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Editorial

The swing of the pendulum

Six months ago the cocoa-growing industry was depressed by surpluses which had been increasing year by year and had reached a critical level. Prices had fallen to the lowest level for many years and were well below the cost of production for many growers. As manufacturers we recognise that this position is unhealthy and if it continued it would not be in the long-term interests of either consumers or producers. For this reason we support an international scheme for regulating cocoa prices.

The major difficulty with the cocoa crop is the way in which yields fluctuate from year to year, resulting in sharp changes in the cocoa market. In this respect we must admit that cocoa does not compare favourably with other tropical plantation crops. These fluctuations are difficult, if not impossible, to predict. The steep increase in production that took place in Ghana in 1960 and 1961 was due largely to spraying, and might have been predicted, but the more recent increase in the last crop seems to have been due to weather conditions. This underlines our ignorance of the influence of the weather on the cocoa crop. What features of the 1964 weather pattern in West Africa were so favourable for cocoa? Is a good crop inevitably followed by a poorer one? How much rain, and at what stage in development of the crop, is ideal? What climatic factor influences bean size? These are questions to which there is no answer at present. This suggests a field of research which is largely unexplored, and the findings of which would be of benefit to producers and consumers alike.

G. A. R. Wood.

Suchard

This is the fourth in a series of articles on the larger cocoa and chocolate manufacturers. The first three dealt with Cadbury, Nestlé and Rowntree

Origin

For nearly 150 years the Suchard name has been so intimately connected with quality chocolate that very often, more or less the world over, one has become synonymous with the other.

The foundation of Suchard goes back to 1826 when, at the age of 29, Philippe Suchard created in Neuchâtel, a Swiss town on the shores of the lake of the same name, the small enterprise which was to become, in course of time, the important Suchard Group.

Philippe Suchard was a man of initiative and imagination, and he was one of the outstanding figures of Switzerland's economic development. He was a pioneer in all he did, and not only created one of the first chocolate firms in Switzerland, but also introduced many other industries, such as the working of asphalt mines, the cultivation of silk-worms, and workshops for cutting precious stones for use in watch-making. He was the founder of shipping companies for navigation on Lake Neuchâtel and the Rhine. A keen traveller, he visited the U.S. where he founded the Swiss Colony. Philippe Suchard was undoubtedly a personality in the full meaning of the word. He not only gave his name to the Suchard firm but also his dynamism which has animated the executives of the company to this day.

From the small beginnings at Neuchâtel Suchard has grown to its present size, and now not only does the factory cover the greater part of the small village of Serrières on the outskirts of Neuchâtel, but Suchard also embraces a range of factories throughout the world.

Towards the end of the last century, and again in the beginning of this, factories were established in the following centres:
Lorrach, Germany 1879; Bludenz, Austria 1888; Paris, France 1903; San Sebastian, Spain 1909; Varese, Italy 1923; Zaventem, Belgium 1924; London, England 1932; Buenos-Aires, Argentina 1932 and manufacturing arrangements also exist in South Africa, U.S.A. and Mexico.

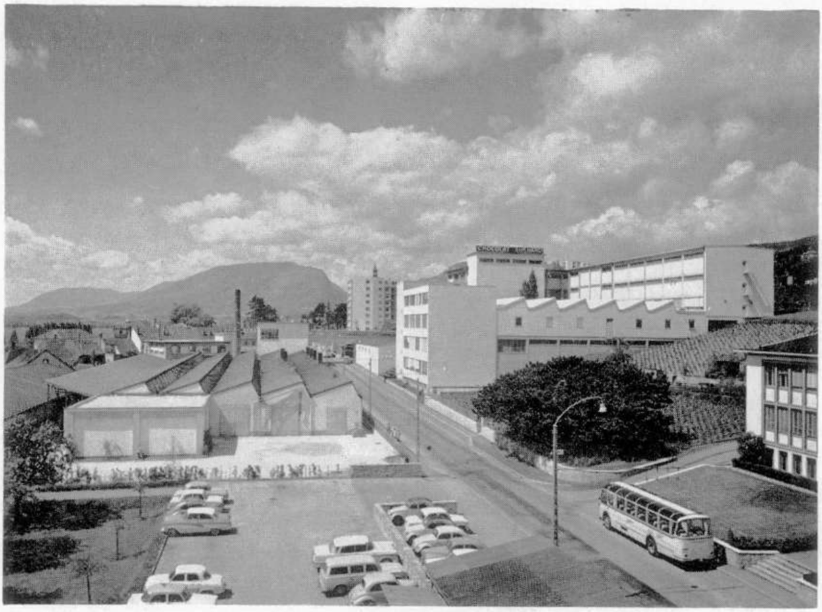
Factories had also been established in Roumania and Poland before the last war but these are no longer under Suchard control.

It has been the policy of the Suchard Group, in whatever country they manfacture their products, that their image, which is synonymous with the high quality and standard of Swiss chocolate, as well as their own specialised presentation, should be maintained.

In addition, from an early start of the activities of the Suchard Swiss factory, exports have played an important part in the development of the Company's activities, and Suchard chocolate products have been exported to every part of the globe for many years.

Following the development of Suchard factories in various countries, there was a natural development in export, in particular to the Colonies and areas under the influence of each country where Suchard chocolate was manufactured.

In the post-war years, with the rapid growth of independent nations previously linked with European countries, export policy has necessarily been revised, but although the Swiss factory still dominates world markets, export continues to be actively pursued by the whole Suchard organisation.



The original Suchard factory at Serrières, Neuchâtel. Photo: Fernand Perret.

New building for the Company's technical services, Serrières. Photo: Willy Gloor.

Suchard specialises in quality chocolate

The Suchard policy throughout the years has been to concentrate on chocolate and chocolate products rather than a diversification in other food fields. In some factories, however, they have widened the range and entered into general confectionery, in particular with the "Sugus" Fruit Caramels, which have over the years won recognition in several of their manufacturing markets as well as in the export field.

Generally, however, concentration has been on the development of chocolate products in the widest sense, and the Suchard range now embraces a selection of products in the tablet, filled tablet, chocolate bar and chocolate confectionery and chocolate beverage sections to suit every taste, not only throughout the year but with a wide variety of special presentations for the Easter and Christmas Seasons.

In order to maintain the Suchard standard of quality and presentation and to keep abreast of the constant developments in the chocolate field by carrying out wide research, including conservation and manufacturing problems, Suchard Holding Ltd. have set up two distinct sections to provide these central services.

The economic, commercial and financial aspects of management, as well as the protection of industrial property and trade marks, are controlled from the commercial Head Office of the Group in Lausanne.

From the technical point of view a "Services Techniques" has been established in the village of Serrières, adjacent to the main Suchard factory, in a separate building specially designed to house the several technical laboratories and experimental departments, as well as drawing offices and engineering sections necessary to a world-wide Group.

Furthermore, by continuous experimentation and research into all aspects of chocolate manufacture and scientific developments in this field, the Central Services can greatly assist development throughout the Group.

The Engineering section are also organised to assist in planning factory expansions and design for the Group as a whole, as well as centralising research and information on the wide range of machinery and plant development which is now available to the chocolate manufacturing industry.

A further function of the Services Techniques is in the training of Suchard technicians, who obtain a wide knowledge of every aspect of chocolate manufacture during their stay with the Technical Services.

A Liberal Policy

It must not be thought because such wide Central Services are supplied by the Head Office organisation that the individual development and activities of the overseas companies are restricted. Each company is an individual organisation with its own Board of Directors and Management and is to a large degree autonomous under the guidance of the parent company.

This autonomy is particularly marked in the policy and decisions regarding the purchase of cocoa beans and other raw materials. Although guidance is given by the Central Services the responsibility for such purchasing rests in the hands of each local Management.

Senior members of the various Suchard factories have in the past taken, and continue to take, an active part in various organisations and associations concerned with the supply of raw materials, particularly cocoa.

Review of Production and Consumption

Production

We publish overleaf some of the figures of production and grindings that were issued by F.A.O. in October 1965.

The figures issued six months earlier (quoted in Bulletin No. 5) showed a surplus of 43,000 tons resulting from the 1963-64 crop and a surplus of 241,000 tons in comparing the estimated 1964-65 crop with a forecast of 1965 grindings. More accurate figures are now available and these surpluses have been reduced to 38,000 and 196,000 tons respectively; the latter figure will probably be revised again when final figures for grindings in 1965 are issued.

The early estimates for the coming year prophesy a sharp swing from surplus to deficit, the deficiency forecast by F.A.O. being 57,000 tons. Other forecasters have estimated larger deficits. This change is due to lower crops from West Africa and an increase in grindings.

If, as seems likely, the 1964-65 crops for West Africa reached record levels owing largely to favourable weather conditions, then it seems highly probable that these conditions would not be repeated and that current crops will lower. Current estimates of the crops in Ghana, Nigeria and Ivory Coast show sharp decreases, and the weekly purchasing figures reinforce these opinions.

Grindings

There is no doubt that the lower prices that prevailed in 1965 have stimulated consumption, which is estimated to have risen by 139,000 tons in 1965, an increase of nearly 12 per cent. A further increase of 7-8 per cent is forecast for 1966.

G.A.R.W.

WORLD COCOA PRODUCTION AND GRINDING FIGURES

issued by FAO in October 1965

(Thousand metric tons)

PRODUCTION

	1963–64	1964–65	1965–66 (estimate)
Africa	899·5	1,193·2	995·7
South America	201·5	203·3	241·3
North and Central America	100·7	98·9	99·1
Oceania	22·3	24·4	29·5
Asia	7·2	7·8	7·8
World total	1,231	1,528	1,373
Principal countries:			
Ghana	427·7	580·0	457·0
Nigeria	220·3	298·3	254·0
Ivory Coast	98·2	147·0	120·0
Cameroun	85·0	94·0	95·0
Spanish Equatorial Region	31·0	33·0	30·0
Brazil	125·0	108·0	150·0
Ecuador	36·0	50·0	45·0
Dominican Republic	44·7	40·0	40·0
Mexico	30·7	30·0	30·0
New Guinea and Papua	17·0	21·5	25·0

GRINDINGS

	1964	1965 (forecast)	1966 (forecast)
Western Europe	528·2	566·8	586·7
Eastern Europe	64·9	73·5	80·0
U.S.S.R.	67·0	90·0	95·0
North America	282·7	302·0	324·0
Central America	49·8	45·9	48·0
South America	92·3	98·7	110·3
Asia	41·2	47·2	51·5
Africa	49·4	90·8	117·5
Oceania	17·1	17·0	17·1
World total	1,193	1,332	1,430
Surplus (Prod. > Grind.)	38	196	—
Deficit (Grind. > Prod.)	—	—	57

How Useful is Soil Chemical Analysis?

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There was a time, not very long ago, when all scientists who worked with soils were automatically referred to as "soil chemists" and in most cases the description was probably accurate. Today, however, the study of soils has developed into a science of its own which, like other sciences, employs a wide variety of specialists. Indeed, the true soil chemist, primarily interested in the chemical analysis of soils and its interpretation, is now in a minority amongst his colleagues who specialise in such fields as soil survey, soil fertility, soil physics and soil microbiology. Yet the average educated farmer, or general agriculturalist, still pins his faith on soil analysis. If he has a soil problem, he asks for his soils to be "tested", and expects this to be done in a laboratory. His faith is understandable. But how far is it justified? Only the laboratory can give him information on the amounts of "N, P and K" in his soils, of the essential nature of which he is daily assured in fertiliser advertisements and pamphlets. Furthermore, the precision of laboratory data instils him with confidence. But how meaningful are these precise figures? How much can he rely upon them to guide him in his farming practice? This article seeks to place the value of soil analysis in perspective amongst other fields of soil and plant science, with special reference to the guidance sought by a cocoa farmer.

The first problem facing a potential cocoa farmer is the choice of a suitable site for his trees. Later he may want to know what is wrong with his cocoa or, if its growth is satisfactory, he may wish to learn how to improve his yields. In so far as these problems relate to soil factors, their solution depends on our ability to determine the characteristics of the soils concerned and to establish the relationship between these characteristics and the requirements of the cocoa tree. This may seem an obvious statement, but it serves to emphasise the main difficulty in making use of soil chemical analysis data, for it is extremely difficult to relate such data to the nutritional requirements of plants, especially tree crops. It is worth considering why this should be, before going on to discuss the application of soil analysis to each of the problems listed above.

Problems of Interpreting Soil Analysis Data

Plant nutrients are present in the soil in a variety of forms, not all of which are equally available to the plant. The first problem, therefore, is to find a means of extracting for analysis only those nutrients in the soil which would be available to the plant. Unfortunately there are large gaps in our present knowledge of the mechanism by which plants absorb nutrients from the soil. Several hypotheses have been advanced and, indeed, it is very possible that plants absorb nutrients by different processes simultaneously (1). Lacking any firm guidance in this direction, therefore, soil chemists have developed a variety of methods for extracting nutrient solutions from the soil for analysis. It is realised that these methods are unlikely to have any direct relationship to the processes employed by the plant, and different values for the content of "available" nutrients in a particular soil are obtained by using different extracting agents. Nevertheless, by field and greenhouse experimentation, it is often possible to calibrate these different values with actual crop performance and to select the method which gives the closest correlation. It is important to emphasise, however, that correlations obtained with any given method can only be applied with confidence to the limited range of crops and soils on which calibration trials were conducted. In some areas, notably the humid tropics where cocoa is grown, attempts to correlate determinations of "available" nutrients with crop performance have met with very little success, even with short-term arable crops, for which the experimental problems are much less formidable than met with in a tree crop such as cocoa.

A second problem arises when we attempt to set values for optimum levels of individual nutrients, for we cannot assess these without taking account of the levels of other nutrient elements present in the soil. As far as we know, the major plant nutrients, nitrogen, phosphorus and potassium, are absorbed by plant roots almost independently of one another. But there are antagonistic effects between other groups of nutrients; excessive concentrations of potassium, for example, are known to suppress absorption of magnesium, manganese, zinc and other nutrients. Many other examples of the effects of nutrient imbalance could be quoted. Although plant growth may be satisfactory under a wide range of conditions, provided sufficient amounts of each nutrient element are present, problems related to imbalance may greatly complicate the interpretation of analysis data for marginal soils. As yet, there is insufficient knowledge available to establish "limits of adequacy" for ratios between all the different groups of nutrient elements. The problem is very complex, for acceptable ratios are likely to vary in different environments, in different soils and even for different crops. We must also recognise the possibility of trace element deficiencies, or toxicities, in the soil, which may not be detected by normal analysis procedures but which could make nonsense of the most carefully considered analysis interpretation. Fortunately such instances will be rare in the areas potentially suitable for cocoa.

Further problems are concerned with the time and depth of soil sampling for analysis. The time factor affects both the chemical status of the soil and the nutrient requirements of the plant, which may change at different stages of growth, and, with perennial crops, during different seasons of the year. Whilst some chemical properties, such as lime and phosphorus status, remain fairly stable in most soils throughout the year, there is often considerable fluctuation in the availability of other nutrients, particularly nitrogen. These fluctuations are due to changes in moisture and temperature and to related changes in the activity of micro-organisms. Much research remains to be done in order to establish the time, or times, of the year at which sampling for analysis will provide the most valuable indications in relation to the requirements of cocoa.

For deep-rooted plants, especially trees, analysis of samples obtained from the top few inches of the soil clearly does not provide an adequate basis on which to predict crop performance. Even with cocoa, which usually develops a large proportion of its feeding roots in the surface horizons, we can scarcely ignore the possible nutritional contribution of deep-seated roots. Yet truly formidable problems are involved in attempting to arrive at an integrated assessment of soil potential based on the analysis of samples from different depths, especially in the tropics where dramatic changes in nutrient status between surface and subsurface horizons are the rule.

Locating areas suitable for cocoa

In considering how soil analysis can help in the location of areas for cocoa planting, it is convenient to distinguish between investigations in areas where cocoa has never been grown before and the selection of new sites in established cocoa-growing areas.

In the first case, the support of soil analysis data can be regarded as essential for it provides a means of distinguishing soils which, although similar in their morphology, differ widely in their chemical characteristics and thus in their ability to support cocoa. In this context, the chemical determinations which are most helpful are those which give information on the ability of the soil to store and release nutrients (base exchange capacity) and on the extent to which this storage capacity is already filled with nutrients (base saturation and pH). Since we are concerned here with major differences in soil characteristics rather than with subtle differences in the balance of individual nutrients, the difficulties described in the previous section scarcely arise.

Within areas in which cocoa farming is already an established industry, much greater reliance can be placed on the study of physical soil characteristics in the selection of sites for new cocoa farms. Unless there are marked changes in land-form, geology or climate within the area, we are justified in assuming that the nutrient status of the soil is, in general, satisfactory. Indeed, the relative nutrient status of different soils can usually be inferred with considerable confidence on the basis of field investigations alone. It is noteworthy that in both Ghana and Western Nigeria, where the most extensive surveys for "cocoa soils" have been carried out, the classification of soils in relation to their suitability for cocoa has been based almost entirely on their physical characteristics (2, 3). In Western Nigeria it was possible to show that such a classification provides a reliable guide to sites on which cocoa will grow successfully (3).

The solution of nutritional problems

Soil analysis might be expected to provide valuable assistance to the cocoa farmer in the solution of problems of poor growth due to nutrient deficiency. In fact, this is rarely so. The existence of deficiencies is usually detected by observation of the symptoms which are induced in the tree itself. Because these symptoms have received extensive study, they often provide a reliable guide to the actual nature of the deficiency, which can frequently be confirmed by chemical analysis of parts of the tree, usually the leaves. Even when there is strong reason to suspect a deficiency of a particular nutrient element, soil analysis may, or may not, confirm a shortage of this element in the soil, for failure to absorb the element may be the result of antagonism with other nutrients or the result of other conditions in the soil, such as high or low pH. For the same reasons, together with our lack of knowledge of levels of adequacy for different nutrients, particularly trace elements, deficiencies of minor nutrients can very rarely be predicted by the study of soil analysis data.

On the other hand, soil analysis may prove very useful in pointing to the causal factors of other growth problems which are less obviously related to nutrition. By way of example, data obtained by Kowal (4) from the analysis of soils under 14-year-old cocoa planted at different spacings and of a soil under forest, in adjacent plots in Western Nigeria, are quoted overleaf:

Spacing of Cocoa	Depth	pH	Carbon %	Nitrogen %	C/N	Base Exch. Capacity m.e./ 100gms.	Total Exch. Bases m.e./ 100gms.	Base Satn. %
5′×5′	0—4″	6·45	2·11	0·222	9·6	7·7	6·6	86
7½′×7½′	0—4″	6·20	2·06	0·196	10·5	7·3	5·7	78
15′×15′	0—4″	6·00	2·05	0·188	10·9	6·8	4·7	69
Forest	0—4″	6·40	2·83	0·270	10·5	11·4	10·3	90

All the soils analysed by Kowal belonged to the same soil series and little morphological difference was detectable between them. The impoverished nutrient status of the soils under cocoa, especially at the wider spacings, in relation to the soil under forest is clearly apparent from the analysis figures, however, and Kowal further states that the level of individual exchangeable bases under cocoa was only 50 per cent of that found in the soil under forest. Data such as these may provide a valuable clue towards an explanation of the difficulties experienced in West Africa in attempting to rehabilitate old cocoa farms by planting new cocoa.

Obtaining increased yields from good quality cocoa

In many areas, the application of fertilizers undoubtedly offers one of the most promising methods of increasing the yield of healthy cocoa. It would be very convenient if "quick" chemical tests of the soil could be devised for predicting the fertilizer needs of individual cocoa farms. Unfortunately, all the problems of interpreting soil analysis data, which were discussed earlier, militate against our achieving this aim. Indeed the possible addition of nutrients to the soil in the form of fertiliser creates new problems of interpretation, as well as aggravating the older ones. In addition to assessing the effects of the added elements on nutrient balance, for example, an attempt has to be made to estimate the proportion of these added nutrients which will be immediately "locked up" in insoluble forms unavailable to plants, a proportion which in many tropical soils will be substantial. The failure of soil analysis to solve the nutritional problems of cocoa is partially responsible for intensive research into obtaining the required information by analysing the leaves, bark and incised roots of the cocoa tree itself. But these methods have their own problems and, as yet, there is no satisfactory substitute for field experimentation to establish the fertiliser requirements of cocoa.

Conclusion

In this article the problems at present associated with interpreting soil analysis data have been emphasised. The reader should not conclude, however, that the chemical analysis of soils is useless in cocoa research. In the same way as a physician may call for laboratory analysis of samples to confirm his patient's well-being, so a soil surveyor or soil fertility specialist may turn to the soil chemist for confirmation of the fitness of their soils for any particular purpose. In both cases the analysis may show that all is not well. This is very valuable information in itself, but in neither instance can we assume that the laboratory alone will be able to reveal the exact cause of the trouble or point a way to a cure. In seeking solutions to soil problems we must employ the whole armoury of modern soil and plant science within which soil chemistry is but a single weapon.

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Is Chemical Clearing a Possibility?

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The choice in opening up tropical forest for plantations is mainly between burning and not burning. Food crops are normally planted at close distances, 3 ft. × 1 ft. to 3 ft. × 3 ft., and it is only by burning that the ground can be cleared of the great mass of felled vegetation and made accessible for planting food crops such as maize and cassava. Perennial crops such as cocoa, coffee, rubber and oil-palm are planted at wider spacings, varying from 10 ft. × 10 ft. for cocoa and coffee, 20 ft. or 30 ft × 10 ft. for rubber and 30 ft. × 25 ft. for oil-palm. In the first years after planting only a relatively small part of the total cleared area is utilised, and actually only points or strips would have to be cleared to plant these crops. The disadvantage of not burning would then seem to be that the working conditions in the plantation are more difficult and that the cost of establishment and early maintenance is likely to be increased.

The effects of burning on the soil organic matter are much debated. It is certain that the litter layer is largely destroyed by the burn and thus the bare soil is exposed to sun and rain. Rain on an unprotected soil surface causes serious degradation; the soil compacts, surface run-off increases, and especially on a sloping surface, erosion can become serious. In the absence of leaf litter there is nothing to check surface flow of water. The soil surface should, therefore, be kept protected as much as possible against the impact of heavy rain.

Mulches could have an important part to play in the protection of exposed forest soils; however, it would be too expensive to cover the soil with mulch directly after burning. Another good method is to sow leguminous cover crops, but even if this is done just after burning it takes a considerable time before the soil is completely covered; in the meantime the harm is already done.

The method here described is an alternative. It consists of two measures: the killing of the forest trees by chemicals and the establishment at stake of a crop in the poisoned area.

It is a common practice in many countries to use chemicals for the destruction of trees. Arboricides (chemical tree-killers) are used for selective thinning in commercial forests; for poisoning shade trees in cocoa plantations; and for poisoning of old rubber trees before replanting on rubber estates.

Sodium arsenite seems to be the most reliable arboricide and probably the cheapest. However, it is extremely toxic to human beings and animals and great care must therefore be taken in handling it. After girdling the trees, sodium arsenite is applied to the wound. Girdling implies removal of bark together with deeper-seated tissues to form a continuous strip around the tree, a measure still relatively expensive in labour.

Experiments with arboricides containing 2,4,5-T have been carried out since 1961, at the Agricultural Research Station, Kade, which is part of the University of Ghana. The results of the experiments can be summarised as follows:

(*a*) A 2½ per cent solution of Trioxone-100 in diesel oil—that is, one part Trioxone-100 mixed with 39 parts of oil—applied to the bark of trees killed 30 to 40 per cent of the trees in three months and 70 to 80 per cent

A clear-felled area.

Felling the jungle by hand.

in six months. Over 90 per cent of the trees were dead one year after poisoning.

(*b*) Girdling increased the cost of application considerably, but application of the solution to a girdle was no more effective than bark treatment.

(*c*) There seemed to be no difference in the mortality rate (=number or percentage of dead trees) whether the solution was applied in the wet or in the dry season.

(*d*) If other arboricides containing 2, 4, 5-T are used the active ingredient of the formulation should be taken into account to obtain the same effect as with Trioxone-100. This chemical contains 10 lb. active ingredient per gallon. If, for instance, an arboricide containing 5 lb. active ingredient per gallon is used, twice the amount of this arboricide should be mixed in diesel oil to obtain a similar mortality rate as with Trioxone-100.

As the solution is applied to the bark of trees, an oil is required as a carrier. At Kade, diesel fuel oil was used for this purpose. The use of oil has the advantage that it can be applied effectively during the wet season as it is not subject to dilution by rain water.

The arboricides containing 2, 4, 5-T have no harmful effect on man if handled in a normal careful way. The solution may be mixed in any 1- or 2-gallon container and is then applied to the bark of trees with a paint brush. The mixture is painted round the bole of the tree at a height suitable to the operator, and in a band twelve to fifteen inches in width. It is advisable to remove any vines or creepers from the area to be painted before application, in order to ensure a complete coverage. Thorough wetting is essential, but liquid running down the trunk indicates excessive application and is a waste of material.

Most species of forest trees reacted quickly to the application; some trees of more tolerant species had to be re-treated.

Disintegrating trees.

Young cocoa trees, two-and-a-half years after planting, in a poisoned area.

The procedure at Kade was to underbrush and fell those trees which had a girth of less than one foot. After that the remaining trees were poisoned.

On average there were 147 trees per acre with a girth of one to three feet; thirty trees with a girth of four to six feet; twelve trees with a girth of seven to nine feet; and nine trees with a girth of more than ten feet.

Some of the trees killed by the poison were as big as those cut for timber, and an axe-man would have raised a platform in order to fell them.

Four labourers were able to poison approximately 200 trees per acre in one day, using eight gallons of the $2\frac{1}{2}$ per cent mixture of Trioxone-100 in diesel oil. The cost of poisoning one acre of forest came to £8 12s. 0d.

Underbrushing ..	14 m.d. at 7s. ..	£4 18s. 0d.
Poisoning: Labour ..	4 m.d. at 7s. ..	£1 8s. 0d.
Solution (8 Gallons) ..	..	£2 6s. 0d.

The cost of clearing one acre of forest by hand will vary with the type of forest and the crop to be planted. In 1964 a maize farm was established at Kade. The normal farmers' way of clearing was used, leaving the larger trees standing. The clearing cost per acre was £26 14s. 0d.

Underbrushing ..	14 m.d. at 7s. ..	£4 18s. 0d.
Felling of Trees ..	34 m.d. at 8s. 6d. ..	£14 9s. 0d.
Trashing and burning ..	21 m.d. at 7s. ..	£7 7s. 0d.

Perennial crops such as rubber and oil-palm are normally established on clear-felled land. To provide easy access to a plantation it is necessary to remove some of the timber from the planting points or rows. The cost of clearing a rubber plantation at Kade averaged £43 per acre.

Underbrushing ..	14 m.d. at 7s. ..	£4 18s. 0d.
Felling of Trees ..	46 m.d. at 8s. 6d. ..	£19 11s. 0d.
Trashing and burning ..	25 m.d. at 7s. ..	£8 15s. 0d.
Cutting and removing of timber ..	28 m.d. at 7s. ..	£9 16s. 0d.

In some of the rubber experimental areas all the timber was lined in the 20 ft. wide inter-rows. The cost of clearing, cutting the trees into suitable lengths and lining the timber came to as much as £80 per acre.

These figures indicate that chemical clearing is much cheaper than hand clearing; when felling by axe, trashing and burning have to be carried out.

After poisoning an area in September 1961, lines four feet wide and ten feet apart were clean-weeded on half-an-acre. As there were no large logs or other timber in the way, as in a clear-felled area, pegging and clearing of the lines took only five man-days per acre. Ungerminated cocoa seeds of Amazon types were planted at 2-ft. intervals in the row; this high initial stand was chosen to compensate for the expected damage from falling timber.

The dead trees generally remain standing for some time and gradually disintegrate, doing relatively little damage even when the trunk eventually falls. It should be realised that the falling parts of the tree are totally dried out and therefore reduced in weight. Some damage to the young stand is inevitable, and although the extent of it is variable, the damage was not more than 10 per cent in the first three years after planting. The damage is of various kinds—a clean break of the stem, breaking of branches, a young tree bent over and held down by the weight of timber, bark scraped off by a glancing blow from a falling branch. The damage can often be cured by pruning, as the young plant will put out a new shoot.

Since the damage was considerably less than expected, a large number of the cocoa trees were thinned out in June 1964, three years after planting. Poisoning being the most convenient method of getting rid of the unwanted trees, a 2½ per cent solution of Trioxone-100, in diesel oil, was applied to a band of bark at a height convenient to the operator. All the treated cocoa trees were dead within one month. The first cocoa pods were harvested in October 1963.

The results obtained from this small-scale trial were therefore very encouraging, and in November 1961 an area of 18 acres was poisoned and planted with cocoa at stake at 10 ft × 2 ft. The cost of poisoning and planting was £10 6s. per acre, including the cost of the 2½ per cent solution of Trioxone-100 in diesel oil. During the following dry season the foliage still gave sufficient shade to prevent the moisture from evaporating too quickly from the soil. The cocoa seedlings developed well under these conditions; by the time the root system was well developed and the foliage of the cocoa plants partly covered the soil, the poisoned trees had lost their leaves, smaller branches and part of the larger branches, and the condition in the plantation resembled very much those of a clear-felled area. Some replanting of cocoa seedlings and repoisoning of trees was necessary in the first year. The cost of these measures and of general maintenance came to £13 per acre. The maintenance costs, including capsid control, in the second and third year were £7 5s. and £8 10s. respectively. These costs are less than those for maintenance on the clear-felled cocoa plantings at the station. The damage due to falling timber was again very limited, and thinning of cocoa trees was necessary.

One may argue that the system described is dangerous for men working in a poisoned area. One should indeed be very careful and not enter the poisoned area after heavy rain or in strong winds. To limit the danger to men working in the poisoned areas the method of chemical weed control could be adopted. By using chemicals that prevent weed growth for several months (e.g. simazin), workers will only have to enter the area a few times a year.

Another possibility is to poison an area one or two years before planting. A large number of trees will have come down by the time of planting. The few trees still alive could be felled just before planting.

Since more light will reach the undergrowth this will have developed and the cost of underbrushing before planting may be somewhat higher, but the advantage of undisturbed, unexposed soil is still there.

In conclusion we point out that for various reasons, such as the rising cost of labour, it becomes important to search for cheaper and better ways of establishing and maintaining plantations of perennial crops. Further, it is of first importance to keep the organic matter content—mainly located in the top layer of the forest soil—at as high a level as possible. The system described in this article may be one of the possible ways of achieving these aims.

The interesting points are:

(*a*) Low costs compared with the normal method of clearing by hand and burning.

(*b*) No exposure of the bare soil after clearing, and therefore reduced soil deterioration.

(*c*) Good growth and early production of cocoa trees.

Although the results and the costs of the first years of the experiments cannot be regarded as conclusive, they provide evidence that the poisoning method has been used cheaply and successfully. It may therefore be worth while to try this method in commercial plots of perennial crops such as cocoa, rubber and oil-palm.

An important point to consider is to what extent the shade should be removed. The experience at the Agricultural Research Station, Kade, showed that, if too much shade is removed in the initial stages of a plantation, cocoa has a difficult time to survive. Leaving too much shade on the other hand means delay in coming into bearing. When planting cocoa one may consider leaving a few of the emergent forest trees to provide shade. This will also limit the danger to man and may reduce the damage to the crops still further.

When rubber or oil-palm are planted—crops that need full light for optimum development—all the trees should be poisoned.

Photographs on pages 13 and 14 by the author.

Cocoa Mirids
Part 2. Their Control

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It was mentioned in the first part of this article (1) that mirids became known as pests of cocoa in Ceylon as early as 1863 and that by 1910 their destructive nature had been noted in the Gold Coast and Cameroon in West Africa. It is thus scarcely surprising that the history of attempts at their control covers a considerable period of time. The advent of the chlorinated hydrocarbon insecticides, which were first used in cocoa about 1945, conveniently divides this period.

Control up to 1944

Probably the first attempt at mirid control was in Ceylon in 1907 where the spraying of sulphur and of Macdonaghues' mixture (constituents unknown) proved a failure. In 1910 trials with kerosene/soap emulsion in the Gold Coast produced only a low mortality in the insects, and attempts with Bordeaux mixture were soon abandoned. Also in the Gold Coast, in 1943 (2), sprays of 40 per cent nicotine sulphate at dilutions as low as 1:1,500 were reported to give complete control, but unfortunately required the application of up to four gallons of fluid to each mature tree, an almost unmanageable volume. 30 lb. per acre of a 7½ per cent nicotine dust was also effective.

Tar and petroleum distillates (in the form of the proprietary "Tropical Mortegg") had also been tested and found unsuccessful, partly due to the severe leaf scorch caused at dilutions appropriate for acceptable levels of control (2).

Meanwhile the Dutch planters had been active, principally in Java. Apart from being the only people to make successful use in cocoa of a natural vegetable insecticide, derris, which they did from about 1939 onwards*, they can claim to have originated, undoubtedly in desperation, the most bizzare method of control ever used. This consisted of burning *Helopeltis* feeding on pods by means of a petrol-soaked pad on the end of a long bamboo pole (3). They can also take the credit for having been the only people to successfully control cocoa mirids biologically. They achieved this by increasing the numbers of the "black ant" *Dolichoderos bituberculatus*, by disseminating "artificial" nests. The ants were persuaded to nest in bundles of banana or cocoa leaves. For a while there was a steady trade in such nests, and although this ant proved to be aggressive to both *Helopeltis* and to man, making work in the plantations uncomfortable, some idea of the esteem in which it was held can be obtained from a notice displayed at the entrance of one large plantation in Java, "Zonder Zwarte Meinen Geen Cacao" (without black ants—no cacao) (4).

This healthy, vigorous approach to cocoa mirid problems was not universal. In 1944 Silva (5) wrote of the plantations in Bahia (Brazil) that chemical control was not possible due to the large area to be covered, its difficult topography,

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*Pyrethrum and derris were tested in the laboratory in the Gold Coast in 1943, found to be good, but apparently never tried out in the field.

A simple knapsack sprayer with lance for treating young trees.

the high cost of materials, lack of skilled labour and the small margin of expenditure. He suggested that cocoa mirid attack might be discouraged by raising the level of available phosphoric acid in the soil by applying potash after the manner in which tea *Helopeltis* had been said to be controlled in Ceylon. Indeed he might have had a sound precedent in the Belgian Congo where as early as 1930 it had been reported that one plantation had completely thrown off attack by *Sahlbergella singularis* two years after treatment with superphosphate (6).

1945 onwards

The discovery, in the mid 1940s, of insecticidally-active chlorinated hydrocarbons revolutionised the possibilities of mirid control. This period also saw the appearance on the market of several types of easily portable motor-powered spraying machines which, with low volume spraying techniques, were to conquer those three problems of cocoa pest control—access, difficult terrain and shortage of free water. By 1948 work had started at the West African Cocoa Research Institute (W.A.C.R.I.) in the Gold Coast, where it was soon shown that good control could be achieved with a 2.5 per cent solution of D.D.T. This was applied by a brush to the jorquette and to branch unions, the resting places of mirids, on seedlings and younger trees and by pneumatic knapsack sprayers to older trees (7). By 1953 W.A.C.R.I. had begun an experimental comparison of D.D.T. with another promising chlorinated hydrocarbon, gamma-benzene hexachloride (B.H.C.), and showed the latter to be superior to D.D.T. even at much lower concentrations. Mirid control by B.H.C. as an emulsifiable concentrate was further developed by the Gold Coast Department of Agriculture in co-operation with a commercial company in 1954-56 (8), work which resulted in the first firm control recommendations to be issued in the Gold Coast. These were that, using motor-powered knapsack machinery, four applications should be made each year, in June and July and in October and November, the object of the second half of each double treatment being to destroy mirids which had emerged from the eggs present at the first application. Excellent control was achieved by spraying an initial 4 oz. toxicant and subsequent 2 oz. applications each in five gallons of water per acre.

Following on this, emulsifiable concentrates of B.H.C. came to be widely used throughout West Africa, the means of application varying with the country. In Nigeria pneumatic knapsack machines were employed because very many farmers already possessed these for black pod control, whilst in the Ivory Coast and in Cameroun, where much spraying was done directly by the government, Swingfog machines, in which B.H.C. is vapourised in diesel oil and by which large acreages may be treated quickly, were much used. The time of application also varied, with the mirid season, from place to place.

Mention must be made of the most interesting method of control, combining the use of a 2·2 per cent B.H.C. dust with general plantation sanitation practices, which was evolved at the Lukolela Plantations in the Belgian Congo (9 and 10). The growth of all trees was arrested by pruning chupons from below the first jorquette so that the trees would not grow too tall to be treated with simple hand dusters. All trees were inspected at monthly intervals, when excess chupons, pods infected with black pod disease, damaged and mirid attacked branches were removed and trees with fresh mirid attack dusted. The method was economic and very good yields were obtained (over 1,000 lb. dry weight cocoa per acre). Trials to assess this method, comparing D.D.T. as a dust and an emulsion, were set up in the Gold Coast, where the emulsion proved the most efficient.

Subsequent to the successful application of B.H.C., of which wide use was made outside West Africa, several other chlorinated hydrocarbons became available and were tested, mainly at W.A.C.R.I. in Ghana, but also in some

A mist-blower being used to treat mature trees.

Young cocoa trees being sprayed with insecticide.

other West African countries. Of these the most promising was aldrin and, indeed, this was recommended on grounds of economy for general use in Sierra Leone (11). It has also been used to some extent in Nigeria.

In 1959 Armstrong (12) in Ghana began the laboratory evaluation of a very wide range of insecticides, including not only chlorinated hydrocarbons but also organo-phosphorous compounds, carbamates and others. Some of those he found to be most promising were tested in field trials in 1960.

The discovery that *Distantiella theobroma* in Ghana (13) and *Sahlbergella singularis* in Nigeria (14) were showing signs of resistance to cyclodiene chlorinated hydrocarbons lent considerable impetus to this programme as the need to find an alternative means of control became pressing. Two main candidate insecticides, carbaryl and fenitrothion, emerged as most promising and the large amount of data obtained on these should soon lead to the formulation of practical recommendations for the use of one or both.

Selection and testing of insecticides

Before an insecticide can fairly be recommended for general use in cocoa it must undergo rigorous tests which are outlined here.

1. *Efficiency evaluation.* An insecticide which shows up well in laboratory tests may not at first stand up so well under field conditions. This is often a matter of application methods; the highly volatile toxicant, the success of which in part depends on a fumigant action, may not need to be as evenly and efficiently distributed during application as one which is not volatile and depends entirely upon contact for action. In early field trials carbaryl was applied like B.H.C. and the results were poor, but when an application technique was developed which took cognizance of the non-volatile nature of carbaryl very much better results were obtained. Formulation may also be important; it has been shown several times that dusts are less effective vehicles in cocoa than are liquids.

2. *Effects on the tree.* The principal adverse effect which insecticides have been noted to have on cocoa is leaf scorch. This has been particularly noticeable with emulsifiable concentrates of D.D.T. at around 5 per cent, but it is not certain if this is caused by the insecticidally-active principle or by some constituent in the formulated product.

Some insecticides, even when applied only to the aerial portions of the tree, show systemic activity; that is, they are absorbed into and moved about by the sap stream. There is always a danger that such chemicals may be deposited in the beans and eventually end up in the manufactured product. Consequently, tests for toxic residues and for taint in fermented and dried cocoa beans are carried out extremely carefully before recommendations for the general use of the insecticide are released.

3. *Effects on insects other than mirids.* The provocation to increases in numbers of insects normally only of minor importance as crop pests has often resulted from the inept choice or misuse of insecticides. A number of occurrences of this nature has been seen in cocoa (15) and each has been clearly traced either to the too-frequent application of a non-persistent insecticide or the use of a highly persistent one. Those insects which have so far been concerned are all either borers in wood or mine beneath the epidermis and are thus protected for a considerable period of their lives from the effects of contact insecticides. Increases in number result from a differential action of an insecticide upon such insects and their parasites, greater numbers of the

parasites than of the host insect being destroyed. On small sprayed areas this effect may pass unnoticed because parasites from adjacent untreated areas of cocoa can easily migrate into the treated area and redress the host/parasite balance, but on large areas such migrations take much longer and hence very considerable damage can result. Furthermore, the larval period of some wood-boring insects is very long, with the result that population upsurges may take up to 18 months to manifest themselves (and conversely a very long time to disappear). Consequently, in testing candidate insecticides for this effect it is essential that the experimental plots be large (10 acres is suggested as minimal) and observations be carried out for two years before conclusions are drawn, unless a very clear effect has appeared before the elapse of this period.

4. *Toxicity to man.* It is of very great importance that the toxicity to man and domestic animals and to wild life of an insecticide intended for use in cocoa be very carefully considered. A highly toxic chemical should never be placed in the hands of peasant farmers, who may not only not appreciate its dangers, but may actually misuse it, as for instance as a fish poison with resultant far-reaching contamination of public water supplies.

Mirid resistance to insecticides

The first instance of resistance to an insecticide was of *Helopeltis* in Java to D.D.T. (Laoh, 1953) though this does not appear to have been fully confirmed. In 1963 (13) it was reported that *Distantiella theobroma* was, in some areas of Ghana, showing resistance to all the cyclodiene chlorinated hydrocarbon insecticides (B.H.C., aldrin, dieldrin, endrin, thiodan, etc.), and that in one small area of Nigeria *Sahlbergella singularis* had begun to show similar tendencies (14).

These events, whilst serious enough, were to have been expected after spraying on a considerable scale over a period of years, and serve to point out the need to seek several chemically unrelated insecticides so that swift changes in control materials may be made when necessary. They also emphasise the desirability of investigating certain other control possibilities that have begun to open up in recent years, such as the use of chemosterilants and the employment of identified sex-attractant substances for bait-trapping of male insects.

Mirid numbers, even when at the population peak, are not large compared with those of many other insects when at pest levels. Also the distribution of cocoa mirids in the field tends strongly to discontinuity. These two facts together do not favour control by parasitic insects, low numbers of hosts retarding increase in numbers of parasites and discontinuity of distribution hindering parasite spread. Biological control seems thus to be limited to two possibilities: by predator or by pathogen.

Some investigations into predators have already been made, mostly in the ants, but apart from parasitic fungi the pathogens of mirids remain unexplored. It should be remembered that some pathogens may be introduced into insect populations by spraying and that they may at times pass from generation to generation through the egg offering extended control possibilities.

Plans are already afoot for the investigation of some of these control possibilities, the early reports on which must be eagerly awaited by many people.

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The Tolai Cocoa Project, New Guinea

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Introduction

Rabaul, the main town in the New Guinea Islands region of the Trust Territory of Papua and New Guinea, is situated in the north-east corner of the Gazelle Peninsula in New Britain. It is the centre of a large area of rich volcanic soils, ideally suited for the cultivation of coconuts, cocoa and other crops. The terrain is undulating, rising from sea level to an altitude of 1,200 ft., the higher ground being dissected by a number of steeply cut valleys. The region carries a large population of about 45,000 people, known as Tolai; they are probably the most advanced people in the whole of the Trust Territory, a fact which may be attributed to the fertile soils and the proximity of Rabaul.

Prior to 1914, at which time the Germans occupied New Guinea, considerable areas of land were alienated from the Tolai, and large coconut plantations established. Cocoa was introduced during this period but was never developed seriously as an economic crop. During the Australian Mandate, from 1918 to 1942, experimental work was conducted at the Keravat Experimental Station near Rabaul, and a few Tolai people planted blocks of cocoa. Production amounted to 100–200 tons per annum before the outbreak of war with Japan stopped further development. After the war cocoa was planted extensively on plantations, frequently as an inter-crop with coconuts, and also by the Tolai people who have planted four million trees. Exports from the Rabaul area were about 8,300 tons last year; of this total the Tolai Cocoa Project processed about one quarter.

Rainfall in the area ranges from 90 inches in Rabaul, to as high as 150 inches per annum in some of the more hilly areas. During the north-west monsoon season, rainfall is heavy and cloud coverage may persist continually for periods up to three weeks.

The cocoa is a Trinitario type which is highly variable, and as the planting material being distributed is derived from this type, it displays this lack of uniformity. A good deal of selection work has been done at the Lowlands Experimental Station at Keravat, but this is slow work and much remains to be done before more uniform types can be made available. The variations in bean type give rise to problems with fermentation; the weather also contributes to make processing by individual Tolai farmers hazardous. In the early '50s a few growers had already started to process beans and had produced cocoa of very inferior grade.

Legislation had been passed to assist in disease and pest control, and the same ordinance gave the Department of Agriculture powers to compel growers to register their cocoa blocks and plant at least 500 trees, properly spaced, lined and shaded.

It became obvious that some form of organised processing and marketing should be introduced. About this time Local Government Councils had been established amongst the Tolai, so a plan for a number of small processing centres, to operate within the Council structures, was formulated, finance on a limited scale being made available from both the Councils and the Department of Agriculture. These centres, nine in all, were duly built and utilised bush materials, depending mainly on sun-drying. By 1954 it was necessary to review this first phase, as the crop was rapidly increasing and the Tolai were still planting cocoa extensively. At that stage over two million trees were planted, and most of these were due to come into production within two years.

The Project

A series of conferences between the departments concerned with the Tolai Councils and growers decided that immediate action would have to be taken to augment the existing scheme and place it on a more substantial basis. After a number of proposals had been investigated, it was finally decided to negotiate a bank loan, guaranteed by the Administration, to each of the five Local Government Councils for the purpose of enlarging the existing fermentaries and establishing a number of new centres. The Councils were primarily responsible for the repayment of the loans, which was to be charged against each ton of cocoa produced. The repayment rate was originally set at £A35 (thirty-five pounds Australian) per ton but this was subsequently adjusted and now represents roughly 10 per cent of the net return per ton.

The loan was negotiated and became available at the end of 1955, and the Project started operations in January 1956. The Administration appointed three officers to act as Manager, Field Manager and Accountant, their salaries being paid by the Administration; this was the only financial assistance given to the scheme by the Administration. These officers operated through a central office in Rabaul and were responsible for the executive work, marketing, accounts and general field supervision. They were assisted by a team of English-speaking clerks who worked at the various centres.

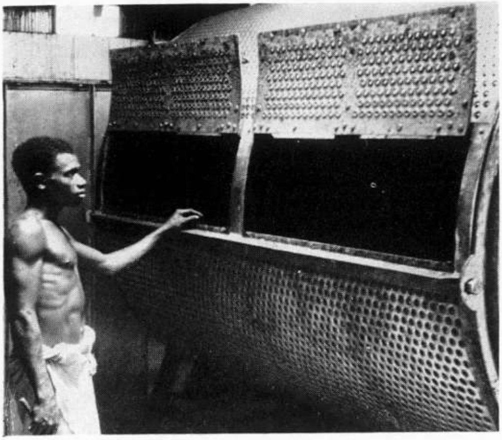
During the nine years the scheme has been in operation only minor modifications to the original scheme have been necessary. At the present time the Project operates eighteen processing centres placed at strategic points in heavily-planted localities. The project operates as a non-profit, public utility type of organisation but has no legal entity; this means that the assets of the project are vested in the Local Government Council—the original five Councils have been amalgamated into a single body, the Gazelle Local Government Council—which is a corporate body. Only major policy changes have to be referred to Administration headquarters in Port Moresby; general control of the scheme rests with a Board of Management. This board is composed of:–

(a) The Deputy District Commissioner who acts as Chairman.
(b) The district Agricultural Officer or his representative.
(c) The Manager of the Project.
(d) Eighteen elected representatives, one for each of the eighteen fermentaries.
(e) Four appointed representatives of the Gazelle Council.

Regular meetings of the Board decide general policy, approve expenditure and discuss the general operations of the Project; delegates are informed about the work of the central office, marketing and loan situation, etc.

General Operations

Growers make their own arrangements for the delivery of wet cocoa beans to the fermentaries. Over 500 Tolai people own trucks or utilities. Groups of growers hire these or use bicycles or small handcarts or, if their cocoa block is near to the processing centre, they carry the beans. Growers receive an advance payment of about two-thirds of the value of their beans and every six months they receive a final payment, representing the balance of cash available after all expenses have been deducted.



A rotary drum drier.

"Universal" hot-air or sun drier showing fan and duct work.

Hot-air or sun drying platform at a Project fermentary.

Growers are issued with discs showing the name of the fermentary and an identification number—this is necessary as Tolai names are frequently duplicated. A roll book records this number together with other relevant details of the grower's name and address. Upon delivery, beans are weighed and a docket given to the grower. This shows his name and number, also gross, tare and net weights and the amount advanced. The fermentary clerk uses the duplicate of the docket to enter in his records. These consist of the following:–

1. Wet-Bean Sheets—which show details of all deliveries to a centre and the amounts of each advance. These sheets must balance and are checked monthly at the central office. Monthly totals for each grower are also entered on an additional sheet, which, when completed every six months, becomes the "final pay sheet" and enables the central office to calculate the rate and amount due to each grower as a final settlement.

2. Growers' Cards—these give a complete record of all deliveries by each grower. This is necessary to establish individual equity in the scheme if and when this needs to be done.

In addition to the above records, the clerk is expected to maintain a simple cash book system and a record of production and shipments. The latter shows ferment number, total wet bean intake each week, estimated and actual dry bean weights for each week, bag numbers and details of deliveries of bagged cocoa. All records are regularly checked at the central office in Rabaul which maintains a complete set of control ledgers, etc. However, each centre is treated as a separate entity so that some centres may pay growers more than others—this, of course, depends on their efficiency and encourages a centre to produce superior beans in order to obtain a premium. The central office prepares balance sheets and operating accounts half yearly and these, together with the books, are submitted to public auditors for checking.

Equipment

A brief summary of the type of equipment which has proved satisfactory for New Guinea conditions is given below:–

Scales. Large clock-face scales are used so that growers may themselves check their wet bean weights. The scales need to be sturdy and corrosion-proof for they are subjected to damp conditions and the acid drippings from wet cocoa. A type of scale used in the U.K. for weighing fish has proved highly satisfactory, after the scales were "rat-proofed"—small rodents found them highly satisfactory as nesting places. (Avery Model 3205 CLM 300 lb. capacity).

Fermenting Vats. These are standardised throughout the scheme. They are constructed of local hardwood planks, $1\frac{1}{2}''$ thick. The vats may be dismantled when required to facilitate cleaning. Individual vats are $6' \times 5' \times 3'$ and have a capacity of about 4,000 lb. of wet beans. They may be erected in batteries of any number, depending on the size of the shed housing them. The Project experimented with $1''$ thick marine plywood—made with waterproof glue—but the constantly damp, acid conditions to which vats are subjected affected the glue, and the plywood layers tended to separate and break.

For turning fermenting beans and handling them in and around the centres, ordinary shovels with blunted edges are used. They do not cut the beans, nor has the steel any adverse effect on the beans during the few seconds it is in contact with them.

Driers. During the past ten years a number of different types of driers have been used; two main types are now favoured. The first is a combined sun-hot-air platform drier known as "Universal". This is basically a $40' \times 20'$ bed raised about $30''$ above ground level by concrete or brick walls. Rails $85'$ long on either side allow the roof to be rolled off for sun-drying. At the opposite end is a shelter which houses an oil-fired furnace, heat exchanger fans and blowers and the duct-work to convey the heated air under the bed. The bed is covered with $\frac{1}{8}''$ aluminium sheeting, perforated at $\frac{5}{8}''$ centres with $\frac{5}{16}''$ holes. This aluminium sheeting has proved very satisfactory and dries beans at a faster rate than galvanised wire mesh, which also has the disadvantage of rusting away in about eighteen months. Aluminium sheeting is about three times more costly than wire but its life appears to be unlimited. In emergencies both sun and hot-air may be used for drying.

This type of drier is very versatile and can handle up to about 10,000 lb. of fermented beans without difficulty.

The other type favoured is the common rotary drum type. Two different models are used by the Project, one made in Australia and the other in Scotland. Both have had to be modified for local conditions, and in their present models are quite effective. The rotary drier is very efficient and has the added benefit of reducing skin weight and polishing the beans to improve appearance.

All centres are well equipped with the normal sliding-roof sun driers. These are frequently constructed so that they may be easily converted to the "Universal" type mentioned above. The Project uses sun-drying whenever possible.

General Equipment. Cleaning is done with simple shaking tray winnowers. These are driven electrically to maintain constant speed. Correctly adjusted, these simple machines prove quite satisfactory. General carrying and handling of the cocoa beans is done by wheelbarrows with inflated tyres and deep trays. These are versatile and easy to use by unskilled labour; by the use of small wooden ramps they may be run on to the aluminium beds without damage to the aluminium. Over the years, corrugated aluminium roofing has proved superior to galvanised iron, which requires constant attention. The aluminium does not need to be coated with bituminous or epoxy resin paints and seems to have an indefinite life; it also has the added advantage of making sliding-roofs much lighter.

Costs. The following details of processing expenses are in Australian currency:–

	£A	s.	d.
Loan redemption	15	0	0
Wages	12	10	0
Fuel and Oil	5	8	0
Transport of beans to port	4	0	0
Bags and twine	2	6	0
Repairs and maintenance	1	18	0
Administration and overheads	1	10	0
	£A42	12	0

or £34 per ton (sterling)

During the two years ended December 1964 the Tolai farmers received an average price of 7d. per lb. for their wet beans; this is equivalent to £130 (stg.) per ton.

Conclusion

The Project, being a non-profit scheme, returns 78 per cent of the net income received from the sale of the beans. As soon as the loan repayments are completed in about four years, the Tolai people themselves will own and control an asset that has been built up to assist them with their processing and marketing problems and contribute to their general and economic development.

Notes on Contributors

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Joined the Colonial Research Service in 1951 after graduating in geology at Cambridge. After a post-graduate studentship in soil science in Scotland, spent ten years in Western Nigeria mainly engaged in a soil survey of cocoa-growing areas. Since 1962, Soil Correlator of the Soil Survey and Fertility Branch of the Food and Agriculture Organization of the United Nations.

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Graduated from the State Agricultural University at Wageningen, Holland in 1953. Then joined the staff of the Institute for Perennial Crops at Bogor, Indonesia, and was mainly concerned with research on rubber.
Went to Ghana in 1960 where he started a rubber research programme at the Kade Station of the University of Ghana. Became Senior Research Officer i/c of this station in 1961, and was also concerned with research on other perennial crops.
He now holds a post in his home country, Holland.

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May, 1965

Besse, J. L'amélioration du cacaoyer en Côte d'Ivoire. (Improvement of the cacao tree in the Ivory Coast). Café, Cacao, Thé 8, 4, p. 245-63 (1964).

A comprehensive cacao breeding and selection programme was initiated by the Institut Français du Café et du Cacao in the Ivory Coast in 1960; it will comprise both generative and vegetative selection. The author discusses the main features of the programme, including collections of prospective parents, mother tree selection, production of cuttings, and techniques of generative selection: artificial pollination, raising of the seedlings in nurseries, and field tests. The hybridization programme is predominantly based on crossings between Upper Amazon types with local Amelonados; results obtained so far indicate that some hybrid progenies from these crosses are highly productive. English, German and Spanish summaries. Tables. Graph. Diagram. Fig. Photos.

Lockard, R. G., and Asomaning, E. J. A. Mineral nutrition of cacao (Theobroma cacao L.) I. Deficiency symptoms and nutrient levels in plants grown in sand culture. Plant and Soil 21, 2, p. 142-52 (1964).

In Ghana seedlings of W. African Amelonado cocoa were grown in sand culture; the nutrient solutions applied were complete, deficient in 1 of 12 major and minor elements, or contained an excess of 1 of 4 elements. Symptoms of deficiency in P, K, Ca, Fe, Mn, Cu, B and Mn are described in so far as the data supplement those found in the literature. The dry weight of the plants grown on a complete solution at the age of 8 months was significantly greater than that of the plants in all other treatments. Deficiency in 1 element (except Ca) generally increased the level of other elements in the roots, stems and leaves, but N deficiency induced the transfer of Mg from the roots to the stems and leaves, Fe and Cu deficiency had a similar effect on Al, and Fe deficiency had a similar effect on the distribution of Fe. Tables. Photos. 16 refs.

June, 1965

Ehrencron, V. K. R. Bevloeiingsproef bij cacao. (Cacao irrigation experiment). Meded. Landbouwproefstat., Suriname 34, p. 19-23 (1964).

Seventeen-month-old cuttings of the cacao clone ICS 48 were grown at Paramaribo (Surinam) in containers filled with clayey sand. The plants received 8 l water of different salinity (100-2,000 mg Cl/l) twice weekly; in 2 out of the 3 trials 6 l water was applied to the soil and 2 l to the leaves. Spraying the leaves with water containing over 300 mg Cl/l, while the soil received water of low salinity, resulted in leaf symptoms of salt damage within 2 months; the plants soon recovered when they were watered with fresh water during the next months. Application of saline water to the soil resulted in irreparable damage to the plants. Tables. Graphs opposite p. 17. Photo of leaves with symptoms of salt damage opposite p. 16.

Friend, R. J. Some experiments on the storage of cacao seed in a viable condition. Papua and New Guinea Agr. J. 17, 1, p. 12-8 (1964).

The storage of cacao seed outside the pod was attempted at Keravat in New

Britain (Territory of Papua and New Guinea) using growth inhibitors containing isopropylphenylcarbamate, citric acid, or coumarin, in order to induce a period of dormancy in the seed. None of these substances was found to prolong the life of the seed significantly. The storage of cacao seed inside the pod was attempted, using various fungicides and various paraffin wax treatments to increase the storage life of the pod. The methods using fungicides did not prolong the life of the seed significantly. Using paraffin wax, the average period for which the seeds in the pod could be kept in a viable condition was doubled, being increased from about 14 days to 28 days, with 1 pod lasting for 90 days. Author's summary. 3 refs.

Maravalhas, N. Cacau verdoengo rende menos. Influência do grau de maturaçâo dos frutos do rendimento e na qualidade do cacau. (Greenish cacao yields less. Effect of the degree of maturity of the pods on the yield and quality of cocoa). Cacau Atualidades 1, 5, p. 1-2 (1964).

Tray fermentation trials with cocoa from pods of different degrees of maturity were conducted in the State of Bahia (Brazil). Fully ripe, nearly ripe (greenish) and unripe (green) pods gave the following results, respectively: maximum temperature during fermentation 50, 46 and 47°C; weight of dry cocoa obtained from 1,000 pods 39, 36 and 32 kg; mean bean weight 1·09, 1·07 and 1·00 g; percentage of violet beans 13, 22, and 36. Tables. Graph.

Newton, K. Cacao drying with a Bentall rotary drier. Papua and New Guinea Agr. J. 17, 1, p. 1-7 (1964).

A 2·4 × 1·8 m rotary drum drier was tested at Keravat in New Britain (Territory of Papua and New Guinea) for its suitability as a cocoa drier. The heat exchange system was too heavy for easy handling on a plantation and the foundation required to support the drum bearings was too elaborate. Initial trials, carried out with baffles fitted in each of the 4 drum compartments, demonstrated that baffles lead to extensive damage to the beans at the end of the drying period. Further trials showed that, although the unit was unsuitable as a complete rotary drier, it could be used as a final drier after 1 day of sun-drying provided that it was fully loaded and drum speed was reduced. The best performance was obtained with beans which had received an initial 2 days of sun-drying; under these conditions the drier could handle a load equivalent to 2·5 tons of dry beans with a fuel consumption of 115-135 l/ton. From author's summary. Table. Graph. Photos.

Tinsley, T. W. The ecological approach to pest and disease problems of cacao in West Africa. Reprinted from J. Royal Soc. of Arts, p. 353-65, 1964. Graphs. Figs. 21 refs.

Text of a lecture, stressing the need to look at problems of cacao pathology not as isolated subjects but as part of an integrated system. Approach on these lines, initiated in Nigeria in 1957, has led to a more rational system of swollen shoot control. It has also led to the recognition that the widespread decline of cacao fields, ultimately resulting in deterioration of the soil to a point where it is unfit for any purpose but grazing, is initiated by mirid attack and only aggravated by the swollen shoot virus. Spraying against mirids in the "area of mass infection with swollen shoot" in many cases resulted in a remarkably rapid recovery of the plantings, making replanting an economic proposition, though the large majority of the trees still carried the virus. The discussion (p. 365-71) made it clear that the speaker's conclusions are not always applicable to Ghana.

Toxopeus, H. Erfolg und Zukunft der Kakaozüchtung in Westafrica. (Achievements and prospects of cacao breeding in West Africa). Afrika Heute, Jahrb. 1963, p. 291-9 (1963; received 1965).

A brief review of the nomenclature and classification of the cacao tree (*Theobroma cacao*) is followed by a short description of cultivation practices in West Africa. The breeding and selection programmes in Nigeria and Ghana are discussed. High yielding, early producing types of good quality and highly tolerant to swollen shoot virus disease are already available for the African farmer. Promising results have been obtained with regard to the selection of types showing resistance to black pod disease caused by *Phytophthora palmivora*. 14 refs.

Wilbaux, R. Les problèmes que pose le stockage due cacao. (Problems raised by the storage of cocoa). Café, Cacao, Thé 9, 1, p. 24-36 (1965).

Subjects discussed in this paper include: differences between cocoa grades with respect to the relation of the moisture content of the beans to the relative humidity of the ambient air; moulds and insects attacking stored cocoa; factors influencing the susceptibility of the beans to moulds and insects, and the existence of a latent period of at least 6 months before mould develops; the effect of daily fluctuations in temperature upon stored cocoa; the construction of warehouses with special reference to the thermal conductivity of various building materials; re-drying of commercial cocoa before storage; different methods of storage: in bulk, in bags, and under covers; disinfestation by fumigation with methyl bromide, and possibly in the future by storage in a CO_2 or N_2 atmosphere. English, German and Spanish summaries. Tables. Graph. Photos. 14 refs.

Lockard, R. G., and Asomaning, E. J. A. Mineral nutrition of cacao (Theobroma cacao L.) III. The effects of different levels of nitrogen and calcium on the growth and nutrient content of seedlings grown in sand-culture. Ghana J. Sci. 4, 2, p. 94-102 (1964).

In Ghana, cacao seedlings were grown in sand culture on nutrient solutions containing all combinations of 5 N levels from 10 to 140 p.p.m. and 5 Ca levels from 10 to 125 p.p.m. The total dry weight per plant was not appreciably affected by the N and Ca concentrations until after 4 months from planting of the seed. At the age of 8 months the dry weight rapidly increased with the N concentration and showed a maximum at a Ca level of 100 p.p.m. Increasing N concentrations increased the leaf contents of N and Na and reduced those of K and Mo; Mn and B were higher at the lowest N level than at the 4 higher levels. Increasing Ca concentrations increased leaf contents of Ca, Zn and Mo, and reduced those of N and Na; the Mn content was reduced only at the highest Ca level. Tables. Graphs. 17 refs.

Gerard, B. M. Procedure following the discovery of insecticide-resistance in a mirid pest of cocoa in Ghana. Ghana. J. Sci. 4, 2, p. 133-40 (1964).

The author discusses the history of mirid control in Ghana, the discovery of resistance to lindane among populations of *Distantiella theobroma* in 1961, the distribution of this resistance over the country, and the search for alternative control methods. Resistance to lindane entails resistance to cyclodiene compounds such as dieldrin, but not to organophosphorus insecticides, carbamates, DDT or botanical compounds. Among the insecticides with relatively low mammalian toxicity, carbaryl, fenitrothion and DDT have given promising results, but the correct timing of these substances has not yet been fully worked out, and further investigations into possible side effects are necessary. In the meantime the use of lindane will be continued in areas where it is still effective. Map. 15 refs.

Hahn, J. La préparation de micro-échantillons de cacao. (Preparation of micro-samples of cocoa). Café, Cacao, Thé 9, 1, p. 37-42 (1965).

Seven methods of cocoa microfermentation found in the literature are briefly described, and a new semi-micro method requiring beans from 10 pods (about 1 kg of wet cocoa) is proposed. The pods are opened 48 hours after harvesting; the contents are first exposed to the air for 2 hours. They are then put into a box made of polystyrene foam, measuring $15 \times 15 \times 18$ cm, with a bottom perforated by 5 holes of 8 mm diameter and a lid provided with 1 hole 5 mm diameter. The box is placed on props to allow drainage, and the contents are stirred every 24 hours. Fermentation takes about 6 days and is terminated when the beans have turned dark-brown and an ammoniacal odour becomes perceptible. The beans are then dried in the sun during 6 days; drying is finished in an air-conditioned room. English, German and Spanish summaries.

Biehl, B. Neue Kakao-Fermentationsverfahren in Bahia. (New cocoa fermentation methods in Bahia). Süsswaren 9, 7, p. 358-363 (1965).

Cocoa fermentation in 2 types of rotating apparatus, designed in Bahia (Brazil) is compared with fermentation in traditional and modified sweat-boxes, on trays, and in a simple perforated barrel. The 1st type consists essentially of a horizontal, perforated, wooden cylinder, 2·5 m in length and 1·5 m in diameter, provided with an installation to promote thorough mixing; it is turned every 12-24 hours and fermentation is completed in 4 days. The 2nd type has a somewhat smaller, spindle-shaped drum with a quadratic cross-section, 1×1 m in the middle section. In spite of some imperfections, both types are considered to give better fermentation and, consequently, a better quality product than does the traditional box fermentation. Tables. 15 refs.

September, 1965

Laryea, A. A. Extension and training. In: Papers 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/8, p. 1-10.

Acceptance or adoption by cocoa farmers in Ghana of improved practices resulting from research has generally been fairly rapid; striking examples are the swollen shoot eradication campaign and the mirid control campaign. This is mainly due to the existence of a well-organized extension service which not only instructs the farmer on new techniques and methods but also assists him when the adoption of these techniques is beyond the means of the individual peasant. For this purpose the cocoa-growing area is divided into districts of 240—40,000 ha in charge of an agricultural survey officer or a spraying superintendent: the service also maintains cocoa stations, demonstration plots and capsid control depots. Farmers' training hostels accommodating 36 persons at a time have trained over 20,000 peasants; a training school provides various initial and refresher courses for service personnel. French and Spanish summaries. Tables.

Production — vulgarisation, Service de la Recherche Agronomique, Cameroun. (Production — extension works, Agricultural Research Service, Cameroon) In: Papers 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/29e, p. 1-3, 1-2.

In order to increase the production of cocoa in Cameroon, some 400,000 cuttings are annually distributed among the farmers; this method will be replaced within a few years by the distribution of selected seed. Improvement of cultural methods has been promoted by applying phytosanitary measures to neglected fields; the present method is to organize groups of farmers who pledge themselves to apply improved methods under the guidance of an extension officer. Equipment and chemicals are given as prizes in contests among individual farmers, or sold on easy terms to groups of farmers wishing to apply improved methods of control, in particular of pod rot. The extension service also uses pamphlets, posters and films to instruct the farmers. Brief instructions on pest and disease control are presented in an appendix. English and Spanish summaries.

Glendinning, D. R. Recent advances at the Cocoa Research Institute, Tafo in breeding, selection, and seed multiplication methods. In: Papers 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/12, p. 1-12.

Subjects discussed include: the principles and aims of cocoa breeding adopted in Ghana; testing of varieties for yield, disease resistance, and quality of the product; and methods of seed production in connection with natural pollination and incompatibility. It has been decided for various reasons, one of which is the discovery of hybrid vigour in cocoa, to concentrate upon the development of improved seedling varieties from crosses between Upper Amazon and local Amelonado types. Seed of some varieties is being distributed to farmers. The necessary small-scale testing of many new progenies has its limitations because progenies planted close together interact by modifying each other's environment. The trend in large-scale seed production is towards the establishment of large seed gardens. French and Spanish summaries.

Enriquez, G., and Soria, J. Registro internacional de cultivares de cacao. (International register of cocoa cultivars). In: Papers 1st Sess. Techn. Working Party Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/21, p. 1-2, 1-19.

The Inter-American Institute of Agricultural Sciences in Costa Rica has embarked upon the preparation of a descriptive register of cocoa cultivars. Preliminary investigations are being conducted in order to determine morphological characters suitable for inclusion in the descriptions; among the 16 measurable floral characters studied, 4 had to be rejected because the intra-clonal coefficient of variability exceeded 10%. An appendix presents: (1) a model description; (2) a table of the 16 quantitative floral characters studied and their values in 34 clones; (3) a model of a punched card for the registration of the collected data. English and French translations.

Barros-Nieves, O. Selección de cacao en Colombia. (Cocoa selection in Colombia). Agricultura Trop. 21, 2, p. 108-11 (1965).

Until 1885 all cocoa grown in Colombia belonged to the Criollo type. Subsequently an Amelonado type was introduced, characterized by precocity and resistance to fungal diseases. Natural hybridization resulted on the average in an increased vigour of the offspring but also in a smaller pod size. The range of variation differs according to the degree of interbreeding which has taken place, and is different for various cocoa-growing regions. Five of these are distinguished and brief characteristics are given of the crop population encountered there. F. J. Pound's recommendations for cocoa selection in Colombia, formulated in 1942, are briefly discussed. Table. 5 refs.

Los hibridos trinitario-forastero, esperanza de la producción del cacao en el Perú. (Trinitario-Forastero hybrids, the hope of cocoa production in Peru). In: Paper 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/15, p. 1-8.

Six hybrid cocoa progenies resulting from crosses between Trinitario and Upper Amazon clones were observed at Tingo Maria, Peru, during their first 4 years of life. They showed a high yielding capacity apparently due partly to hybrid vigour, a satisfactory bean size, and a high to fairly high resistance to witches' broom disease. English and French summaries. Tables.

Are, L. Drying treatments to keep cocoa seeds viable in storage. In: Paper 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/4, p. 1-6.

In trials conducted in Nigeria, mucilage-free cocoa seed dried at 29°C for 8 hours, treated with captan at a rate of 1g/100 seeds, and stored in dry charcoal at a temperature of 21°C showed 35% germination after 4 weeks' storage and 14% after 8 weeks' storage. Drying at temperatures of 23-29° for more than 10 hours resulted in much lower germination percentages. The viability of the seeds was rapidly destroyed by storage in a sawdust-NaCl medium after drying, and by storage at temperatures below freezing point either without or after drying. French and Spanish summaries. Tables. Graph. 5 refs.

Asomaning, E. J. A., and Acquaye, D. K. Some observations on the shade, fertilizer and water requirements of cocoa (Theobroma cacao L.). In: Paper 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/13, p. 1-8.

A review of published results of trials conducted in Ghana, supplemented with recent observations, shows that removal of shade after the first few years results in high yield increases in Upper Amazon as well as in Amelonado cocoa. A high light intensity is supported only when water and nutrients are not lacking. Rapid depletion of nutrients should be prevented by high doses of fertilizers; irrigation is probably uneconomic. Shade removal may cause soil deterioration and promote the development of certain pests, but the higher yield will offset the cost of insecticide applications. A high light intensity also reduces the effect of virus infection. Trials in smallholders' fields showed that initially N and P fertilizers are needed most; when yields increase, KMg fertilizers should be applied as well. French and Spanish summaries. Tables. 19 refs.

Quansah, S. T. Progress in shade studies: recent yield trends on unshaded cocoa in Ghana. In: Paper 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/28, p. 1-8.

The effect of shade removal in trials with cocoa in Ghana has usually been greater in amelonado cocoa than in Upper Amazon cocoa: while Amazon cocoa under shade generally yields more than does Amelonado, it appears to be no better without shade. Some wide-spaced fields showed a decline of yields, in some cases as a direct result of insect attack. Peasant farmers have not yet been stimulated to remove thier shade because most farmers' fields are only lightly shaded so that the effect would not be spectacular; moreover, shade should be retained in fields with a wide spacing or with gaps in the canopy, and experience with shade removal is still limited to small areas surrounded by high trees. Future research should be directed towards the effect of large-scale shade removal and the testing of varieties under different light intensities. French and Spanish summaries. Tables.

Lems, G. Problems related to the selection for witches' broom and cushion gall resistance in cocoa. In: Papers 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/6, p. 1-11.

A review of literature on the aetiology of witches' broom disease caused by *Marasmius perniciosus*, and of cushion gall caused by *Fusarium* spp., leads to the conclusion that chemical control of these 2 fungal diseases of cocoa is well-nigh impossible unless systemic fungicides are developed. For the time being, breeding for resistance appears to be the only solution. The geographical distribution of the 2 diseases makes this a matter of special concern for the American cocoa-producing countries; a scheme for international co-operation in this field is proposed. French and Spanish summaries. Table. 35 refs.

Silva, P. Tripes do cacaueiro - causador do "queima" da fôlha e da "ferrugem" do fruto. (The cocoa thrips, cause of leaf scorch and pod russeting). Cacau Atualidades 1, 9-10, p. 1-4 (1964).

A description is presented of *Selenothrips rubrocinctus*, the most noxious thrips on cocoa in the State of Bahia (Brazil), and of the damage caused to the foliage and fruits. Outbreaks mainly occur during the dry season, unshaded fields being more liable to attack than are shaded fields. The attack usually starts in patches; control should start as soon as the population density attains an average of 2 adults per leaf. Farmers are recommended to spray the trees with malathion at a concentration of 0·2% (active principle) and to repeat the treatment twice, at 15- to 20-day intervals, using a concentration of 0·125%. Another thrips species damaging cocoa leaves in Bahia is *Heliothrips haemorrhoidalis;* a predacious *Franklinothrips* sp. has also been found. Figs. 8 refs.

Quansah, S. T. The present mirid position. In: Paper 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/22, p. 1-6.

A search for insecticides that could replace gamma-BHC in the control of cocoa mirids in Ghana was initiated even before resistance to gamma-BHC was discovered in *Distantiella theobroma*. Carbaryl, fenitrothion and DDT were found to be both safe and effective; however, tests for taints caused by fenitrothion are still inconclusive, and DDT, which is used by WHO for malaria eradication, is not recommended because its use for other purposes may result in development of resistance against it in mosquitoes. Thus, for the time being carbaryl is the only alternative to gamma-BHC; unlike this compound it has to be applied laterally to the trunks as well as to the canopy. Large-scale trials so far have not indicated any undesirable side effects. French and Spanish summaries. 19 refs.

Eloja, A. L., and Gandia, I. M. Progress report on the control of the cacao pod borer Acrocercops cramerella Sn. with insecticides. Philippine J. Agr. 27, 1-2, p. 97-103 (1962; published 1964).

In the Philippines, plots of an old cocoa plantation infested by the cocoa pod borer *Acrocercops cramerella* were sprayed with 0·03% EPN, 0·11% DDT or 0·11% DDT + Bordeaux mixture. The percentage reduction in caterpillar infestation of the treatments, compared with the unsprayed control, was 10, 38 and 48, respectively. It is suggested that control would probably have been better if the whole plantation had been sprayed; this was confirmed by another experiment where spraying of all trees with 0·12% DDT gave almost complete control. The effect of the treatments on cocoa pod rot was not significant, although spraying with DDT + Bordeaux mixture resulted in the lowest percentage of infected fruits. Table. Graph. Photo. 1 ref.

Wood, G. A. R. Quality improvement. In: Papers 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/9, p. 1-9.

Improvements in the quality of commercial cocoa have been attained in several countries by the introduction of better fermentation methods, the establishment of central fermentaries, and improved drying either in simple driers of the Samoan type or in large driers with oil-fired heat exchangers. However, too rapid artificial drying may result in a relatively high acetic acid content of the beans and, consequently, in an undesirable fruity flavour. Better storage methods aimed at the preventation of mould development and insect infestation have also contributed to quality improvement. With a view to these improvements, the FAO Working Party on Cocoa Grading in 1963 proposed new standards for the grading of cocoa which are more exacting than those usually adopted; unfortunately these new standards have not yet been generally accepted. French and Spanish summaries. Table. 16 refs.

Quansah, S. T. The future of cocoa. Ghana Farmer 8, 3, p. 98-100, 103 (1964).

In order to maintain her dominant position on the world cocoa market, Ghana has set herself the target to raise cocoa production from 420,000 tons at present to 570,000 tons by 1969, at the end of the 7-year development plan period. Steps taken by Ghana in behalf of the production, marketing and consumption of cocoa include: the development of higher-yielding varieties such as the Amazon types and the new hybrid "Tafo Cocoa", and their popularization amongst farmers; testing new insecticides for the control of capsids to replace gamma-BHC, to which these insects are becoming resistant; the concentration of the entire market for Ghana cocoa in Accra; the establishment of vast storage facilities in Tema; the acquisition of new customers in addition to old established customers such as the U.S.A. and the U.K.; the erection, in Tema and Takoradi, of 2 cocoa-processing factories.

Maravalhas, N. A new type of fermenting box for cacao. In: Papers 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11, Sept. 1964. Working Paper (Ca) 64/27, p. 1-2.

Trials with a new type of sweat box were conducted at Itabuna in the State of Bahia (Brazil). The box measures 1·2 × 1 × 1 m and is divided into 4 compartments by removable vertical partitions 25 cm apart, consisting of double-wall lathworks. Two lateral walls are provided with rows of holes 8 cm apart, coinciding with the position of the partitions and giving access of air to the gaps in the middle of the partitions; a perforated lath sliding over the holes regulates the passage of air. One of the walls facing the partitions can be removed for unloading. Improved aeration, which can be regulated according to the stage of the fermentation process, renders turning of the cocoa unnecessary and allows the process to be completed in 3-4½ days. A series of trials resulted in an average of 50% fully fermented and 43% partially fermented beans. French and Spanish summaries. 1 ref.

Reyes, E. H. Caucagua — un nuevo fermentador para pequeñas cantidades de cacao. (Caucagua—a new fermentary for small quantities of cocoa). In: Paper 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/25, p. 1-5.

Successful trials with a new type of cocoa fermentary were conducted at Caucagua in Venezuela. The fermentary consisted of a basket holding 32 kg of wet cocoa, made from a tall reed (*Gynerium sagittatum*) and strengthened with a rim of lianas (*Bauhinia* sp.) It was exposed to the sun and covered with a polyethylene sheet; the cocoa was turned every 24 hours. A charge of Trinitario cocoa reached a temperature of over 50°C in the upper layer on the 2nd day and at the bottom on the 5th day; fermentation was completed in 5 days, and after drying 86% of the beans were found to be well fermented. English and French summaries. Table. 9 refs.

Mould, H. A. Cocoa storage and shipment. In: Papers 1st Sess. Techn. Working Party on Cocoa Prod,. Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/10, p. 1-9.

Increased cocoa production in Ghana has aggravated problems of insect infestation. Initial infestation should be kept low by avoiding contact with foodstuffs and by keeping warehouses clean. The moth *Cadra cautella* can be controlled by nightly fogging with 0·5% pyrethrins in oil; the spray is effective for 1 day only and piperonyl butoxide has no synergistic effect against this insect. Weevils and beetles are controlled by fumigation with methyl bromide under gastight sheets; leaving the cocoa covered with the sheets protects it against mould, but mould development should be prevented in the first place by constructing and managing warehouses so as to keep the humidity of the air as low as possible. Ship inspection was started in 1962; misting of holds with 0·2% malathion is effective against most insects found in them, but fumigation with methyl bromide is necessary when *Trogoderma* is present. French and Spanish summaries. Table. Photos. 16 refs.

Greenwood-Barton, L. H. Cocoa beans and cocoa pods; have they any unconventional uses? In: Papers 1st Sess. Techn. Working Party on Cocoa Prod., Rome, 7-11 Sept. 1964. Working Paper (Ca) 64/7, p. 1-12.

Consumption of cocoa in most producing countries is very low; its expensiveness is the main factor militating against an increase. In producing countries which process beans for cocoa butter the residual powder might be used as a flavouring for food products such as fermented cassava. The chemical composition of cocoa cotyledons, butter, shells, germs, germ oil, pulp, and pod husks has suggested several ways of using the by-products or extracting chemicals from them. Theobromine is already extracted from inferior quality beans and shells; shells and pod husks are used as fertilizers, and pod husks are fed to cattle. A critical examination of other proposals reveals that very few of them are likely to be realized because the same purposes can be served using cheaper raw materials. French and Spanish summaries. Tables. Graphs. 17 refs.

Acquaye, D. K., and Smith, R. W. Effects of ground covers and fertilizers on establishment and yield of cocoa on clear-felled land in Ghana. Exp. Agr. 1, 2, p. 131-9 (1965).

A trial on the establishment of cocoa on clear-felled land, conducted at Tafo (Ghana), comprised 6 soil cover treatments on which NP$\times$KMg treatments were superimposed. Growth of the cocoa was improved in mulched and clean-weeded plots; the unshaded trees began bearing 2 years after planting. Responses to NP fertilizer were obtained in the 3rd year; in the following year yields were up to 2,430 kg dry cocoa per ha. This was partly responsible for K deficiency, particularly in plots without mulch and KMg, which led to declining yields especially on the NP plots. Mulching at the rates used in this experiment is too expensive, but K fertilizer applied at rates higher than 84 kg K_2O/ha/year may be needed on Ghanaian forest soils if they are clear-felled for growing unshaded cocoa. From authors' summary. Tables. Graphs. Fig. 12 refs.

October, 1965

Schroeder, C. A. Temperature relations in cacao fruit. Cacao; Inter-Am Inst. Agr. Sci. 8, 4, p. 8-10 (1963; received 1965).

Measurements of temperatures inside the pericarp of nearly mature cocoa fruits, made in Costa Rica, demonstrated that tissues of pods exposed to the sun undergo a daily fluctuation in temperature greater than that of the air. Fruits on the north side of the trees or inside the leaf canopy attain lower temperatures than those on the south side. Dark red fruits develop higher daytime temperatures than do light green fruits. A temperature gradient within the fruit could be demonstrated, according to which surface temperatures are higher during the day and comparatively lower at night. From author's summary. Table. Graphs. 5 refs.

Verlière, G. Contribution à l'étude de la croissance et de la nutrition des jeunes cacaoyers en Basse Côte d'Ivoire. (Contribution to the study of growth and nutrition of young cocoa trees in the Lower Ivory Coast). Bull. Inst. Franç. Café Cacao 7, p. 1-27 (1965).

A cocoa nursery on a sandy soil in the Ivory Coast, with a spacing of 30$\times$30 cm. was divided into 10 plots of 925 plants each. Samples of 20 plants per plot were taken at 14-day intervals until 18 months after planting the seeds; the fresh and dry weights of the leaves, stems and roots and their contents of N, P, K, Ca and Mg were determined, nutrient ratios and uptake being calculated from the analytical data. A few of the results are: (1) initial differences in size became proportionally larger as the seedlings grew older; (2) at the age of 17 months the average plant had fixed 1·83 g N, 0·15 g P, 1·73 g K, 0·60 g Ca and 0·53 g Mg; (3) the growth rate was significantly correlated with the P content of the soil but not with other soil properties. Tables. Graphs.

Soria, V. J. Observations on varieties and cultivars of cacao in Bahia, Brazil. Cacao; Inter-Am. Inst. Agr. Sci. 8, 1, p. 1-6 (1963; received 1965).

The author presents a review of literature on planting material of cocoa available in the Brazilian State of Bahia, supplemented with observations made during a visit in 1963. He discusses the characters and origins of the 3 types constituting the bulk of the plantations: Pará, Maranhão and Comum and of the 2 albino mutants discovered in 1937-38: Almeida and Catongo. In later years several more albino trees have been found; probably all these trees are segregates resulting from one mutation. Segregation from a cross with Criollo is unlikely because albinism affects various parts of the trees, not just the seeds. The alleged resistance of Catongo to *Phytophthora* should be further investigated. Selection work has been performed by the Uruçuca and Juçari experiment stations; the main criteria were high yield and a low incidence of pod rot. 14 refs.

Rodriguez, R. M., et al. Nutritional requirements of the cacao plant during a yearly cycle. Cacao; Inter-Am. Inst. Agr. Sci. 8, 4, p. 1-7 (1963; received 1965).

A trial with 3-year-old cocoa plants grown in nutrient solution, conducted in Costa Rica, showed that the greatest amounts of nutrients were absorbed during periods of leaf formation (Mch.-Apr. and Sept.-Oct.). Initiation of flowering coincided with a decrease in absorption of Ca, K, and P; much N was absorbed during this stage, and absorption of Mg reached a peak. Root apex development in July was accompanied by increased absorption of P, Ca and Mg, and by excretion of N and K. P was absorbed in large amounts during fruit ripening. During the 2nd half of the cycle absorption was somewhat erratic. Evidently, the rate at which the cocoa plant absorbs nutrients varies greatly, depending on the physiological state of the plant; differences between plants in the same stage of development were only quantitative. From authors' summary. Graphs, 23 refs.

Decelle, J. Travaux réalisés par l'I.F.C.C. en Côte d'Ivoire sur la lutte chimique contre les mirides du cacaoyer de Septembre 1963 à Mars 1964. (Research on the chemical control of cacao mirids conducted by the I.F.C.C. in the Ivory Coast from Sept. 1963 to Mch. 1964). In: Proc. Conf. on mirids and other pests of cacao at the W.Afr. Cocoa Res. Inst. (Nigeria), 24th to 27th Mch. 1964, p. 35-7.

Cocoa mirids in the Ivory Coast are usually controlled by spraying with lindane. Field trials showed that 0·3% fenitrothion (active) gave the best results when trees were sprayed from both sides; 0·3% dichlorvos was but little effective. Spraying with 1·7 kg carbaryl in 100 l water per ha resulted in a residue of 0·13% in the pods and one of 0·15 p.p.m. in the processed beans; it had no perceptible effect on the flavour of the beans. Two sprayings with 500 g fenitrothion per ha at a 4-week interval caused no deterioration of flavour, but a few of the tasters experienced slight allergic effects. English summary. Table. Discussion p. 37.

Telford, J. N. Cyclodiene resistance in cocoa mirids in Ghana. In: Proc. Conf. on mirids and other pests of cacao at the W.Afr. Cocoa Res. Inst. (Nigeria), 24th to 27th Mch. 1964, p. 4-7.

A survey of resistance to lindane and related insecticides in cocoa mirids was conducted in Ghana in 1963; dieldrin-impregnated test paper was used to assess the degree of resistance. More than 10% resistant insects were found in populations of *Distantiella theobroma* in a large area on the border of the Eastern and Ashanti Regions and in several small isolated areas of both regions. *Sahlbergella singularis*, which was thought to have almost disappeared from Ghana, appeared to be on the increase again since it was collected in many areas; this species proved to be more tolerant to dieldrin than was *D. theobroma*, but had nowhere developed resistance to it. A few *Bryocoropsis laticollis* and *Helopeltis* spp. were found on cocoa in the Eastern Region;

it seems unlikely that any of these will become of economic importance. Table Map. 3 refs. Discussion p. 7-8.

Peterson, D. G., and Bond, E. F. The control of cocoa mirids (Hemiptera: Miridae) in Ghana with low-volume applications of carbaryl and sumithion. In: Proc. Conf. on mirids and other pests of cacao at the W.Afr. Cocoa Res. Inst. (Nigeria), 24th to 27th Mch. 1964, p. 18-25.

Trials conducted in Ghana indicated that a 95% reduction of the cocoa mirid population can be attained by spraying each tree twice, from opposite directions, with carbaryl or fenitrothion (sumithion) at a concentration of 0·625% active ingredient, using a mistblower with a delivery rate of 0·9 l/minute. In a normal field with 1,875 cocoa trees per ha this works out at a rate of application of 112 l/ha. In contrast to the usual method of applying lindane, the spray should be directed to the trunks and canopies of the cocoa trees. Tables. 17 refs. See also ibid. p. 26-34: Entwistle, P.F., et al. Field experiments in the control of *Sahlbergella singularis* Hagl. (Hemiptera: Miridae) with sevin and sumithion in Nigeria. Tables. Graph. 4 refs. Discussion p. 34.

Entwistle, P. F. The distribution of mirid species and of resistant mirids in Nigeria. In: Proc. Conf. on mirids and other pests of cacao at the W.Afr. Cocoa Res. Inst. (Nigeria), 24th to 27th Mch., 1964, p. 9-16.

A survey of cocoa mirids in Nigeria was made in 1962-64. *Sahlbergella singularis* proved to be the dominant species, occurring in all cocoa-growing areas and making up 97% of the catches. Resistance of this species to lindane and dieldrin was only found in an area of 150 km^2 in the vicinity of Ondo. The occurrence of *Distantiella theobroma* was mainly restricted to a large area in the eastern part of the Western Region, where it constituted 18% of the catches. Damage to cocoa by *D. theobroma* appeared to occur almost exclusively at altitudes of over 250 m. Only 2 *Helopeltis* spp. and no *Bryocoropsis laticollis* were collected during the survey. Tables. Graphs. Map. 14 refs. Discussion p. 17.

Akinwolemiwa, J. O. Extension work on mirid control in Western Nigeria. In: Proc. Conf. on mirids and other pests of cacao at the W.Afr. Cocoa Res. Inst. (Nigeria), 24th to 27th Mch., 1964, p. 66-9.

The confidence of cocoa farmers in W. Nigeria in the extension service has been most firmly established in the field of crop protection, success with black pod control paving the way for the general adoption of mirid control. Methods of approach include: (1) final trials of control methods in progressive farmers' fields; (2) demonstration plots situated along roads; (3) a farmers' training programme preceded by the training of extension officers; (4) follow-up: visits of extension officers to trained farmers; (5) propaganda by audio-visual means; (6) subsidized prices of pumps and chemicals, and loans for their purchase. In 1956-63 a total of 616,000 farmers followed a 3-day training course in mirid control or a 5-day course in which black pod control was taught as well. Purchases of chemicals are increasing. Table. Discussion p. 70.

Salas, A., and Hansen, A. J. A toxicogenic leafhopper (Homoptera: Cicadellidae) observed on cacao (Theobroma cacao L.). Cacao; Inter-Am Inst. Agr. Sci. 8, 1, p. 6-12 (1963; received 1965).

Greenish-yellow, yellow or necrotic areas observed on adult cocoa leaves in Costa Rica were found to be associated with the presence of nymphs of the leafhopper *Chainaia* (*Tettigonia*) *rubescens*, an insect not previously observed on cocoa. Trials showed that the symptoms were indeed caused by the leafhopper, in particular by older nymphs and young adults; a severe attack resulted in leaf fall. Young and mature leaves are more susceptible than are leaves in the intermediate stage; among 4 UF clones 2 appeared to be more susceptible than the other 2. The type of damage suggests the excretion of a toxic substance during feeding, but the symptoms could not be reproduced by injection of macerations from whole nymphs or their salivary glands. Tables. 20 refs.

Arana, O. El cacao (Theobroma cacao), alimento precolombino. (Cocoa, a pre-Colombian food). Agricultura Trop. 21, 3, p. 179-82 (1965).

Colombia has the 2nd largest per capita cocoa consumption in the world. The total annual consumption is about 30,000 tons; the annual production is only 17,000 tons. About 35,000 ha are planted with cocoa, yielding an average of 400-600 kg/ha. The varieties planted are Trinitarios and Amazon Forasteros 91·5%, locally selected clones 5%, imported hybrids 2·5%, and Criollo 1%. Potentially Colombia could be a cocoa-exporting country instead of a cocoa-importing country. Low yields are a result of deficient management, particularly in the control of pests and diseases. Monilia disease caused by the fungus *Monilia roreri* alone causes an estimated yield reduction of 30-40%. There are no official marketing organizations for the product. A national committee has suggested the establishment of a programme of support to the cocoa growers. Regions suitable for an expansion of the industry are enumerated.

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