estate. Hand-pollination can also be employed, and perhaps generally with greater safeguards, by government or commercial seed-producing organisations for large-scale seed production. The second method, by using hybrid seed-gardens, has the main advantage that once the seed-garden is established the supervision required should be little more than that needed for a similar area of commercial clonal cocoa.

The use of seed-gardens to produce hybrid varieties by "controlled" natural pollination is possible because in most of the varieties so far developed one parent at least is self-incompatible and will not set pods from self-pollinations. However, it has been shown (1, 4) that self-incompatible clones can be induced to set a proportion of selfed seeds when flowers are pollinated with a mixture of their own pollen and pollen from other compatible clones. Such mixed pollinations would occur very frequently in the seed-garden but the practical significance of having a proportion of selfed seeds in the planting material obtained from the seed-garden is not yet known. Accurate hand-pollination is thus the only completely reliable method of producing seeds true to hybrid type, and the adoption of this method for commercial-scale seed production avoids most of the difficulties and uncertainties associated with seed-garden production.

Design of seed-gardens

The design of the seed-garden will vary, depending on whether one parent is self-incompatible or whether both are. The relative vigour, growth habit and flowering characteristics of the parental clones can also influence the design.

Where both parents are self-incompatible, and of similar vigour, habit and productivity, they can be planted in alternate single or double rows to give a simple bi-clonal seed-garden, and the pods produced will be of the hybrid variety and its reciprocal. Fortunately, there are few indications that in the hybrid varieties so far developed there is any appreciable difference in performance between the variety and its reciprocal cross (2).

For hybrid varieties from two self-incompatible parents where one parent is markedly less vigorous than the other, the use of alternate single or double rows may have disadvantages as the weaker clonal parent can suffer severe competition from its more vigorous neighbour. With such hybrids it would be preferable to plant the parental clones in alternate four-row strips. A rather similar situation arises where one parent is of upright habit and the other is more prostrate. If alternate single or double rows of the parents are planted, and basal chupons are not allowed to develop, the more upright parent will tend to close over the more prostrate.

For hybrids where one parent is self-compatible and the other self-incompatible, the former has to be used as a pollinator. Pods from the pollinator parent have to be discarded as they would be a mixture of self-pollinated pods and the reciprocals of the hybrid variety. In seed-gardens of this type estab-

Three-year-old budded plant in hybrid seed-garden, Sabah.

Part of a hybrid seed-garden in Sabah, established by budding in the field.

Photos: D. F. Edwards.

lished in Ghana (3), the central seed-producing area was planted with pollinators in a ratio of 1 to 5 to the female parents, using the layout shown below:

p	x	p	x	p	x	p
x	x	x	x	x	x	x
p	x	p	x	p	x	p
x	x	x	x	x	x	x
p	x	p	x	p	x	p
x	x	x	x	x	x	x

p = pollinators
x = females

In this layout each female tree has a pollinator adjacent, and satisfactory interpollination should occur between the parents, providing they are of similar vigour, habit and flowering characteristics. However, if competition can be expected to suppress the growth and flower production of the pollinators it may be preferable to plant them in groups of four or more trees, partially to offset the effects of competition:

p	p	x	x	x	x	p	p
p	p	x	x	x	x	p	p
x	x	x	x	x	x	x	x
x	x	x	x	x	x	x	x
x	x	x	p	p	x	x	x
x	x	x	p	p	x	x	x

Suppression of a weaker pollinator parent can be reduced by removing all the young cherelles from the trees to encourage vegetative growth and an extended flowering season. Also, branches of the adjacent pod-parent trees can be pruned to reduce competition.

Where hybrid varieties are developed, tested and released from breeders' trials as a series, e.g. the approved "T"-type Upper Amazons (6) or the Tafo Series II hybrids (2), and no differential adaptability of the individual hybrids is detected, the planting of a mixture of the hybrid varieties is usually recommended. A mixture of pods from the produce of several bi-clonal seed-gardens could be used but where a multi-clonal seed-garden is possible this has advantages. In a series of hybrid varieties where all parents are self-incompatible and some of these parents are common to different individual hybrids, it is possible to use a multi-clone seed-garden to produce some or all of the hybrids in the series. In Sabah a 30-acre seed-garden was established to produce approved "T"-type Upper Amazons in the F_1 generation, and the layout used is shown in part opposite.

In this layout the parent common to two different hybrids was used to link together the sections of the seed-garden. It was believed that the occurrence of hybrids other than those intended would be reduced to acceptably low levels by interposing an eight-row barrier between the nearest rows of parents which were not wanted to interpollinate. Pods produced from trees in the barrier strips could be distributed as seed pods of a mixture of two hybrid varieties.

With series of hybrid varieties where one parent in each variety is self-compatible, the design for a multi-clone seed-garden becomes more difficult. Two hybrid varieties with a common self-incompatible parent, e.g. WAE 5 and WBE 3 in the Tafo Series II hybrids (2), could be produced from a single seed-garden by planting the non-Amazon parents alternately as pollinators. If, however, the self-compatible clones have to form the links between sections of the seed-garden, a large proportion of internal discard area has to be accepted if a multi-clone seed-garden is to be established.

Whatever layout is used, unless the seed-garden can be established in isolation from other cocoa, precautions have to be taken to avoid "foreign" pollen being carried into the seed-garden from nearby cocoa. If an isolated site is obtainable the danger of "off-type" pollinations is removed, but such sites are often difficult to find, and also very high losses from rodent damage are usually associated with relatively small plots of isolated cocoa.

In Ghana 14 separate bi-clonal seed-gardens were established to produce Tafo Series II hybrids (2, 3). These seed-gardens were planted at the Cocoa Stations of the Ministry of Agriculture and the precautions taken to avoid contaminant pollinations varied with the compatibility relationships of the parents. Seed-gardens to produce hybrids between self-incompatible Upper Amazon parents and self-compatible Amelonado parents, hybrids coded WAE and WEA (2), were planted in three zones. An outer perimeter zone eight trees deep was planted to the Amelonado parent to form a pollen barrier. The outer zone of the seed-producing area, six trees deep, was planted in a ratio of 1 pollinator to 3 pod parent trees, while the remainder of the area was planted in a ratio of 1 to 5. The main sources of contamination at the Cocoa Stations were unselected Amelonado and F_2 or F_3 generation approved-type Upper Amazons. Any pollen from these sources which was borne through the outer pollen barrier could result in seeds equivalent to F_3 Amazons or, if the pollen were from Amelonado, to seed very

LAYOUT OF SEED-GARDEN IN SABAH

Clone	Pa7	Na 32	Pa 7	Na 32	Pa 7	Na 32	I.M.C. 60	Na 32	I.M.C. 60	Na 32	Na 32	Pa 35	Na 32	Pa 35	Pa 35	Na 31	Pa 35	Na 31	Pa 35
	x x x x x x x x	x x	x x	x x	x x	x x x x x x x x x	x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x
	x x x x x x x x	x x	x x	x x	x x	x x x x x x x x x	x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x
	x x x x x x x x	x x	x x	x x	x x	x x x x x x x x x	x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x
	x x x x x x x x	x x	x x	x x	x x	x x x x x x x x x	x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x
	x x x x x x x x	x x	x x	x x	x x	x x x x x x x x x	x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x
	x x x x x x x x	x x	x x	x x	x x	x x x x x x x x x	x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x
	x x x x x x x x	x x	x x	x x	x x	x x x x x x x x x	x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x
	x x x x x x x x	x x	x x	x x	x x	x x x x x x x x x	x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x
	x x x x x x x x	x x	x x	x x	x x	x x x x x x x x x	x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x x x x x	x x	x x	x x	x x
Seed Types Produced	Perimeter Discard	Pa7 × Na32 and Reciprocal = T60 and T79				Mixture of Na32 × Pa7 and Na32 × I.M.C.60	I.M.C.60 × Na32 and Reciprocal = T72 and Recip.				Mixture of Na32 × I.M.C.60 and Na32 × Pa35	Na32 × Pa35 and Reciprocal = T63 and T82			Mixture of Pa35 × Na32 and Pa35 × Na31	Pa35 × Na31 and Reciprocal = T76 and Recip.			

similar to that of the intended variety. Such contamination, provided it were limited, was thought to be unimportant.

For seed-gardens where both parents are self-incompatible or where a multi-clonal garden is planted, and an isolated site cannot be obtained, an outer discard area is also required. Probably the simplest solution is to plant the parents on a consistent pattern and to discard the produce of the outer trees as seed-pods. If, however, in a bi-clonal seed-garden of this type one parent was markedly more vigorous or more floriferous than the other, a perimeter pollen barrier of this parent could be planned. In Ghana it was possible to plant all seed-gardens of this type, the WEB and WBE coded hybrids (2), at least one-eighth mile distant from any other cocoa. With these hybrids the effect of contaminant pollinations from unselected Amelonado or unselected Amazons would have given seeds distinct from the intended varieties.

The effectiveness of an outer pollen barrier can be expected to be fairly low in the early years of establishment of the seed-garden, especially if more mature cocoa is planted nearby, and the purity of the seed produced should increase with the age of the seed-garden.

If an outer pollen barrier is to be planted, or a discard area allowed, clearly the larger the seed-garden the better as the loss of seed-producing trees becomes proportionately lower. Also, the amount of foreign pollination from outside sources can be expected to decrease with increasing seed-garden size. In Ghana a minimum size of ten acres was suggested but in fact the smallest seed-garden planted was more than double this size.

Establishment of seed-gardens

There will be an inevitable delay between final approval of hybrid varieties from breeders' trials and the time when seed-gardens to produce these varieties can be brought into bearing. Part of this delay is unavoidable as the time between establishment and the production of significant quantities of seeds cannot greatly be shortened. However, the method used for propagating the parental plants and the method of field establishment employed may affect the speed with which the seed-garden can be brought into bearing. Whether the parental plants are propagated by rooting cuttings or by buddings will depend on local circumstances. For the Ghana seed-gardens all plants were propagated from cuttings but in that country propagating units existed on most of the Cocoa Stations, and clonal cutting nurseries including the parents of all Series II varieties had been established before the decision to release a limited number of the hybrids was made. Even so, planting of some of the larger seed-gardens had to be spread over several years because the production of cutting material from several of the parental clones was very slow.

The establishment of a seed-garden by using buddings has advantages in that the process is more rapid, is less expensive and needs fewer skilled staff than if cuttings are rooted. Budding is also much more economical in the quantity of propagating material required. Another point in favour of budding is that while most clones can be budded with equal ease, cuttings of some clones are much more difficult to root than others.

Whether buddings are made onto nursery seedlings or direct onto stock seedlings in the field will depend on local convenience. Budding in the field has the advantage of greater flexibility, especially when budwood is short or has to be moved from a distant centre. As stocks can be budded successfully from about

1 cm to 3 cms in stem diameter, budding can be spread over an appreciable period, and as later buddings on larger stocks usually grow more vigorously than earlier buddings on younger stocks, a reasonably uniform seed-garden can still be obtained.

Buddings have some disadvantages as compared with cuttings and the most important of these is the need, more particularly in the early years, for very careful attention to the removal of chupon growth from below the bud union. Low budding and the encouragement of scion rooting reduces the number of stock chupons produced. If a stock is used which has a distinguishing vegetative character it is easier to separate stock and scion growth. In Sabah, seeds from an Upper Amazon clone were used for stocks as all seedlings from this clone had leaves of a marked lanceolate shape so that stock chupons were easily recognisable.

As very few plantings from seeds produced in the earlier established seed-gardens in Ghana and Malaysia have yet reached bearing age, it is not known how closely the characters and performance of trees in these plantings conform to those in the breeders' trial plots. The designs employed for these seed-gardens have been fairly arbitrary and largely based on inferences from studies made on clones and varieties which may differ in flowering patterns from those of the clones used as parents of hybrid varieties. Many of the questions affecting the design of seed-gardens have yet to be answered.

Different clones have different seasonal flowering patterns and also vary considerably in the numbers of flowers produced. During some periods of the year flower production on one parental clone in a seed-garden could be insufficient to allow adequate interpollination, and in such periods the proportion of contaminant pollinations could be expected to increase.

Another more practical problem is that peak pod production may occur at times when seeds are not usually needed. For example, in Ghana where most plantings are made by beans at stake, conditions are suitable for planting during the main and early minor rainy seasons although less than half the annual crop is harvested during this period. How far pod production from the seed-garden can be manipulated to give a greater proportion of its crop during the periods when seed-pods are most needed remains to be studied.

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Measuring temperatures with thermistors inside a stack of cocoa beans at Apapa.
Photo: J. Riley

Cocoa Storage in Nigeria

A Review of the work of the Nigerian Stored Products Research Institute

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Introduction

Storage facilities for about three-quarters of the cocoa crop in Nigeria are needed because of the concentration of the harvest into the three months October, November and December. Infestation by insects is endemic in the producing areas and increases by multiplication during storage. One of the functions of the Nigerian Stored Products Research Institute and its precursors has been to give advice to the authorities responsible for storage and pest-control problems.

Early research

When the West African Pest Infestation Research Unit began to carry out research on cocoa storage in 1952 infestation by insects was not considered a problem, and fungal attack was kept under control by strict attention to the dryness of cocoa together with legal action to prevent water coming in contact with the beans. Only about 100,000 tons were produced annually at this time and this cocoa was mainly stored in warehouses of about 500-tons capacity, belonging to Buying Agents licensed by the Marketing Boards, and similar warehouses at ports were used as transit sheds.

Research was concentrated on studying the species of insect present in the cocoa, the rate of build-up of infestation and traditional methods of insect control, using sticky strands to trap moths and soap bowls to catch moths and beetles. These methods were only partially effective in controlling infestation.

A paper by Riley (2) shows the typical build-up of infestation found in cocoa stacks, and it is apparent that *Lasioderma serricorne*, the tobacco beetle, and *Cadra cautella*, the tropical warehouse moth, are the major pests of stored cocoa, followed by the flour beetle, *Tribolium castaneum*. Most insect-damaged beans are caused by the two former insects. Examination confined to examining the sievings from whole bags shows only the beetle infestation, whereas the use of sticky traps or suction traps shows the moth infestation clearly. Only one species of moth is involved, however, so the sieving method is the best for a general assessment of infestation. Such an examination of cocoa from a large stack was recorded at a later date by Riley (4) and it is shown that apart from the species damaging the cocoa there are large numbers of other beetles which may be secondary pests or fungus feeders. Of these, *Cryptolestes pusillus* and *Ahasverus advena* seem to be the most numerous followed by *Oryzaephilus mercator*, and the largest beetle present, the predator *Tenebroides mauritanicus* (the Cadelle). This beetle in adult and larva form is a voracious eater of *L. serricorne* larvae, but in the course of its activities extensive tunnelling through cocoa beans occurs. The ratio of *T. mauritanicus* to *L. serricorne* in the survey reported above was 23 to 2,045, based on sieving 92 bags of cocoa.

Introduction of pest control

With increasing attention to hygiene in importing countries, Nigeria had to consider the effective control of insect infestation, and in 1957 a pest-control team was formed under the control of the Produce Inspection Division of the Western State Government.

The procedures to be adopted by the team were discussed with experts from the United Kingdom, in view of the difficulties faced.

Photo: J. Riley *Specially designed cocoa stores at Ikeja.*

Fumigation, the most positive method of insect control, could not be efficiently applied at the Licenced Buying Agents' premises because of the constant trading of cocoa and the resulting cross-infestation after fumigation, and it was understood that physical protection could not be given by covering the stacks because of condensation problems.

Attempts were made to use pyrethrins synergised with piperonyl butoxide applied as a mist in the hopes of controlling the major pests *L. serricorne* and *T. castaneum*. However, experimental work carried out by the West African Stored Products Research Unit showed that the treatment was ineffective and fumigation had to be considered. As a compromise it was decided to fumigate the cocoa at port in the sheds designed for the transit of cocoa from the up-country stores to the ship, and priority evacuation to port of cocoa with more than forty beetles per bag was arranged. Considering that groundnuts may frequently have more than 500 beetles per bag, the level set for heavy infestation in cocoa reflects the higher standard set for the latter where hygiene and flavour are important. Fumigation immediately prior to shipment became the standard treatment. Methyl bromide was applied at a rate of 1 lb. per ten tons of cocoa, using plastic coated sheets or unsupported plastic sheets to contain the gas. There seemed to be no problems using the techniques recommended by Burns Brown (1), somewhat simplified for ease of operation.

Improved storage conditions

With increasing production of cocoa, new warehouses were rented at the port of Apapa, which has always handled the greater part of the cocoa crop. In these warehouses stacks of 1,000 tons were built to a standard rectangular pattern about 110 feet long by 32 feet wide by 27 bags high, and it was felt necessary to carry out a careful study of fumigation techniques and physical conditions in such stacks. Although the warehouses were intended for goods in transit the cocoa was often stored for one or two months before shipment. The warehouses were permanently ventilated and it seemed that the humidity of the environment was such that cocoa would be expected to suffer deterioration through mould if it were in equilibrium with the humidity of the atmosphere. Work done in 1963 by Riley and Rollings (6) showed that temperature rises of up to 7° C. occurred in the central parts of the stack in a period of four weeks. At all layers except the bottom the temperature inside the cocoa stack was higher than that of the air temperature outside the stack (see photo).

Riley (5) repeated the investigations and found that a similar rise in temperature took place. On this occasion the moisture content was recorded, and small but statistically significant changes in moisture content were found to occur.

Of the 70 inner bags chosen 46 showed a fall in moisture content and of the 50 outer bags examined 35 showed a rise. Changes were less than one per cent, however, and the moisture contents were in the region of 7 per cent—just below the level at which mould would develop (8 per cent). Thus, it seemed that large cocoa stacks could maintain their own environment but that care had to be taken to ensure air circulation round the stack. This opinion was borne out when a fumigation sheet was accidently left on a stack for several days and severe condensation led to mould developing on the bags at the top of the stack.

Studies on insect control in large cocoa stacks were carried out in the same warehouses used for physical studies.

Pest control was carried out by the Western Nigeria Produce Inspection Service, now the Western State Produce Inspection Service, but all treatments and methods had to be approved by the Nigerian Stored Products Research Institute, a Federal Government Organisation. The standard fumigant in use, methyl bromide, is heavier than air and tends to sink to the bottom of a stack when released at the top. Thus, high stacks pose special problems.

An analysis of gas concentrations obtained during fumigation of these stacks with methyl bromide is reported by Riley (3) who found that *concentration x time* products of methyl bromide ranged from 132 to 837 milligrams per litre per hour, the higher dosage being at the base of the stack as expected. The lower dosage was considered sufficient to kill all insects, however, and the higher dosage led to bromine residues estimated at 15 parts per million. The permitted limit in the United States of America is 50 parts per million. Accordingly, the treatment could be safely recommended for the large cocoa stacks. During the last few years approximately half the cocoa exported from Nigeria has been fumigated.

Problems of safely storing the increased quantity of cocoa (234,208 tons in 1967/68) led the Western Nigeria Marketing Board to build new cocoa stores about 16 miles inland from the port. Advice on the nature of the stores was given jointly by the Nigerian Stored Products Research Institute, the Tropical Stored Products Centre in Britain and the Building Research Institute in Britain. Six units were built, each divided into six subsections, each capable of holding about 2,400 tons. (See photo). The stores have controllable ventilation and special doors which when closed achieve almost gas-tight conditions, facilitating fumigation without the use of sheets. Once more the Institute investigated fumigation techniques using methyl bromide and also tested phosphine applied in the form of proprietary tablets of aluminium phosphide. The work was reported by Riley and Simmons (7) (8) who found that both fumigants could give satisfactory pest-control of insect pests although some leakage of gas took place through the closed ventilation system, and the levels of methyl bromide concentration were less than those reported from sheeted stacks. Fumigation with methyl bromide remains the standard treatment but phosphine is still under consideration at the present time, and efforts have been made to prevent leakage of gas by more efficient closure of ventilation.

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Cocoa Abstracts

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Ripailles, C., and Rossion, J. Prévisions de récolte pour le cacao. (Forecasting of cocoa crops). Café, Cacao, Thé 12, 2 p. 103-13 (1968).

A method of forecasting the cocoa crop, worked out for the Ivory Coast, is based on pod counts made 3 months before harvesting and 33 and 66 days later. Pods with a length of 6 – 11 cm and longer pods are counted separately; the number of the first category is multiplied by a factor expressing probability of survival, which was determined experimentally. Counts are conducted in fixed plots on a random sample of farms in the main cocoa-growing regions; the national production is estimated by multiplying production in the previous year by the ratio between pod counts in the current and the previous year. The method has yielded estimates within 5 per cent of actual productions for 2 successive years; it is more reliable for the main crop than for the minor crop. English, German and Spanish summaries. Tables.

Madero Sandoval, L. Suelos de las zonas cacaoteras de Venezuela. (Soils of the cocoa-growing regions of Venezuela). Cacao, Bol. Inform. 4, 1, p. 1-40 (1967).

An introduction outlines edaphic requirements of cocoa. Part I contains a brief account of the history of cocoa growing, a general characteristic of the soils, and a review of pedological studies made in each of the main cocoa-growing regions of Venezuela: the central coastal valleys, the Barlovento area, the Catatumbo-Escalante area, the eastern region (including areas of the State of Sucre and the Orinoco delta), and the Yaracuy area. Part II presents similar information on the soils of 2 regions offering prospects for an expansion of cocoa growing: the Barinas area and the area S. of the Maracaibo Lake. Part III compares soils of the Venezuelan cocoa-growing regions with those of Ghana. Table. 20 refs.

Couprie, F. La fermentation du cacao en Ouganda. (Cocoa fermentation in Uganda). Café, Cacao, Thé 12, 2, p. 157-65 (1968).

In Uganda, box fermentation of cocoa was tried in 1963-66 and tray fermentation subsequently. Neither method was completely satisfactory because cocoa is growing at rather high altitudes and, consequently, the temperature of the mass at the start of fermentation is only 20-24°C. A combined technique worked out in 1967 yielded good results, reducing the time to reach 45°C from 81 to 61 hours with Upper Amazon cocoa. Trays are filled as pods are opened but not stacked until all pods have been opened. They are then stacked in piles of 12 trays divided into 4 groups by 3 wooden boards; the pile is put into an isolated box and left untouched for 3 days. The cocoa is then transferred to a box and fermented for another 7 days, the mass being stirred daily. English, German and Spanish summaries. Tables. Graphs. Fig. Photos. 4 refs.

Cacao: Production outlook, 1970-72. Coffee, Cacao J. II, 1-2, p. 6-7 (1968).

A FAO-study of 1966 forecasts a world output of 1·6-1·7 million tons of dry cocoa beans by 1970-72. Whether this estimate will be reached or exceeded depends largely on prices paid to farmers, and on the confidence governments will have in long-term prospects resulting from international agreements. African countries may produce 1·26-1·32 million tons, or 150,000 tons more than in 1964-65. Planting continued until 1965 particularly in the Ivory Coast and in Nigeria. It declined in Ghana after 1961-62. In Latin America, increase of production is estimated at only 25,000 to 40,000 tons. Some planting continued in Mexico, Colombia and Ecuador, and some rehabilitation takes place in Brazil. Plantings in Papua and New Guinea, established since 1955 and covering approx. 50,000 ha, are expected to increase production to approx. 40,000 tons by 1970-71. Table.

Kelly, W. H. Selection of the Lafi 7 cocoa for Western Samoa Trust Estates Corporation. S. Pac. Bull. 18, 3, p. 29-31 (1968).

To replant the old cocoa plantations in W. Samoa, the locally selected clone Lafi 7 has proved to be outstanding. The clone was found to have the following favourable qualities: (1) production of a very large number of large well shaped pods containing 40-50 seeds; (2) a less seasonal bearing, the pods ripening throughout the year; (3) well shaped seeds, having Criollo type characteristics; (4) pods which appear unattractive to rats; (5) pods which are rarely affected by black pod disease, probably because of their ripening pattern early in the harvest season. A yield of 4,000 to 4,140 kg dry cocoa/ha was obtained from cuttings of Lafi 7 as compared with an average production of 625 to 750 kg/ha from unselected seedlings. Favourable results have also been obtained with seedlings derived from this clone. Table. Photos.

Newton, K. Harvesting of cacao in New Guinea. Coffee, Cacao J. II, 1-2, p. 10, 12, 27 (1968).

On the basis of experience obtained in New Guinea, the author presents practical recommendations for cocoa harvesting. On estates in New Guinea, teams of labourers paid on a piecework basis harvest often at 4-day intervals. Area to be harvested may vary each day, depending on seasonal variation in pod production and capacity of the fermentary. The interval between harvests should not exceed 3 weeks. Uniformity in the condition of the wet beans reaching the fermentary will be achieved by completing the harvest needed for any one ferment in a single day and by harvesting only healthy, fully ripe pods. Diseased pods must be removed from the trees to prevent spread of pod rot. Regular shifting of breaking points facilitates the distribution of pod husks as a source of plant nutrients around the farm. Some reference figures of man-day tasks are presented. Fig.

Schulten, G. G. M., and Kuyken, W. "Warehouse moths" and some tropical products stored in the Netherlands. Bull. Dep. Agr. Res. Roy. Trop. Inst. 290 p. 584-92 (1967).

The warehouse moth *Ephestia elutella* is common, and causes each year great damage to cocoa beans and groundnuts stored in the Netherlands. The life-cycle in unheated storehouses in schematically presented. The tropical warehouse moth *Cadra cautella* is often imported with tropical products into the Netherlands. It will not survive a Dutch winter in unheated storehouses. In cocoa beans, time from newly hatched larvae to moths, at 30°C, is 45 days; and in groundnuts 30 days. Control of moths in the warehouses consisted formerly of mistspraying of an insecticide containing pyrethrins and piperonyl butoxide. At present plastic strips containing dimethyl 2,2-dichlorovinyl phosphate (dichlorvos) are widely used. Tables. Fig. 8 refs. Rep. from Meded. Rijksfac. Landbouwwetensch. Gent 32, 3-4 (1967).

Acquaye, D. K. Mineralisation of pod husk. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1965-66, p. 137 (1968).

Preliminary results of investigations conducted in Ghana on decomposition of cocoa pod husks, returned to cocoa plots, showed that most of nitrogen and phosphorous fertilizers, applied at rates of 112-448 kg N and 1,680 kg P/ha, to soil treated with pod husks at 25 tons per ha, were immobilized and rendered unavailable. N applied at the above rates generally had a very small effect on the decomposition of the pod husks. The total K content of the husk was converted into exchangeable form during incubation for 120 days. A higher percentage of husk was mineralized when applied at 25 tons than at 50 tons per ha. Husk particle size had no important effect on the decomposition of pod husk. Fresh wet husk and dried husk decomposed at the same rate.

Asomaning, E. J. A., and Kwakwa, R. S. Physiology of cocoa. Effects of mineral nutrient toxicities on growth of cocoa seedlings. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1965-66, p. 101-6 (1968).

In Ghana, mineral toxicity symptoms were induced in Amazon and Amelonado cocoa seedlings in sand cultures. Excess urea, Mn, B, Zn or Fe produced distinctive toxicity symptoms, which are described. No toxicity symptoms resulted from excess P, K, Ca, Mg, S, Mo or Cu, but seedlings treated with excess N, P, K, Ca, Mg or S generally were bigger and greener than control plants which had normal complete nutrition. Excess Cu, Zn, B or Fe had depressing effects on growth of both Amazon and Amelonado plants. In all treatments, the Amazon plants generally showed higher dry weights, larger leaf areas, stem diameters, stem heights, and numbers of leaves, than the Amelonado plants. Tables.

Lodos, N. Cocoa pentatomid: Bathycoelia thalassina (H.S.). Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1965-66, p. 39-42 (1968).

Studies conducted in Ghana showed that *Bathycoelia thalassina* is not responsible for the distortion of cocoa pods as previously reported by several workers. The insects feed directly on the developing beans which then turn brown; subsequently, the feeding site on the pod ripens prematurely, and eventually the whole pod turns yellow, then brown, and finally black. In general the insect causes more damage and thrives better in Amazon and hybrid types of cocoa which tend to crop throughout the year, than in Amelonado cocoa, which has a more seasonal cropping habit. A preliminary field survey showed that egg parasites play an important role in regulating the population of this pest. Tables. 4 refs.

Lodos, N. Coreid studies; Pseudotheraptus devastans (Dist.). Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1965-66, p. 42-3 (1968).

Considerable pod damage observed in fields of the Cocoa Research Institute at Tafo, Ghana, during 1964-65 appeared to be caused by *Pseudotheraptus devastans*, a new coreid pest. The species, which occurs in central and western parts of tropical Africa, has no preference for size of pods. Few insects lesions on young pods and cherelles may cause wilting, and in older pods heavy malformation. Two sprays of a lindane formulation mixed with sevin at rates normally used for control of resistant mirids, completely freed the infested plots from the coreid population. Table.

Gibbs, D. G., and Pickett, A. D. Distantiella theobroma on plants of different water status. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1965-66, p. 45-6 (1968).

Experiments conducted in Ghana on the effect of water stress in cocoa plants on development of the capsid *Distantiella theobroma* showed that larvae developed readily on fully watered plants but usually survived less than a week on seedlings kept under severe water shortage. While on fully watered plants young tissue was not attacked, on "lower water" plants the retarded young leaves were usually affected. "High and intermediate water" plants which developed side-shoots tended to show more stem damage than did those without side-shoots. The characteristic drop in capsid number in the field towards the end of the dry season is very probably due to the combined effect of water stress and external desiccation. Further tests have suggested that internal nutritional properties of the plant are important as well.

Marchart, H. Fumigant action of lindane. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1965-66, p. 48-9 (1968).

To test the fumigant action of lindane for control of *Distantiella theobroma* capsids, 2 concentrations of lindane, viz. 0·28 and 0·56 kg a.i. per ha, were mist blown on cocoa trees in Ghana; 5 minutes after application gauze cages containing 150 4th and 5th instar larvae were placed in the treated area at 1·50 m and 4·20 m above the ground. In a plot treated with 0·28 kg a.i. per ha, pods were collected subsequently, and placed with capsids on it at the sites of the cages to study contact action combined with fumigant action. Mortality of the capsids was recorded hourly. The results indicate that the fumes generated by the sprays did contribute substantially to the efficiency of lindane. Table. 2 refs.

Marchart, H. Capsid movement experiment. Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1965-66, p. 54-55 (1968).

Distantiella theobroma larvae (4th and 5th instars) were released on small cocoa trees at 3 different sites in Ghana, and upward and downward movements of each insect recorded in terms of cms per insect per hour. With adults and the larvae, a resultant average upward movement of 9·1 and 0·63 cm/hr, respectively, was observed. Activity of the insect was highest under open canopy, less under partial canopy, and lowest in cocoa trees under closed canopy. These findings agree with the observation that in cocoa grown under shade capsid damage tends to concentrate in pockets, while in unshaded cocoa plantings damage usually is of a more diffuse character.

Plummer, C. R. Tray fermentation of cocoa. Coffee, Cacao J. II, 1-2, p. 14-5 (1968).

In the Solomon Islands where cocoa areas are scattered and communications are poor, tray fermentation could have advantages over box fermentation. Small-scale trials using Trinitario cocoa resulted in a product with good flavour and better uniformity than with box fermentation; results obtained with 3 to 8 trays were similar to those of overseas workers using 12 trays in the stack. Apart from the bottom tray, a uniform temperature of 47°C was reached in all trays at the end of the 2nd day. A 4-day fermentation period gave the best results. Wooden trays of $120 \times 90 \times 10$ cm, the bottom being made up of dowels of 6 mm each, with 12·5 mm beading, were used. After 24 hours of fermentation the whole stack was covered with a stitched sack until the end of the fermentation. Fig. 4 refs.

February 1969

Smith, F. E. Influência do BHC e do Aldrinna germinação e crescimento inicial do cacaueiro. (Effect of BHC and aldrin on germination and initial growth of cocoa plants). Cacao; Inst. Interam. Ciencias Agr. 13, 1, p. 1-3 (1968).

A pot trial was conducted in Bahia (Brazil) to study the effect of BHC (1, 3 and 6%) and aldrin (5%) on the initial growth of cocoa. The pots received 8 g insecticide by 2 applications of 4 g each; the first incorporated in the soil at sowing time, and the second applied to the soil surface at the time the cotyledons fell off. At the 15th day after sowing, germination was retarded in all treatments. From 30 days after sowing, no real difference was noted in germination and development of plants between plots treated with BHC (1%) and aldrin (5%) and the controls, whereas BHC (3% and 6%) continued to depress germination and to kill the plants eventually. The second application of BHC (1%) and aldrin (5%) did not result in growth retardation or phytotoxic effects. English summary. Table. 6 refs.

Quesnel, V. C. Oxygen consumption and heat production during the fermentation of cacao. Turrialba, Rev. Interam. Ciencias Agr. 18, 2, p. 110-4 (1968).

In Trinidad, oxygen consumption and heat output of box fermenting cocoa beans were calculated from daily determined ethanol and acetic acid contents of pulp adhering to the beans. Whereas ethanol content increased the first 2 days and then decreased, acetic acid content increased continuously. Assuming that ethanol completely penetrates the cotyledons, calculated oxygen consumptions were about 20 times the air space volume of the fermenting mass. When it is assumed that ethanol does not penetrate the cotyledons, calculated oxygen consumption was about 100 times the air space volume of the fermenting mass. In both cases, calculated temperatures were lower and considerably higher (from 3rd day on) than were the observed temperatures, respectively. Spanish summary. Tables. 14 refs.

Ascenso, J. C. Cacao budding in São Tomé. Trop. Agr., Trinidad 45, 4, p. 323-9 (1968).

The cocoa tree is usually grown from seed, although several methods of vegetative propagation are now available. In São Tomé, an island at the west coast of

Africa, patch and inverted T budding methods were tested in the clonal multiplication of cocoa. Topworking by patch budding of chupon branches emerging from cut-back adult trees was fairly satisfactory and time saving. Percentages of successful unions varied from 50 up to 80. Some 1,452 buddings were performed using the inverted T method of budding on to yellow Amelonado seedling stocks raised in polythene pots; of these buddings 63 to 90% were successful. Union failures were often caused by *Phytophthora palmivora* infection which is controllable with 0·3% cupric oxychloride sprays. Table. Figs. 8 refs.

Bhat Shama, K., and Leela, M. Cacao and arecanut are good companions—for more cash. Indian Farming 18, 4, p. 19-21 (1968).

Trials conducted at Vittal in Mysore (India), showed that there is no competition between cocoa and arecanut (*Areca catechu*). Cocoa has shown encouraging vegetative growth with early bearing habit. The climatic requirements of cocoa seem to be met well by the conditions prevailing in arecanut gardens. In this article, attention is paid to shade for cocoa, especially at the seedling stage, and during the first years of the life of the cocoa tree. Cultural practices are described briefly.

Newhall, A. G., et al. Control of Phytophthora pod rot on cacao with fungicides. Results of three experiments. Cacao; Inst. Interam. Ciencias Agr. 13, 1, p. 3-13, (1968).

Three field trials were conducted in Costa Rica to study the effects of mist-blowing of copper and organic fungicides on the control of *Phytophtohra* pod rot of cocoa. The results are presented and the economics of the different treatments discussed. $CuSO_4$ is still the most effective fungicide, but $Cu(OH)_2$, CuO and CuOC1 may be good substitutes. Frequent treatments commencing 2 to 3 months before harvest peak will yield the greatest returns. Addition of lindane appeared to increase the number of harvested pods still more, and was found to be economic. Spraying of shaded cocoa resulted in higher bean production than did spraying of unshaded cocoa. The number of applications required should depend on factors such as rainfall, size and development stage of the crop, and number of pods per tree. Spanish summary. Tables. Graphs. 9 refs.

Smith, E. F., et al. Ensaio de insecticidas no combate a insetos filógos do cacaueiro, no Espírito Santo. (Experiment on insecticidal control of leaf-eating cocoa insects in Expírito Santo). Comun. Técn., CEPLAC 14, p. 1-8 (1968).

Colaspis and *Nodonota* spp. (*Coleoptera, Chrysomelidae*) and *Lordops, Naupactus* and *Lasiopus* spp. (*Coleoptera, Curculionidae*) are the main leaf-eating insect pests of cocoa in Espirito Santo, Bahia (Brazil). Experiments were conducted to test the effect of 6 insecticides. The results assessed in terms of average number of insects killed 24 hours after treatment showed that dusting with BHC (1 and 1·5%) or endrin (2%) was more effective than dusting with folidol (2%), malatol (4%) or diazinon (1·5%). BHC (1·5%) applied at a rate of 15-17 kg/ha was very effective in the control of all the species, whereas BHC (1%) at the same rate only effectively controlled *Chrysomelidae*. Tables. 3 refs.

Maravalhas, N. Secagem mecânica do cacau fermentado. Novos tipos de secadores (Mechanical drying of fermented cocoa. New types of dryers). Cacao; Inst. Interam. Ciencias Agr. 13, 1, p. 13-8 (1968).

Literature on mechanical drying of cocoa beans is reviewed and information is presented of 2 dryers originally developed for coffee and cereals, and of a new dryer developed for cocoa by Cepec, Bahia (Brazil). The new dryer is more efficient and practicable than the 2 other dryers. It has a capacity of 200 to 1,300 kg dry beans per 12 to 15 hours and a very low fuel consumption; the beans are turned mechanically during drying. Tests showed that mechanically dried beans were plump and showed a better colour, less tendency to internal mould and, contrary to the findings of other workers, a reduced volatile acidity as compared to sun dried beans. Its external appearance was equal to that of the best "danced" beans. English summary. Tables. Photos. 12 refs.

March, 1969

Piñal Rivero, C. S. del, and Acuña Gale, J. Fisiología floral del cacao. (Flower physiology of cocoa). Rev. Agr., Cuba 1, 3, p. 82-111 (1967).

In Cuba, the flower morphology and flowering cycles of cocoa are described and the techniques and results of pollen viability tests and compatibility tests conducted with 6 UF clones from Costa Rica are presented. It was concluded, among others, that: (1) abundant flowering occurs from June to Nov. under favourable conditions of humidity and decreases thereafter gradually; under severe drought flowering decreases, however, earlier and abruptly; (2) flowers normally open at 7 p.m.,* but remain closed or half-opened almost the whole day at temperatures of approx. 15°C; (3) pollen collected 1 to 2 days after exposure to temperatures of 14°C or less germinate slowly; (4) of the 6 UF clones tested UF 221 appears to be self-compatible, and UF 667 and UF 613 highly self-incompatible. English summary. Tables. Graphs. Figs. Photos. 5 refs.

Weststeijn, G. Susceptibility of some cacao clones and seedlings to Phytophthora pod rot disease. Mem. Cocoa Res. Inst. Nigeria 16, p. 1-11 (1967).

In Nigeria, the incidence of pod rot from July to Jan. and the annual pod losses in cocoa caused by *Phytophthora palmivora* were calculated for a large number of clones and seedling trees on the basis of harvest recordings made from 1963/64 to 1965/66. The clones and seedling trees were arranged in 6 susceptibility classes. Most of the S. American and Trinitario clones were found to be susceptible (up to more than 60% infection) and only 2 clones were fairly resistant (5-15% infection). Some clones and seedlings, although being susceptible (15-60% infection), partly or completely escaped from infection because their fruiting periods fell between February and May or later in the dry season. However, such clones may be of practical use only in areas with a marked and sufficiently long dry season. Tables. 4 refs.

Renovacão mal conecou. (Renewal has hardly started). Coopercotia, 25, 226, p. 18-21 (1968).

About 60% of the cocoa plantations in the State of Bahia in Brazil are over 50 years of age. Mean yields per ha declined from 654 kg in 1939 to 315 kg

**Editor's Note:—The abstract gives the time of flower opening as 7 p.m. The original paper has not been consulted but the time of opening of flowers is generally accepted as early morning. See, for instance, Entwistle, H. "Cacao Pollination" Proc. Cacao Breeding Conf. Tafo 1956, 19-20.*

nowadays. Absenteeism of landowners and traditionalism hampers technical improvements. An integrated programme of technical assistance and rural welfare was started some years ago. Plantations older than 40 years are uprooted and rejuvenated by planting new trees of better quality. Preference is given to a variety with white cotyledoned seeds, resistant to *Phytophthora* and yielding around 1,200 kg/ha on farm level. Scarcity of plant material has limited the rate of renovation. Within 5 years 50,000 ha will be replanted, representing 33 % of the total area required. Landownership, social conditions in rural areas, and the techniques of the renovation of the old cocoa plantations are briefly discussed. Photos.

Dakwa, J. T. Black pod disease. The effects of infection with viruses and Phytophthora palmivora on cocoa seedlings. (Ann.) Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1966-67, p. 33-5 (1968).

In Ghana, Amelonado cocoa beans were infected with one of the following virus isolates. New Juaben (1A-virulant), Mampong, Bisa and Kpeve. The infected seedlings were root inoculated with *Ph. palmivora*. The different viruses in combination with the fungus affected more markedly the development of the seedlings than did the fungus alone. Seedlings infected with AD7 or AD75 CMLV-isolates from *Adansonia digitata* showed wilting 13 days after inoculation with the fungus, but were fully recovered by the time of harvesting; seedlings infected with AD75 virus recovered earlier. The cumulative effects of AD36 or AD191 isolates from *A. digitata* and the fungus were smaller than those of the AD7 or AD75 isolates and the fungus. Tables.

Roivainen, O. Control of mealybugs with systemic insecticides. (Ann.) Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1966-67, p. 39 (1968).

In Ghana, mealybugs (*Pseudococcoides njalensis*) on mature cocoa trees were controlled with 2 systemic insecticides. Azodrin or bidrin painted on the trunk at the rate of 3,000 to 5,000 p.p.m. a.i. per weight of the aerial part of the tree reduced mealybug population to 1 mealybug per tree or less. The same degree of control was obtained by pouring the insecticide into 4 holes near the base of the tree at the rate of 150 to 450 p.p.m.

Dakwa, J. T. Black pod disease. Obomeng variety trial. (Ann.) Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1966-67, p. 30-2 (1968).

Data for yield and black pod disease (*Phytophthora palmivora*) incidence in 19 different cocoa selections, recorded in Ghana from 1963-64 to 1966-67, are, presented in tabular form. Of all the selections (except 1) at least 1 parent mostly of the Trinitario type shows a certain resistance to black pod. The data indicates, however, that none of the selections can be called resistant, although 2 selections gave a marked lower disease incidence with relatively higher yields. Two selections, having the susceptible Nanay 32 (Amazon type) variety as a parent, consistently yielded well, but showed a high incidence of pod rot. Table.

Lodos, N. Studies on mirid parasites. Investigation of egg parasites of mirids. (Ann.) Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1966-67, p. 39-40 (1968).

Studies were conducted in Ghana on the biological control of the cocoa mirids *Helopeltis bergrothi*, *Bryocoropsis laticollis*, *Distantiella theobroma* and *Sahl-*

bergella singularis by egg parasites. Mirid-damaged pods were cut with the entire peduncle on which mirids usually lay their eggs. Peduncles which had unhatched eggs were examined in the laboratory. The methods and problems of this investigation are briefly recorded. It was found that egg parasites of mirids emerged 3 to 5 days later than did the mirid nymphs. In the field, parasitism of the eggs of *H. bergrothi* and *B. laticollis* seemed to be higher than that of other mirids of cocoa. Mirids may have some active parasites in other cocoa-growing regions of the world.

Missiaen, E. Nationhood set for Equatorial Guinea, key African cocoa grower. Foreign Agr. Serv. U.S. Dep. Agr. 6, 41, p. 7-8 (1968).

Equatorial Guinea, one of Africa's smallest countries but 5th largest cocoa exporter, became independent in Oct. 1968. Over 90% of the country's cocoa is produced on the island of Fernando Po, which is a much more developed province than the Rio Muni province on the mainland, where the main products are coffee, timber, and cocoa. The growing conditions for cocoa in both areas are described. The country's production of cocoa and to a smaller degree of coffee is presently quite profitable, because Spain buys almost the whole output at prices above world level. Considering the Spanish price support and the Spanish consumer taste (the cocoa is bitter due to the reduced time of fermentation), it is expected that the major part of the country's cocoa will continue to be exported to Spain for some time to come.

Newton, K. Box fermentation of cacao in New Guinea. Coffee, Cacao J. II, 3-4, p. 44-6 (1968).

Recommendations are presented for box fermentation of cocoa in New Guinea, with special reference to the construction of the sweat-boxes, fermentation length, frequency and method of turning, depth of beans in the boxes, interrupted fermentation, and sampling for the determination of the optimum fermentation length. The optimum bean depth was found to be 75 cm; length and width of the boxes should be adjusted to the needs. Turning should be done daily and the beans are to be removed in layers. This results in a better and more even temperature pattern, lower acidity and a more even fermentation than with turning at 2-day intervals. Interrupted fermentation was not found to give better results. In determining the optimum fermentation length, samples should be taken each day from different depths before 8 a.m. and be sun dried.

April 1969

20 mil hectareas en cacao siembran en Uraba y Antiguo Caldas. Se invertiran 130 millones de pesos en cinco años. (Planting 20,000 ha of cocoa in Uraba and Antiguo Caldas. An investment of 130 million pesos in 5 years). Arroz 17, 180, p. 12 (1968).

A cocoa development project is being planned for several regions in Colombia. The establishment of 20,000 ha of cocoa in Uraba and in the district of Antiguo Caldas is the first stage of this project. The main purpose is to provide employment and an improved living standard to farmers. Of the 130 million pesos to be invested within a period of 5 years, 20 million pesos will be used the first year for granting loans to the farmers who will cultivate the new lands.

Roussel, M., and Couraud, A. Notes sur le bouturage du cacaoyer à la Station d'Ambanja (Republique Malagasy). (Notes on the rooting of cocoa cuttings at the Ambanja Station (Madagascar). Café, Cacao, Thé 12, 3, p. 215-22 (1968).

The methods of cocoa propagation by cuttings applied at Ambanja in Madagascar are described. The cuttings are grown in permanent pots (perforated polythene bags). The pots are placed in polythene-covered propagators. The cuttings are recut at the base at an angle of 45° and are dipped in a 2:1 mixture of exuberon V and charcoal powder before they are placed in a fine sandy medium in the centre of the pots. The hardening-off starts 6 weeks thereafter, the first 10 days at 25% light intensity and the next 2 months at 40% light intensity. With the best growing and yielding clones (20% of the Trinitario and 1% of the Criollo clones), a rooting percentage of 85 has so far been obtained. English, German and Spanish summaries. Photos.

Keleny, G. P. Storage, transport and packaging of cacao seed. Coffee, Cacao J. II, 5-6, p. 68-70 (1968).

Methods of handling cocoa seeds and pods for dispatch as recommended in a number of cocoa producing countries are summarised. The methods of seed and pod treatment vary largely and depend on time interval from dispatch to arrival. Basically, they are aimed at prevention of attack by micro-organism and at conservation of the moisture content of the seeds. The results depend on factors such as treatment of the seeds or the pods, storage conditions and duration of the transport, maturity and conditions of the pods, and parent tree. Transport of seeds is often preferred to that of pods since pods may carry pests and diseases, and the transport of pods is more expensive and less practicable.

Pickett, A. D. Greenhouse experiments on the influence of psyllids on the growth of young cocoa trees, and field observations on their effects on mature trees. (Ann.) Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1966-67, p. 55-62 (1968).

Experiments conducted in a greenhouse in Ghana showed that the growth of young cocoa plants may be delayed seriously by heavy attack of psyllids (*Mesohomotoma tessmanni*). The plants recovered soon after the insects were withdrawn. Under less favourable conditions prevailing in the field damage will probably be more serious. The mere deposition of eggs in young leaflets results in desiccation and death of the tissues; if the leaves continue to grow, small dark-coloured necrotic areas around the eggs develop and later on small holes are left in the leaves. The damage caused by nymphs which feed on developing buds and leaflets is more serious. The damage caused by psyllids may be distinguished from capsid damage by the absence of dead attached leaves. Tables.

Asomaning, E. J. A., and Kwakwa, R. S. Physiology of cocoa. The potassium requirements of young cocoa plants. (Ann.). Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1966-67, p. 87-92 (1968).

A pot trial was conducted in Ghana to study the effect of 5 different K levels, viz, 20, 60, 120, 180 and 240 p.p.m. in nutrient solutions, on the growth and dry weights of Amelonado and Nanay (Amazon) cocoa seedlings. From the results it was suggested that K requirements of the 2 varieties are quite different. Total dry weights of the Nanay plants were generally higher than those of the Amelonado plants at 6, 12, 18, 24, 30, 42 and 54 weeks after planting. Whereas the growth of Nanay plants at the highest K level was optimal at the first 4 harvests the lowest K level was even significantly sub-optimal for early growth of Amelonado plants. It seems that the higher K requirements of the Nanay plants cannot be attributed to the naturally bigger growth of these plants. Tables.

Okaisabor, E. K. An active fungal parasite of Phytophthora palmivora. PANS; Sect. B. Plant Disease Control 14, 4, p. 353-60 (1968).

In Nigeria, a fungus which was isolated from black-pod disease lesions on cocoa pods was found to be actively parasitic on *Phytophthora palmivora*. Parasitic hyphal coils around chlamydospores are formed which are later penetrated by infection hyphae. The cell contents of sporangia and hyphae of *P. palmivora* become disorganised, and finally disintegrate in double cultures of the host and parasitic fungi. Pure cultures of *P. palmivora* are easily destroyed and rendered uninfective by the parasitic fungus. A biological method of controlling black-pod disease may be feasible in future. From author's summary. Tables. Figs. 3 refs.

Lodos, N. Potential major pest: Bathycoelia thalassina (H.S.). (Ann.) Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1966-67, p. 41-5 (1968).

A recent survey conducted in Ghana showed that *Bathycoelia thalassina*, which is a pest of cocoa, is a polyphagous species. In the field, nymphs and adults of the pentatomid were found feeding on the fruits of *Kigelia africana* (*Bignoniaceae*), *Cucumeropsis edulis*, *Coccinia barteri* (*Cucurbitaceae*) and *Randia longiflora* (*Rubiaceae*). In the laboratory it was successfully bred on the fruits of the egg-plant. Studies conducted on egg parasites are described. *B. thalassina* has quite a number of egg parasites; however, parasitism is not high enough. To keep down its population, it is recommended: (1) to plant Amelonado cocoa which produces 2 yields a year instead of hybrid or Amazon types which produce the whole year; (2) to avoid host plants in the plantations.

Pickett, A. D. Test on young cocoa trees with the systemic insecticides—azodrin and bidrin. Plot H10 Square Mile, C.R.I.G. (Ann.) Rep. Cocoa Res. Inst. (Ghana Acad. Sci.) 1966-67, p. 64-5 (1968).

At Tafo in Ghana a block of about 600 cocoa trees was stem-painted with 50% azodrin in Dec. and a similar block was sprayed in Jan. with 0·25% azodrin (50%). The treatments were repeated at monthly intervals. In the control plots, the numbers of psyllids (*Mesohomotoma tessmanni*) did not decrease before the April flush and substantial numbers of capsids appeared. In the treated block, capsids, aphids, psyllids and mealybugs were almost completely controlled. Up to the end of Sept. about 72% of the capsids removed from the control plots were *Distantiella theobroma* and 28% *Sahlbergella singularis*. Adult psyllids, invaded from nearby untreated trees, caused damage by oviposition in the treated blocks; however, the nymphs did not develop. Table.

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