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Contents

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Editorial

The Use of Pesticides

In this issue we publish an article on the part played by chocolate manufacturers in the development of pesticides. This article follows one which described the work of the chemical manufacturer in the discovery and testing of pesticides. Whatever else may be learnt from these two articles, it will be abundantly clear that a vast amount of work and time is involved before a pesticide is recommended to growers.

The word "pesticide" covers all agricultural chemicals which control fungi and weeds as well as insects and other pests, but in these articles we are largely concerned with insecticides. Their widespread use on cocoa is relatively recent—it was in 1959 that gammexane was first used widely in West Africa to control capsids—but their use is sometimes inevitable if good yields are to be attained, and the need to apply approved insecticides to control some insect pests is accepted by all concerned. Having said that, one must sound a note of caution. There is today much argument about the proper use of pesticides in general. On the one hand there are those who accept their use readily, on the other there are those who are acutely conscious of the possible long-term effects. The truth, of course, lies somewhere between the two points of view.

Some caution is right and proper, not only on the part of manufacturers but also by growers themselves. Too free an application of insecticides by growers would be unwise; in the second issue of this Bulletin an instance was quoted where insecticides accentuated a pest problem by killing predators and parasites rather than the pest itself; in addition, there is the possibility that resistance will develop. Apart from these points, growers must bear in mind the toxicity of the chemicals they use and hence the danger they present to those who handle them, a point which applies to pesticides generally.

Manufacturers are concerned lest the use of an insecticide should lead to some alteration of flavour or to the presence of toxic products in the cocoa beans. The dangers were first emphasised at the time when dimefox was being tested in Ghana for use in swollen shoot control. This systemic insecticide is highly toxic, and it was largely for this reason that it was never adopted, but tests indicated that it might lead to some off-flavour in chocolate. Such highly toxic chemicals are no longer in favour, but the problem of the possibility of off-flavours and toxic products remains. Hence the rather complicated and time-consuming tests that are described in this issue. We regard these tests as an important safeguard for the consumer and for the industry's products, and hence for the whole chocolate industry which, of course, includes the cocoa grower.

G. A. R. Wood.

The Mackintosh Story

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

John Mackintosh & Sons Limited of Halifax and Norwich are one of the leading chocolate and confectionery manufacturers in Great Britain. The origins of the Company—which is now world wide—can be traced to a small pastrycook's shop in King Cross Lane, Halifax.

In 1890, John Mackintosh—then aged only 22—began the business which now bears his name, when he opened the shop a few days after his marriage. His aim was to provide only the best specialities, and this led him to experiment with confectionery. At that time English toffee was hard and brittle, and very soft caramels were being imported into England from America. He had the notion of blending English butterscotch with American caramel, and eventually produced a new product which he named "Mackintosh's Celebrated Toffee." This was the origin of toffee as we know it today.

His flair for publicity led him to introduce the line with free samples, and this, coupled with the distinctive nature of the product, ensured its success. John Mackintosh had continued his work in a cotton mill—leaving his wife to run the shop—but with the success of the toffee he left his job and devoted all his energy to building up his own business.

Within four years it became apparent that the shop was far too small, and the manufacturing business was transferred to a neighbouring warehouse. Trade continued to increase and, after a further move, a factory was built in Queens Road, Halifax, in 1899. The business was then turned into a private company—John Mackintosh Limited—and other factories were acquired in the town.

In 1911, the Queens Road factory was destroyed by fire, and in order to maintain continuity of supplies production was transferred to other factories in the town. Gradually the business expanded and new factories were acquired. In addition, the Queens Road factory was rebuilt with a greater capacity than hitherto. Until the acquisition of A. J. Caley Limited in 1932 the manufacture of chocolate was concentrated there—and still is to a certain extent.

In 1921, the year after the death of the founder, the Company became John Mackintosh & Sons Limited, under the Chairmanship of his eldest son, Harold, who later became the first Viscount Mackintosh of Halifax. He remained Chairman until his death in December, 1964.

The factories acquired in Halifax since 1890 have all been modernised in the last 20 years, and a programme of extension was completed by the addition of a large new factory in 1964. This factory, Mackintosh's fifth in Halifax, was built over an old canal, and the original canal basin provided room for extensive cold-storage facilities.

A decade before John Mackintosh opened his shop in Halifax, a Norfolk chemist—A. J. Caley—had a shop in London Street, Norwich, where—as a sideline—he made soft drinks. The sale of these developed so quickly that eventually, in 1880, he established a small factory in Chapel Field, Norwich, where Mackintosh's present Norwich factories are situated. Because soft drinks were a seasonal sale he started to make cocoa as a winter drink. A natural consequence, following in 1886, was the manufacture of chocolate. The direction of the firm remained, with a further diversification into the manufacture

(*Above*) *Close to the heart of the City lies Mackintosh's Norwich factory with its large Offices and roof-top car park.*

Photo: Aerofilms

A Mackintosh's distribution van crossing Westminster Bridge.

Photo: A.F.C. Ltd.

of crackers, in the hands of the Caley family until 1918 when it was purchased by The African and Eastern Trade Corporation. When it was offered for sale in 1932, the business was purchased by John Mackintosh & Sons Limited who wished to extend their interest in the chocolate market.

Shortly after the acquisition talks took place with Leonard Monheim GmbH of Aachen, Germany. The outcome of the discussions was a complete re-organisation of the Norwich factory and the installation of Monheim Praletta plant. This was a great advance on anything so far designed to produce moulded chocolates with a variety of fillings. It was this plant which enabled Mackintosh's to produce the famous assortment Quality Street, and later Rolo.

In April, 1942, following an air-raid, the Chapel Field factory was destroyed and all production at Norwich ceased. Fortunately, by pre-arrangement, supplies to Mackintosh's customers were continued without a break by the substitution of goods made by other firms—much coming from Cadbury's, Bournville, and Fry's, Somerdale. After the war the factory was rebuilt, and is now one of the finest confectionery plants in the country. A recent innovation has been a roof-top car park, the first to be built in Norfolk, for the use of employees. In the United Kingdom some 5,000 people are employed in the Company's confectionery business, and although Halifax is the larger manufacturing unit, the executive offices are in Norwich.

The Company's reputation was initially founded on its toffee. It was only with the acquisition of the Norwich chocolate factory that sales of chocolate lines began to play a more prominent part. The breakthrough came in 1936 when "Quality Street" was launched. This is Mackintosh's largest selling product and, after over thirty years, still remains Britain's leading wrapped assortment. Further reorganisation since the war has meant that "Quality Street" is now made in Halifax, and the manufacture of chocolate is by no means restricted to Norwich. It is interesting to note that sales are four times what they were in pre-war years: in fact, the 1966 sales of "Quality Street" alone exceeded the total sales by the Company thirty years ago! The brand is now exported to many countries and in 1967 the manufacture of "Quality Street" began in the Republic of Ireland.

In a different field, another familiar Mackintosh product is Rolo, which pioneered the handy pocket pack of chocolate toffees, and which has the added attraction of separate pieces, Soft toffee in milk chocolate cups was quickly appreciated, and sales have grown to such an extent that in 1966 the Norwich factory produced over 1,022m. pieces!

Toffee Crisp is another example of Mackintosh's successful entry into a new field. The attraction of chewy toffee and crispies covered in smooth milk chocolate has assured its continuance as a prominent member of the Mackintosh range.

Overseas the Mackintosh name is well known. In addition to factories or manufacturing facilities in six countries, exports are sent to nearly every country in the world. 1966 was a record year, beating by 20 per cent the previous all-time export record set up only the year before.

The Mackintosh Group also includes a number of other confectionery concerns. Anglo Confectionery Limited, also of Halifax, was formed before the war to market the chewing-gum products of the Group, and it has now grown to be the second largest unit in this particular field. More recently Joseph Bellamy & Sons Limited of Castleford, Yorkshire, was acquired. They manufacture a wide range of liquorice and children's confectionery. A new £1m.

factory for Mackintosh's is to be built alongside the present Bellamy factory and should be completed towards the end of 1968.

The Group has a policy of diversification and as well as the Christmas cracker business mentioned earlier—now handled by a separate company—(the soft drinks business having been sold at the end of the war), it also controls subsidiary companies in biscuit manufacturing, confectionery wholesaling and wrapping machine manufacturing.

In spite of its growth and diversification Mackintosh's remains very much a family concern, and the present Chairman, Mr. Eric D. Mackintosh, C.B.E., J.P., is the youngest son of the founder, John Mackintosh. Within the organisation it has been possible to retain a friendly and intimate atmosphere although it is now a very large public company.

Review of Production and Consumption

(November, 1967)

A. P. Williamson, Cadbury Brothers Limited.

Production

The F.A.O. Statistical Committee has confirmed its earlier 1966-67 production estimate of about 1,330,000 tons and it has forecast 1967-68 production at 1,316,000 tons.

1967-68 Ghana production is put at 416,000 tons, 35,000 tons more than last year, although some of the increase is artificial, as last year's Ghana figure did not include the tonnage smuggled into the Ivory Coast. This increase is more than counteracted by a fall of 50,000 tons in the Nigerian estimate and a smaller fall in that for the Ivory Coast. Again, the latter does not necessarily reflect a change in production but a reduction in the level of smuggling. Elsewhere, production is forecast at very much the same level as last year, although an increase of 7,000 tons is shown for Brazil and an increase of 4,000 tons for New Guinea.

Grindings

The estimate of 1967 grindings has been reduced by a further 24,000 tons to 1,389,000 tons. This reflects the disappointing European quarterly figures and also a reduction in the estimates of Eastern European and local West African usage.

The committee has also made its first preliminary estimate of the 1968 requirements. The figure of 1,425,000 tons is 2.6 per cent more than the 1967 estimate. The increase is attributed to the increased requirements of Eastern Europe and to increased local processing in West Africa.

World stocks and prices

Supply fell short of demand by a total of over 220,000 tons in 1966 and 1967 which more than cancelled out the 1965 surplus of about 180,000 tons. This was reflected in the higher price levels experienced during 1967. For the first nine months of the year, the price for Spot Ghana Cocoa fluctuated between £215-250/ton compared with an average of £196/ton in 1966 and £140/ton in 1965.

The fact that the poorer production level of 1965-66 and 1966-67 has been forecast to continue in 1967-68 means that there will be a further substantial deficit in 1968. In many parts of the world stocks are already at a fairly low level and pressure from these areas will mean that the upward trend in prices is likely to continue. Whether the 1968 consumption forecast makes sufficient allowance for this upward price movement remains to be seen.

International cocoa agreement

The efforts to secure an international cocoa scheme have continued throughout 1967 and there have been several meetings of the working party of seven leading consuming countries and seven leading producing countries. Substantial progress was made at their last meeting at Geneva in October and a full Negotiating Conference is to be held in Geneva during December.

WORLD COCOA PRODUCTION AND GRINDING DATA
Issued by the F.A.O. in November 1967
(Thousand metric tons)

Production

	1965-66	1966-67	1967-68 (forecast)
Africa	860·5	961·7	934·5
South America	250·7	266·1	269·1
North and Central America ..	74·7	74·5	74·2
Oceania	20·9	24·6	30·1
Asia	8·1	7·6	7·9
World Total	1,215	1,334	1,316
Principal Countries:			
Ghana	415·7	381·3	416·6
Nigeria	184·0	264·0	213·4
Ivory Coast	113·3	150·0	137·0
Cameroon	78·8	85·0	88·0
Fernando Po/Rio Muni	30·5	38·6	37·0
Brazil	170·9	173·3	180·0
Ecuador	36·0	49·0	44·0
Dominican Republic	28·0	27·0	27·0
Mexico	22·5	23·8	24·0
New Guinea and Papua	18·0	21·0	25·0

Grindings

	1966	1967	1968 (forecast)
Western Europe	608·7	587·4	585·7
North America	311·4	313·6	316·0
Eastern Europe and U.S.S.R. ..	134·8	160·0	171·5
Australia and New Zealand	18·4	18·2	18·6
Central and South America ..	156·1	153·9	154·1
Asia	60·5	54·5	55·7
Africa	92·9	101·7	123·7
World Total	1,383	1,389	1,425
Principal Countries:			
United States	293·4	295·0	297·0
West Germany	153·0	151·0	153·0
Netherlands	117·0	110·4	105·0
United Kingdom	107·7	100·0	100·0
U.S.S.R.	70·0	85·0	90·0
France	63·4	55·0	55·0
DEFICIT	168	55	109

The principal stumbling block at the two earlier Negotiating Conferences in 1963 and 1966 was the overall price range within which the control measures would operate. Agreement has now been reached, however, on an overall price range of £160-232/ton and also on the mechanism of quota control within this range.

Postscript

Since the time of writing it has been announced that this latest Conference has also been unsuccessful. There were outstanding differences on a number of technical points and the negotiations have been adjourned pending further progress in informal consultations.

F. J. Pound and his Contribution to Cocoa Improvement

B.G.D. Bartley

Cocoa Research Unit, University of the West Indies, Trinidad

During the first thirty years of this century cocoa was the most important crop in Trinidad and Tobago. In 1927 it was considered that long-range research on this crop was necessary and that the recently-founded Imperial College of Tropical Agriculture at St. Augustine, Trinidad would be a suitable site for a research station considering Trinidad's position as a cocoa producer at that time. A programme for a Cocoa Research Scheme was drawn up with financial backing from Commonwealth cocoa producers and manufacturers and provision was made for the appointment of a geneticist, a plant physiologist and a soil chemist.

Three young men were recruited. They arrived in Trinidad late in 1930 and the first organised cocoa research station was established. The man appointed to the post of geneticist was F. J. Pound and, under the direction of Prof. E. E. Cheesman, then Professor of Botany, he began the task of improving Trinidad's cocoa population. Pound's active working life thereafter was devoted to the improvement of cocoa and embraced a period of 18 years.

F. J. Pound worked at the Imperial College of Tropical Agriculture until 1935 when he received the Doctor of Philosophy degree for his work on "The Fruitfulness of Cacao." He then joined the Trinidad Department of Agriculture as Cocoa Agronomist and became Deputy Director of Agriculture shortly before his departure from Trinidad in 1949. During World War II he was heavily involved in the island's food production efforts. On leaving Trinidad he went to Liberia for the Stettinius Corporation to examine the possibilities of growing cocoa in that country. Shortly after his arrival there in 1949 he lost his life in an accident at sea, and this ended a most notable career which had been devoted to the cocoa industry.

Dr. Pound's work on cocoa breeding falls into three categories. The first is the study of variability within the Trinidad cocoa population, and the subsequent application of his observations to individual tree selection. He also worked on the problem of fruit setting, which was the first study of the very interesting incompatibility mechanism which occurs in the species. The third field was the study of genetic resistance to witches' broom disease, and this included the search for resistant genotypes in other countries.

Most of his writings are to be found in *Tropical Agriculture* and the *Annual Reports on Cacao Research* published by I.C.T.A. Being virtually the pioneer in the field of selection studies in cocoa he made a number of observations which are still valid today.*

At the start of the Cocoa Research Scheme one of the features of the Trinidad cocoa population was the large genetic variation with yields averaging about 300 lb. per acre. This production came from a relatively small proportion of the trees. It was assumed that by selecting the higher-yielding individuals and propagating them vegetatively an improvement in average yields would be ob-

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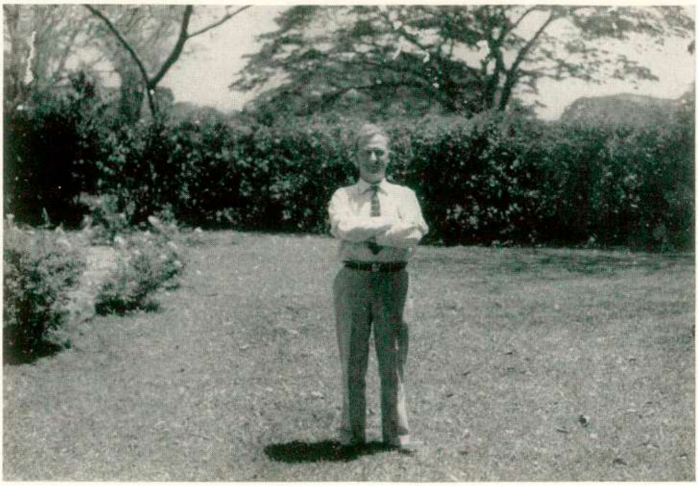
* Individual tree selection was used in Trinidad and Java in conjunction with budding some years prior to 1930 but the selections obtained have had little application in breeding programmes.



The late Dr. F. J. Pound.

tained when the poor trees were replaced with superior varieties. As a result of intensive studies on three cocoa estates Pound drew up his criteria for selection and from records of approximately 1,000 trees he selected 100 individuals which were the Imperial College Selections (I.C.S.). These clones were subsequently evaluated for yield in trials and the best clones were utilised by the Rehabilitation Scheme in Trinidad and later sent to other countries where they were used for planting and research programmes.

Pound's methods of single-tree selection were adopted by other countries with varying success. One reason for this was the large effect of environment on yield which Pound had pointed out but which was not always taken into account by other workers. He also observed that variability in yield was increased by poor environmental conditions which would affect the relation between genetic and phenotypic yields and result in poor efficiency in selection.

Shortly before the Cocoa Research Scheme was started, a new disease, witches' broom, had made its appearance in Trinidad cocoa. In the 1930s this became very serious, more so because of the economic depression, so that when Pound joined the Department of Agriculture he became involved in combating the disease. Other methods of control had not been effective and it appeared that genetic resistance would be the only satisfactory method of reducing the losses. Pound, therefore, started to look for resistant trees in parts of the island where the disease was severe. Buddings and progenies of apparently resistant trees, selected out of 150,000 trees examined, were planted at a station of the Department called Marper Estate. (The word "Marper" was derived by combining the first syllables of the name *Marasmius perniciosus*, the fungus which causes witches' broom disease).

None of these selections was resistant, and as a result of promptings from cocoa growers the Government of Trinidad decided to finance expeditions to "the home of cacao" for the purpose of obtaining resistant trees and superior varieties. Pound undertook the first of these trips to Ecuador from May to July, 1937, following the report by F. Stell of the occurrence of witches'-broom-resistant trees in that country. During this visit Pound collected pods from uninfected trees which he sent to Trinidad. There appear to have been 17 collections of budwood which were established at Marper the following year, after quarantine in Barbados to prevent the entry of *Monilia* disease into Trinidad.

Pound observed that the resistant trees differed from the two main populations cultivated in Ecuador, and postulated that the former were progenies of introductions from an area east of the Andes in the Amazon basin. His next expedition was to this region, and he travelled up the Amazon river to Iquitos in Peru early in 1938. In this area he found uninfected trees growing amongst heavily diseased trees. Four populations were described by him. These were the Nanay (Na), Parinari (Pa), Island (IMC) and Morona (Mo). Plants from these types were also introduced to Marper Estate. The number established from the two trips was about 2,500.

As a follow-up of his trip to Peru, Pound returned to Iquitos in 1942 where he re-examined the uninfected trees seen in 1938. Budwood was taken from those still free of the disease and also from another type, which he called Napo, and duplicate collections established in Iquitos and in Trinidad. These collections originally came from 32 trees and are referred to as the "P" (and sometimes "Pound") clones. These expeditions contributed greatly to the knowledge of the germ-plasm in Ecuador and Peru. This was probably the first time that genetic variation was described in the Forastero population of the Amazon Valley, and Pound's observations have been amply confirmed by subsequent expeditions.

When, in 1943, the Cocoa Research Station of the Gold Coast Department of Agriculture, Tafo, decided to enlarge its range of genotypes, in order to find tolerance to the swollen shoot virus, A. F. Posnette, plant pathologist at the station, came to Trinidad to collect some of the cocoa types existing there. Among the material sent to Tafo were a number of open-pollinated and hand-pollinated pods from trees of the 1937 and 1938 collections. Progenies of crosses among the Amazon types soon showed their superiority over the Amelonado cultivated in West Africa, so that by 1949 plant breeders at W.A.C.R.I. were becoming enthusiastic over their potentialities. The Upper Amazon types were responsible for a revolution in the cocoa industries of West Africa, and led to a considerable advance in production. From these introductions are being developed new varieties which are expected to further improve production in West Africa. The Upper Amazon types have also been introduced into other countries such as Papua and New Guinea and Malaysia.

In most cocoa-producing countries diseases play an important part in reducing yields, and breeding programmes usually are concerned with finding means of controlling these diseases by introducing resistant varieties. Two selections from Ecuador, Scavina (Sca) 6 and 12 are the most important sources of resistance to witches' broom available. These are being studied intensively and have formed the basis of several hybrid varieties, where the genes for disease resistance and high yield have been combined with the good characters of other genetic types.

In West Africa and the West Indies evidence of resistance to Black Pod disease has been shown to occur in the Forastero group. Resistance to *Ceratocystis fimbriata*, which is a devastating fungal disease in South America, also occurs in this group, and Trinidad and nearby countries are breeding for resistance. Tolerance to the swollen shoot virus of West Africa is also found in the Pound collections.

On account of their diversity Pound's collections are important for genetic studies, particularly in the case of incompatibility where the Iquitos collections were shown to behave differently to other types. This has augmented studies in this interesting subject which is unique among plant species.

The range of variability in the collections may be exploited still further. The "P" clones derived from the 1942 expedition have hardly been touched. Among these we know that P12 carries genes for vigour and has been reported as witches'-broom-resistant in Peru. Although the seedlings brought from Ecuador in 1937 comprise the largest and most varied collection, very little information has been collected about them or their potential value in cocoa improvement.

Experience with breeding has shown that maintenance of a large fund of genetic variability is necessary to deal with the numerous problems which arise or are likely to arise in the cocoa industry in a world-wide sense. Pound's contribution is in the size of the collections and especially in the fact that he was able to conserve genetic types which probably would not be in existence today. It should be borne in mind that during the time Pound worked in Trinidad conditions were generally difficult, due to the depressed state of the cocoa industry in that country resulting from the depression and World War II. However, he was always confident that his efforts would help the cocoa industry of Trinidad.

Perhaps one of the best ways by which we can summarise Pound's achievements is by quoting from a paper he read at the Cocoa Research Conference held at the Colonial Office in London in 1945.

"Brief and possibly incomplete as this note is, I trust that it will be useful in emphasizing that before a campaign is attempted in any crop, whether for yield or quality improvement of disease resistance, it is absolutely essential to be conversant with the whole range of the crop. We know the Trinitario cacao, the Andean cacao, the Cacao Nacional of Ecuador and the Amelonado of Brazil, but we did not know how they were related to one another, nor did we know what existed in the centre of the circle of which these types made the periphery. Now we do, we know how these cacaos are linked together, and we have discovered the fulcrum, so to speak, of the cacao world. Already this fulcrum has provided us with types definitely resistant and even immune to witches' broom disease under certain conditions, and on my suggestion they are being included in the attempts to find resistance to the swollen shoot virus of West Africa.

"Who can tell what other factors of interest can be obtained from this reservoir of cacao characters when the cacao breeding programme can be placed under way?"

Establishment and Maintenance of Cocoa on Borneo Abaca Limited's Estates

Part 2. Maintenance

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Weeding

Immature Cocoa. The area round the plant is hand-weeded until the wood is brown. If large seedlings are used this occurs almost immediately after planting. Once it is brown, "Gramoxone" (Paraquat) is used for this and for arsenite susceptible shade. The remainder of the area is strip-sprayed with sodium arsenite.

Mature Cocoa. Wherever possible weeding is done by hand by the allocation of blocks of cocoa to families for weeding in the afternoon after their main task. Failing that, herbicides are used, either high-volume applications of sodium arsenite solution, which must be applied with care and with good supervision to avoid harming the cocoa trees, or low-volume applications of one pint of "Gramoxone" per sprayed acre. Improvements may well be made following the study and development of the methods advised by Kasasian for the Caribbean (5).

Pruning

Initially the plant is restricted to a single trunk held at the first jorquette over five feet above the ground. Subsequently the plant is allowed to develop one more jorquette above this. There is no sound local evidence as to whether or not this is the best policy. But it is thought to be a reasonable compromise between loss of crop through pruning, and increased costs of harvesting and spraying through not pruning. It may well be that the pruning of the new, more vigorous crosses will need to differ.

Shade adjustment

The level of shade can never be quite right unless the shade trees are manicured at infinite cost. If costs are to be kept within bounds, the level of shade tends to fluctuate between too much and too little.

With one notable exception, shade trees are poisoned by ring barking and the use of sodium arsenite paste—1 gallon of water to 5 lb. of sodium arsenite with 6 oz. of starch. The exception is regenerated Leucaena or Leucaena which is too small to ring bark. Both are difficult to kill. The side branches are lopped, then alternate rows cut out and regeneration sprayed with low-volume 2, 4, 5-T made up of one part "Trioxone" mixed with one part "Lissapol" and 30 parts of water added. The remaining rows are either defoliated, when this is required, by spraying 2, 4, 5-T at the base and/or thinned in the same way as the alternate rows of shade. The use of 2, 4, 5-T requires care and is risky. The cocoa has been damaged in hot, dry weather but not killed.

Pests and Diseases

The main pests are bee-bug, *Helopeltis*, a variety of borers and rodents.

"Gammalin" 20 has been applied by Motoblo at 2·8 oz. active ingredient per

**The Editor wishes to apologise for the mistake in Mr. Brown's initials in the last issue.*

acre. This is applied twice, in two applications a month apart, against *Helopeltis* and bee-bug. 80 per cent γ BHC colloidal suspension is under trial.

"Dieldrex" 15, diluted to 1 per cent, has been used against stem borer. It is applied by jet oiler to the borer holes. "Gammexane" 26 DP has recently been applied at $\frac{1}{4}$ oz. per tree at the collar of immature trees and this appears to reduce attack by stem borer.

Damage to young plants by leaf-eating insects is checked by applications of 1 per cent lead arsenate solution. Fruit baits, injected with 0·01 c.c. of "Endrex" 20, are used successfully against arboreal rodents. Pig, monkey and civet cats are hunted.

The most common disease is *Botryodiplodia theobromae*. This causes die-back and can be fatal when a young fan branch dies back to the first jorquette. Then the whole fan is often affected and dies. While the disease does not appear to be as serious as in New Guinea, where general pruning of all diseased wood was advised (7), pruning is necessary when the whole fan is affected. It is important to remove all the diseased material by pruning back about 18 inches beyond the discoloured wood. The disease is thought to be severe only when something else is wrong, usually too much or too little shade. So when pruning is necessary, the primary cause should be sought and corrected.

White thread blight occurs. This is treated by the inclusion of "Perenox" (Cuprous oxide) at 1·6 oz. per gallon in the spray against capsids.

Fuller details of pests and diseases and their control are given in the Annual Reports of the Department of Agriculture, Sabah (3, 4, 5), and in a paper by Conway (2) on mirids. The help given by the Sabah Government Entomologist and Plant Pathologist is much appreciated.

Fertilizers

The nutritional problems of the basaltic soil types have been described by Allen (1). In the early years, Christmas Island rock phosphate and magnesium limestone were applied as fertilizers. The effect was uncertain. Subsequently sulphate of ammonia and muriate of potash were added. Latterly urea and compound fertilizers have been used.

It appears likely that applications of nitrogen and/or potash produce economic responses in yield, increase the canopy and hence reduce weeding. From work on abaca on these soils N, K and P could be deficient or marginally available.

In general terms, the aim of fertilizer applications, which are, of course, peculiar to our local conditions, is to apply fertilizer on the replacement principle plus more nitrogen. This would result in applications in the nutrient ratio of approximately 3:1:2. Fertilizer would be used which approaches neutral reaction and has soluble phosphates. This would also be applied to immature plantings. In mature cocoa, applications would aim to be twice a year when the flowers were setting. The experimental work to support this policy is admittedly inadequate but there is a good possibility that it is on the right lines.

(Opposite—top of page)
View of 9-*acre field planted in* 1958 *from which shade was removed in* 1964.

(Below)
Cocoa trees in the same 9-*acre field showing canopy and ground conditions.*

Acknowledgements

The work of all those who have made cocoa grow on Tiger Estate is gratefully acknowledged, particularly that of Mr. W. H. Rodgers. We also thank Borneo Abaca Ltd. and the Commonwealth Development Corporation for permission to present this paper to the Seminar.

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The Development of Pesticides

The Role of the Chocolate Manufacturer

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Insect pests, virus and fungus diseases are responsible for curtailing the yield of much of the cocoa that is grown. Chocolate manufacturers welcome the development of means of controlling such pests and diseases because effective control will help both to ensure an adequate supply of cocoa beans to meet the increasing usage in the world, and will lead to more efficient agricultural production by the cocoa grower. On the other hand, manufacturers wish to make sure that the control of pests does not involve the presence of any harmful residues in the cocoa beans, nor any deterioration in the flavour of the chocolate made from them.

Whilst the presence of harmful residues is important, this article deals largely with the methods which the British chocolate manufacturers, in co-operation through their Alliance*, have developed in an attempt to answer the question as to whether a new pesticide has an effect on chocolate flavour.

Problems of measurement of flavour in cocoa

Although modern gas chromatographic methods are now able to distinguish and measure some of the attributes of flavour, particularly in simpler media such as some of the flavouring essences, the complex taste and smell sensations of chocolate have so far defied sufficiently full analysis. There is no substitute for tasting in the mouth. But taste sensations are notoriously difficult to convert to words or numbers which can be claimed to represent a measurement of flavour.

There is another special difficulty with cocoa. The flavour is not apparent in the beans harvested from the tree. They must first be fermented to develop the flavour potential and then dried so that they can be transported without deterioration. Next, the manufacturer must roast the beans to bring out the flavour, and the cocoa nib, the edible portion, must be processed into a suitable form for tasting. All these processes must be carried out properly in order to develop the flavours expected in cocoa from the area concerned, and we know from experience that many of them can introduce foreign flavours which are quite abnormal to properly prepared cocoa beans. It is not, therefore, sufficient to make one sample of chocolate from beans harvested from trees treated with the new pesticide, and to conclude when a foreign flavour is found, as is not unusual in practice, that it has been caused by the pesticide.

Another difficulty arises from the long period over which the cocoa pod develops from the tiny flower into the huge thick-walled pod. It might be thought that the application of the pesticide shortly before harvesting is the stage most likely to cause an effect on flavour, but it is possible that the thick pod wall will protect the beans, and they might be affected to a greater extent by spraying at a much earlier stage of their development.

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*The "Alliance" refers to the Cocoa, Chocolate and Confectionery Alliance, an association of British manufacturers. The work described in this article is co-ordinated by its Cocoa Scientific Advisory Committee on which the following firms are represented: Cadbury Brothers Ltd., Mars Ltd., John Mackintosh and Son Ltd., The Nestlé Company Ltd., Rowntree and Co. Ltd.

The recommended procedure

These various difficulties which arise when attempting to answer the simple question as to whether the use of a new pesticide affects the flavour of cocoa have to a large extent been overcome, but only by means of a quite extensive testing procedure. This involves a great deal of work for each pesticide use, both by those preparing the samples in the growing area and by the manufacturers who are carrying out the flavour assessment.

First, a comparatively large area of growing cocoa, which has not already been treated with chemicals that might confuse the test, must be selected. This area must be large enough to yield sufficient ripe cocoa pods at the right time for the several harvests required. The cocoa throughout the area must be of one variety only, or if different varieties are normally grown there should be a reasonably uniform mixture. Part of the area should be treated with the pesticide at as least as high a rate, both in numbers of treatments and amount of pesticide, as is envisaged will be required in practice, and preferably at something like double the expected maximum, to provide some margin of safety to allow for the inevitable variations in extensive field application. The remainder of the area, should not be treated with the pesticide to serve as a control.

For each sample ripe cocoa pods should be harvested in sufficient quantity to provide 140 lb. of dry beans. From the treated area, harvests should be taken the day after the last application and then after periods of 1 week, 2 weeks, 4 weeks and 2 months following the last application. Where the pesticide is not applied over a period of some weeks it would be desirable to include a harvest 4 months after the last application to cover any effect on the young pods. Meanwhile, at least two control samples should be harvested from the untreated area at the same time as some of the test samples.

The pods should be opened and the beans fermented and dried by a method which has been found to give consistent results with the quantity of wet cocoa involved, and is comparable with the commercial methods used locally for the same variety of cocoa. At this and all other stages precautions must be taken to avoid contamination or confusion of the identity of the samples. Fermentation is probably the most critical step in the whole procedure, because, while it is easy to state the requirements, in practice cocoa fermentation is affected by many variables, some of which are difficult to control, such as the ripeness of the pods, the condition of the pulp which is affected by rainfall, and the air temperature. Each sample is of necessity the result of a single fermentation, whereas in commercial cocoa a number of fermentations are usually mixed and the effect of an aberrant fermentation will be reduced. Certainly, it has been our experience that quite marked flavour differences can appear in samples, apparently as a result of the fermentation process.

The fermented beans should be dried with care, to avoid mould growth, and bagged for despatch to a chocolate manufacturer, who will receive, for the testing of a single pesticide 5 or 6 samples harvested from treated trees, and at least 2 control samples which have been prepared and transported in exactly the same way as the treated samples. Each sample should consist of 140 lb. of dry beans. To these the manufacturer will then add a further sample taken from commercially prepared beans of the same type.

These 8 or more samples must then be processed into chocolate in a precisely comparable manner. The relatively large size of the samples at 140 lb. allows a full chocolate processing to be given, but it also involves the use of the factory equipment. The samples must be roasted separately, taking care that they are all roasted to the same extent, even if they differ in moisture content. The nibbing and winnowing machine for separating the shell must be carefully cleaned to avoid mixing in other cocoa and a similar cleaning must be carried out between each sample. The cocoa nibs are then processed into chocolate with the appropriate additions of sugar and deodorised cocoa butter, and the various machines must, for the same reason, be cleaned of any remaining chocolate from the previous batch between each sample. Finally each sample is conched. This is a process which lasts many hours, and helps to round off the flavour of the chocolate. It neither develops flavours which were not previously present, nor does it eliminate most extraneous flavours although it can greatly reduce those resulting from volatile compounds. The process both modifies and blends the flavours to produce a more finished chocolate and this makes it easier for tasters to assess the sample and to recognise any abnormal effects.

An adequate quantity of chocolate from each sample is tempered and moulded, with continued precautions to avoid any mixing of residues in equipment or confusion of labelling. The moulded chocolate should be allowed to settle for at least a week before tasting, and meanwhile the samples are labelled under a code which does not reveal their identity.

Tasters are presented with a series consisting of the additional control sample made from commercial beans, labelled "control," and, under code, and presented in random order, another piece of this additional control sample, the five or six samples made from beans harvested at intervals from treated trees, and at least two control samples made from beans harvested and handled with these test samples but taken from trees which have not been treated with the pesticide.

Identical sets of these samples are sent to each of the five manufacturers represented on the Cocoa Scientific Advisory Committee of the Alliance who arrange for their tasting by suitable panels. Each manufacturer's conclusions are reported under a number of headings which include the strength of chocolate flavour, the presence of normal flavours such as astringency, bitterness, acidity, fruitiness, etc., and the presence of abnormal flavours. After all the reports on each sample are received, the separate tasting conclusions are compared and the identity of the coded samples is revealed.

It is then possible to assess the consistency of tasting by comparing the coded additional control made from commercial beans with the named control, both being the same chocolate. The presence of any extraneous flavours arising from the fermentation and handling of the samples can be assessed from the control samples which were fermented with the test samples, and if the use of the pesticide has had an effect, this should be evident from the finding of differences in some at least of the samples prepared from cocoa harvested from treated trees. While the application of the pesticide at a particular time prior to harvesting may produce the greatest effect, the adjacent samples in the series should also show the effect if it has been caused by the pesticide. In this way, the series of samples with different intervals between treatment and harvesting afford some degree of replication of the trial, in addition to covering the application of the pesticide to trees bearing pods of different ages.

This procedure enables a moderate effect on flavour produced by a pesticide to be recognised with reasonable certainty, but difficulties do arise in interpreting the results. For instance, some pesticides are known to produce musty flavours, and the very similar musty flavour caused by mould is not infrequently encountered in experimental samples. If such an off-flavour is found in a few of the test samples, it can be difficult to decide whether it ought to be attributed to the pesticide treatment. Sometimes the fermentation of the sample is found to be unsatisfactory with little development of chocolate flavour, and the presence of undue bitterness and of unpleasant earthy or other off-flavours. Against such a background of flavours, it can be very difficult to detect some abnormal flavours which might be caused by the pesticide treatment.

Conclusion

It will be apparent that a considerable area of bearing cocoa and a great deal of very carefully conducted work is required both by the agricultural station and by the manufacturers to provide a reasonable measure of assurance that a new pesticide treatment will not affect the flavour of cocoa. The agriculturist, however, can at least use the bearing cocoa for extensive observations on the effect of the pesticide on the environment of the cocoa trees. Neverthless, it is obvious that such a test procedure cannot be used as an initial screening test, but must be applied at a comparatively late stage of the proving of a pesticide when it has already been shown to be promising in its effectiveness as a pesticide.

However, at this stage a good deal of work has already been done by the agriculturists, and naturally those investigating the use of pesticides would prefer that the ones which are unsatisfactory on flavour grounds are eliminated much earlier. This is not really practical for another reason. The methods of application and dosage rates used in the trial must be closely related to those which will be used in practice, and it is usually only after considerable experiment that the best technique of application can be decided.

It would, nevertheless, be possible to carry out a preliminary sorting test to eliminate pesticides which produce a marked effect upon flavour, and there are some which do. The agricultural station would have to be able to carry out a reasonably satisfactory small-scale fermentation of some 10-20 lb. of wet cocoa. An abbreviated trial on the lines of the foregoing procedure, with only two or three samples from trees treated with the pesticide at a fairly high rate, could be conducted, providing samples of the order of 5 lb. of dry beans. These would be made into chocolate by a laboratory process and should be adequate to detect marked effects on flavour. Such a procedure involving a good deal less work would enable some unsatisfactory pesticides to be excluded at an early stage, but would not obviate the need for the more comprehensive large-scale trial at a later stage.

Indeed, chocolate manufacturers, conscious of the need to continue providing the consumer with wholesome products of good flavour, must adopt a cautious attitude to the introduction of new pesticides into agricultural practice. The problem of residues from pesticides remains difficult, since the quantities may be so small that the cocoa has to be examined for the presence of amounts which are near to the limit of detection by analysis. And comparatively little is known of the significance of such traces of pesticides and of the extent to which some are converted to other, possibly undesirable compounds. Manufacturers are therefore concerned that adequate testing is carried out to determine whether traces of pesticides reach and remain in the cocoa beans, and adopt a cautious policy as to the amounts which should be regarded as acceptable in that they are recognised to be harmless.

The interpretation of even a comprehensive flavour trial can prove difficult. Where there is an obvious flavour effect, the conclusion is clear, but it is much more difficult to be certain that there has been no effect on flavour. Tasting, particularly of a food like chocolate which produces complex taste sensations, is difficult. There is a danger that some of the tasters may recognise a real difference in some of the samples from the treated trees, but their conclusions may be masked by other tasters, especially where the trial has shown an unusually wide range of flavour effects in the experimental samples. Sometimes the variation, apparently arising from the fermentation procedure, is so great that it is necessary to ask for the trial to be repeated before a conclusion can be reached. But one is reluctant to insist on the repetition of so extensive a trial, although it could be argued that a single trial is scarcely sufficient evidence to form a sound basis for the conclusion that the pesticide, used under varying conditions over a wide area, will not have any adverse effect which can be detected in commercially produced cocoa. This is the conclusion which should be reached before a pesticide is brought into general use.

When does it pay to spray Cocoa?

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Editor's Note:

We are indebted to the Editor of "Cacao," the journal of the Inter-American Cacao Center, Turrialba, Costa Rica, for permission to reprint this article. It originally appeared in "Cacao" XI, 1. Jan.-Mar., 1967.

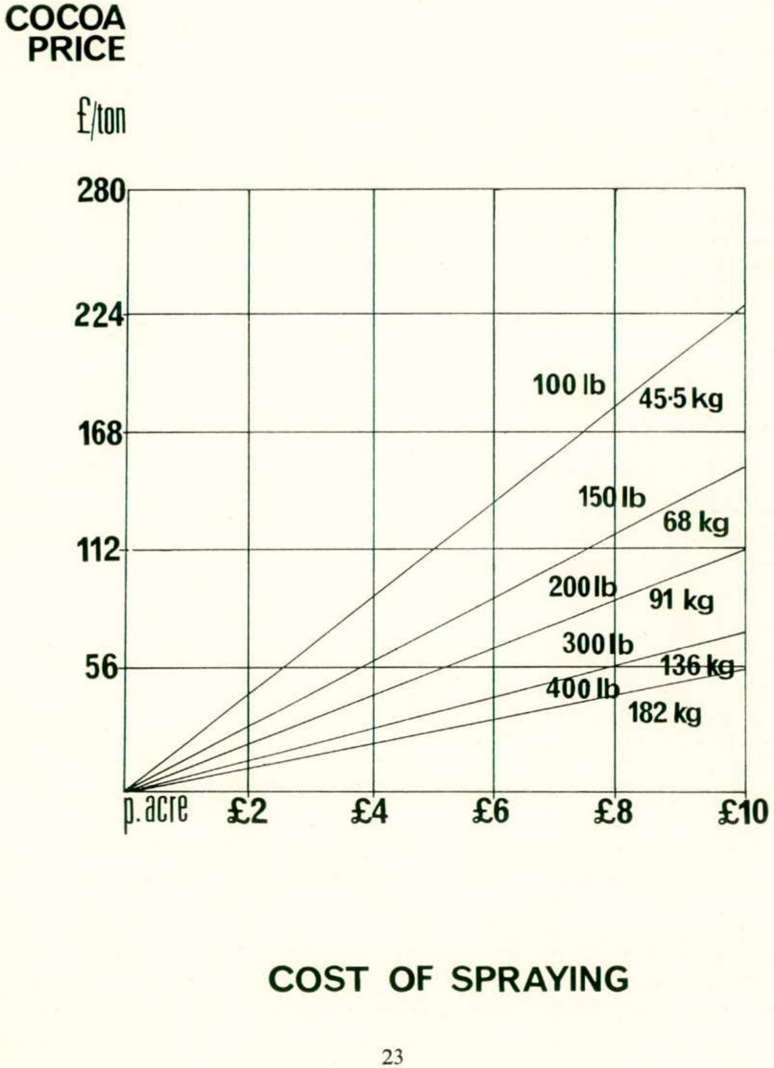
Many growers stopped spraying cocoa for the duration of the recent period of low prices on world markets. But prices have increased appreciably over the past nine months and show no signs of going in any direction but upward for the coming year, largely as a result of crop conditions in Africa. A grower who knows he will lose 20-40 per cent of his crop from Black Pod, and perhaps 10-20 per cent more from other fungi, which can largely be avoided by spraying with copper fungicides, should consider beginning a spray programme now if he has not already.

There are four factors which determine when it pays to spray: (a) the cost of spraying; (b) the yield one can expect without spraying; (c) the increase in yield to be expected from spraying; and (d) the money value of this increase, which is determined by the selling price, and which is usually known fairly well in advance.

With the help of the accompanying tables (Tables 1 and 2) any grower who knows what his normal yields and his losses from disease and insects are can determine whether it will pay to begin spraying. If he does not know what his losses are, he should find out as soon as possible by spraying part of his plantings in full bearing and keeping yield records for at least 6 months. Losses have been anywhere from 2-95 per cent in different countries (19). For Costa Rica it can be said that losses from pod rot at Turrialba and La Lola on unsprayed cocoa in full bearing have been from 25-80 per cent. A common figure is approximately 50 per cent (3, 4, 6, 9, 11, 12, 13). The cost of 10 applications of an effective copper fungicide has been between \$60·00 and \$80·00 per hectare for labour, materials and depreciation using knapsack mistblowers when 2·3 kg. of a fungicide costing \$1·33 per kg. is applied per hectare per application. This includes \$3·33 per hectare for depreciation on sprayers and \$0·75 for a tractor used for hauling water. By reducing losses from 50 to 10 per cent the increase in yield amounts to 30 per cent. With a yield of 500 kilos of dry beans per hectare it is evident from the table that the cost of spraying (\$70·00) is not matched by the 30 per cent increased value of the crop until the price reaches \$0·47 a kilo. But if the yield for a year is 1000 kilos per hectare, one can recover this cost of spraying by an increased yield of only 15 per cent at a market price of \$0·47. Similarly if the yield is normally 1000 kgs. without spraying, a price of \$0·35 would warrant spraying to increase yield 20 per cent. In Ghana a price of \$0·35 per kilo in 1960 was too low to cover cost of spraying when yields were below 500 kilos per hectare (2).

Several facts should be kept in mind when trying to decide when to resume spraying after stopping for a few years. One is that all the benefits do not come the first season, but are cumulative, especially if diseased pods are removed regularly (6, 16, 18). Hammond (6) in Ghana using mistblowers between 1953 and 1956 increased yields each year until he finally obtained over 100 per cent more beans per acre (from 273 to 588 lb.). In Fernando Poo where spraying was practised for 25 years by a majority of the growers, it became possible to reduce

GRAPH OF SPRAYING COSTS AGAINST COCOA PRICES AT VARIOUS YIELD INCREASES



the number of applications to 5 or less according to Thorold (16). The same cumulative benefits have been noted by others (3, 19). In Western Nigeria Thorold (17) recommends a three-week cycle for sprays the first year. On such a schedule Sanders is said by Tollenaar (19) to have obtained a 200 per cent increase in yield with 2 per cent cuprous oxide in seven months in the British Cameroons, and eventually to have tripled production with cuprous oxide and a Kiekens automatic mistblower.

Another benefit seldom stressed because it is not easily measured is closely related to the cumulative effect of fungicide applications. Spraying with copper fungicides has been shown by Nichols (11), by Bartolome (1) and by Gonzales (5) to result in more cherelles remaining on the plant and reaching maturity. Of several cocoa fungi tested at La Lola, that might conceivably cause cherelle wilt, Gonzalez found only *Phytophthora palmivora* was able to do so (5, 10).

TABLE 1

Minimum price per kilogram of dried beans at which it just pays to spray when spray costs are $70 a hectare

	Yields without spraying			
Per cent increase in yield from spraying	500 kg/ha	1,000 kg/ha	1,500 kg/ha	2,000 kg/ha
10	1·4	·70	·47	·35
15	·94	·47	·31	·23
20	·7	·35	·23	·17
25	·56	·28	·19	·14
30	·47	·23	·16	·12
35	·4	·20	·13	·10
40	·35	·17	·12	·08

TABLE 2

Minimum per cent increase in yield needed to meet the cost of spraying ($70.00) at five price levels.

	Yields without spraying			
Price per kilo dry beans	500 kg/ha	1,000 kg/ha	1,500 kg/ha	2,000 kg/ha
·20	70%	35%	23%	17%
·30	47	23	16	12
·40	35	17	12	8
·50	28	14	9	7
·60	24	12	8	6

A third benefit from copper fungicide application is the destruction of the epiphytes (mosses, liverworts and vascular plants) that grow on the trunks and branches of the trees in the wet tropics and are correlated with reduced yields as noted by Thorold (14, 15). In a six-months' comparison of fungicides begun in

1965 in Costa Rica the copper reduced such growth 50 per cent. Yields went up but Black Pod control was largely responsible for this. However, the microclimate close to the flower stalks is probably more favourable for *Phytophthora* activity when epiphytes are abundant on trunks and branches. The effect of copper sprays in suppressing such growth may last for a year according to Thorold (15).

With these three benefits from spraying it is not surprising that yields can be doubled or even tripled by regular applications of an effective copper fungicide (3, 6, 13). However, one should not be mislead by figures of percentage yield increase. Cost of spraying is not very flexible. If normal yield is low because trees are too old and are not capable of high yields even 100 per cent increase in yield may not be enough to offset spraying costs. It may be time to rogue out such trees and replace them with higher yielding stock and improve other cultural practices. Table No. 2 indicates the per cent yield increases needed to offset the cost of spraying at five price levels and four ordinary yield levels.

Experiments at Turrialba and elsewhere have indicated that a cuprous oxide fungicide may be the best substitute for Bordeaux mixture (6, 8, 9, 17, 18, 19). No other copper fungicide currently available has exhibited the tenacity or given the control that cuprous oxide has, although it is still inferior to freshly made Bordeaux. Our experiments have shown that after seven inches of rain cuprous oxide without oil has retained next to 4-4-50 Bordeaux, the greatest protective capacity against *Phytophthora* on cocoa leaves of any of the eighteen fungicides tested in 1965. With little rain some are as good as Bordeaux for a short time. But the fact that cuprous oxide can be employed at high concentration without settling out is in its favour. Mistblown sprays dry much faster than high volume Bordeaux sprays. This is a great advantage in the wet tropics where an average of three to four hours of good drying conditions a day may be all one can expect over much of the year. A spray application that does not thoroughly dry before being rained upon is not nearly as tenacious as one that does, and tenacity is very important in rainy weather if a long cycle spray programme (e.g. four weeks) is to be effective. Hislop (7) noted that it took five hours at 95 per cent relative humidity to obtain the same tenacity of cuprous oxide as he obtained with one hour drying at seventy per cent relative humidity. It may be wise to be less rigid about following a spray schedule every three to four weeks and instead spray after every six to eight inches of rain (15-20 cm.). A simple rain gauge can be made out of a tin can and a ruler.

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Letters to the Editor

Dear Sir,

I enjoyed the extracts from the book by de Chélus and comments on them by H. Toxopeus (Cocoa Growers' Bulletin 8, pp. 29–30) regarding cocoa shade, with the statement that "We now know at least that the tradition did not exist in 1724." I wish to draw attention to early reference to the need for shade in America by Benzoni ("La historia del mondo nuovo", 1565). This work is mentioned by Mueller ("Seltsame Frucht Kakao", 1957) and has been translated by W. H. Smyth (Hakluyt Society, London, 1857)".

Yours sincerely,

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Bedford.

Dear Sir,

I am very grateful for Mr. Thorold's interest in my letter to the editor and for having drawn attention to Hr. Mueller's book "Seltsame Frucht Kacao". As to his challenge he has pointed to documentary evidence that the use of overhead shade for cacao cultivation was known in the Americas as far back as the early 16th century. The cacao farmers referred to apparently went out of their way to make sure that the cacao trees were shaded. However, there are two more references to the use of shade in Mueller's book. On page 24 he quotes the following information from the report to the Pope Clement VII, by Petrus Marty de Angleria, Imperial Co-ordinator in Spain of Reports from the New World.

". . . the bean is somewhat bitter although rather mild, like a peeled almond. The tree is planted in few places because it needs a hot and at the same time humid climate and a rather fertile soil. The tree is planted in the shade of another which keeps it from the hot sun and the fog. . ." "As soon as the cacao starts growing and the roots spread out, *the shade tree is felled.*" On page 25 a young knight in Cortes's army is reported to have given a description of cacao trees growing in the shade of larger trees. This shows that the original Maya cultivators were flexible in their use of permanent overhead shade. There was not, apparently, a *tradition*.

Yours sincerely,

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Notes on Contributors

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Born–New Delhi India, February 1927. Educated–St. Paul's School, Darjeeling and Allahabad Agricultural Institute, Allahabad. Received B.Sc. (Agr.) degree from University of Allahabad 1947. Iowa State College, Ames, Iowa, U.S.A., from 1947, where he studied plant breeding. M.Sc. (1949) and Ph.D. (1950) for work on oat and soya bean breeding studies, respectively. Joined I.C.T.A. April 1951 as Plant Breeder, Cocoa Research Scheme. Now Senior Lecturer. Travelled in most cocoa-growing countries in Latin America and West Indies, taking part in collecting expeditions in Colombia and Brazil. Advised Venezuelan cocoa industry on breeding programme. Research on breeding and genetics, disease resistance, quantitative inheritance in largest collection of cocoa types, studies of Theobroma and Herrania species and interspecific hybridization. Pioneered use of in-breeding in cocoa.

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Joined the Colonial Agricultural Service with a degree in botany, having specialised in cytogenetics. After training in Trinidad, where he worked on bananas, was one of the first botanists at WACRI when it was formed in 1944 at Tafo in the Gold Coast (now Ghana). Two years later he joined the Research Department of Rowntree & Co. at York as a biologist. Has been a member of the Cocoa Scientific Advisory Committee since 1946.

Cocoa Abstracts

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

May, 1967

Smyth, A. J. The selection of soils for cocoa. Soils Bull., FAO 5, p. I–III, 1–76 (1966).

Data on the relation between soil properties and the performance of cocoa are compiled from the literature to provide a guide to the suitability of soils for this crop. Subjects discussed include: climatic requirements of cocoa; factors affecting soil-forming processes in potential cocoa-growing countries; development of the cocoa root system in different types of soils; soil moisture and air requirements under different climatic conditions; soil factors affecting moisture retention, drainage, and aeration of soils; nutrient requirements of cocoa and the assessment of the nutrient status of soils; the assessment of the suitability of soils for cocoa; and field survey methods including mapping. A 3-page appendix contains explanations of some chemical criteria determined by soil analysis. 64 refs.

Allen, A. W. Problem soils in Sabah; brown loams and nutritional disorders in cocoa. Proc. 2nd Malaysian Soil Conf., Feb., 1966, p. 214–28. B.

Symptoms of foliar necrosis and die-back occured in cocoa in Sabah after an initial early high yielding period. The crop had been planted on brown loams derived from basalt and volcanic mudflows of basaltic composition. The soil analysis data of different soil series and the analyses of cocoa leaves are discussed. It is considered that the symptoms of foliar necrosis and die-back result from nutritional disorders related to excesses and imbalances of nutrients in the soil, involving chiefly manganese and possibly aluminium coupled with low calcium and low pH. Maps. Tables.

Newhall, A. G., and Diaz, F. A note for cacao growers on making Bordeaux mixture. Cacao; Inter-Am. Inst. Agr. Sci. 11, 2, p. 9–10 (1966).

Cocoa planters using Bordeaux mixture are given the following hints: (1) the $CuSO_4$ solution can be made in a metal drum if this is lined with a polyethylene bag; (2) hydrated lime will keep fresh if the paper bag is enclosed in a plastic bag sealed airtight; (3) the mixture can be stored for up to 3 weeks by adding a stabiliser such as 0·03–0·06% sugar, 0·05% Triton X–114, 0·03–0·06% $MnSO_4$, 0·03% $ZnSo_4$+0·03% soduim arsenate, or 0·06% coconut milk; (4) formation of large crystals in hot weather can be prevented by using a 1·2–0·5–100 rather than a 1·2–1·2–100 mixture; (5) low volume spraying with 280 l/ha of a 4·8–2·4 –100 mixture, using a mist-blower with continuous agitation, results in quicker drying of the spray and equally good coverage as a drenching spray with 1,400 l/ha of a 1–0·5–100 mixture. 3 refs.

Waite, B. H., and Guillermo Salazar, L. Pod rot of cacao pods caused by Fusarium roseum. Cacao; Inter-Am. Inst. Agr. Sci. 11, 2, p. 6–7 (1966).

Cocoa pods in Costa Rica occasionally show internal rot limited to the pulp or invading the endocarp as well, while they are externally healthy in appearance. Fungal isolates from diseased tissue were identified as *Fusarium roseum* f. *gibbosum*, a common saprophyte. Inoculation of the endocarp, in particular of young and fully mature pods, with these isolates produced internal rot whereas inoculation of wounded exocarp did not. Fungi isolated from external lesions included the pathogen, the f. *graminearum* of the same species, *Colletotrichum*sp., and a few other fungi. It is thought that the pathogen can infect pods only through wounds such as punctures made by *Monalonion*; it appears to be of little economic importance but may accelerate the development of rot caused by *Colletotrichum*. Photo. 2 refs.

Newhall, A. G., et al. Results of some soil treatments on black pod rot of cacao, caused by Phytophthora palmivora. Cacao; Inter-Am. Inst. Agr. Sci. 11, 2, p. 10–2 (1966).

Plots of a 17-year-old cocoa field in Costa Rica were mulched with coffee parchment, sprayed with a wax emulsion, sprayed with a soil fungicide, sprayed with malachite green, or left untreated. None of the treatments, which were aimed at preventing the development of *Phytophthora* zoospores from diseased pod remnants in the soil and/or their reaching the pods on the trees with splashing raindrops, had any appreciable effect on the proportion of pods with black pod disease during the following 7 months. It was confirmed that black pod incidence increased with the number of pods present at any time; a tree spraying programme should be based upon this fact in order to reduce spraying costs to a minimum. Regular removal of diseased pods from the field is recommended. Table. Graphs. 13 refs.

Jiménes S., E., et al. Efecto del nitrógeno, potasio y boro en el crecimiento de la buba de puntos verdes en cacao. (The effect of nitrogen, potassium and boron on the growth of the greenpoint gall in cocoa). Proc. Caribbean Region, Amer. Soc. Horticult. Sci. 9, p. 214–23 (1966).

The effect of N, P and K on the growth of the greenpoint gall was studied in greenhouse experiments at Turrialba, Costa Rica, in relation to the growth of cocoa seedlings which had been inoculated with the fungus *Fusarium decemcellulare*, the cause of greenpoint gall. Nitrogen had a highly significant positive and linear effect on the growth of the gall, and a highly significant negative and linear effect on the growth of the seedling proper, suggesting that gall growth took place at the expense of normal plant growth. Application of K and B had no significant effect on gall growth, but the $K \times B$ interaction was positive though significant only at the 7% level. English summary. Tables. Graph. 12 refs.

Barros N., O. Valor de las prácticas culturales como método para reducir la incidencia de Monilia en plantaciones de cacao. (The value of cultivation practices as a method of reducing the incidence of *Monilia* in cocoa fields). Agricultura Trop. 22, 12, p. 605–12 (1966).

Maintenance of one half (plot A) of a 20-year-old cocoa field in Colombia was limited to 3 annual weedings and replacement of dead trees (the usual system).

In the other half (plot B) some additional measures were taken, viz. removal of chupons, pruning at 6-monthly intervals, wound dressing, and drainage. In the 2nd year, the incidence of *Monilia* pod disease in plots A and B was 17·1 and 8·8%, respectively, whereas the incidence of black pod (about 8%) and anthracnose (about 7%) remained equal in both plots. Yields of dry cocoa per ha were, respectively, 500 and 570 kg in the 1st year, 588 and 1,050 kg in the 2nd year; the large increase in plot B is ascribed to the effects of *Monilia* reduction and pruning. English summary. Tables. Graphs.

González, J. A. Prueba de fungicidas para el control de moniliasis en cacao porcelana. (A trial with fungicides for the control of moniliasis in porcelana cocoa). Proc. Caribbean Region, Amer. Soc. Horticult. Sci. 9, p. 160–4 (1966).

A trial with the spraying of fungicides for the control of *Monilia roreri* attacking pods of the porcelana cocoa variety in the State of Zulia (Venezuela) is described. The trees were sprayed with formulations of maneb (at 1 kg/ha), zineb (at 1 kg/ha), copper oxychloride (at 2·5 kg/ha) and cuprous oxide (at 2·5 kg/ha), in combination with DDT (25% emulsion at 1 l/ha), at 2- and 3-week intervals, respectively. Treatment with maneb plus DDT at 2-week intervals alone resulted in a significantly higher yield of healthy pods. English summary. Tables.

Champaud, J. L'économie cacaoyère du Cameroun. (Cocoa in the Cameroon economy). Cah. O.R.S.T.O.M.; Sér. Sci. Humaines 3, 3, p. 105–24 (1966).

A general account is presented of cocoa growing in the Cameroon Rep., its role as a source of income for the grower, its importance for the economy of the country, and its prospects. The 80,000 tons of cocoa exported in 1964/65 represented over 25% of the total export value. A climatic sketch map indicates that the whole south-eastern part of the country is suitable for cocoa; however, most plantings are to be found in an ethnologically defined region in the western part of this zone. The crop is mainly limited to small family farms, the mean area planted with cocoa per farm being only about 2·5 ha. Methods of cultivation and curing are still very primitive and, consequently, the quality of the product is rather low. A large proportion of the cocoa area is treated against capsids by a government organisation, and other attempts at raising the standard of management are being made by the government. Tables. Maps.

Jiménez Sáenz, E. Estudio de la fermentación del cacao obtenido por dos sistemas de quiebra de la mazorca. (A study of the fermentation of cocoa beans obtained by two different pod breaking systems). Proc. Caribbean Region, Amer. Soc. Horticult. Sci. 9, p. 206–13 (1966).

The fermentation of two batches of cocoa beans, one batch having been obtained from mechanically broken pods and one from hand broken pods, was studied at Turrialba, Costa Rica. Apart from a slight delay in the rise of temperature in the first batch, there were no significant differences in the fermentation process as judged on the basis of the development of temperature and Quesnel index, and the internal appearance of the dried beans. The external appearance of the beans obtained from mechanically broken pods was, however, inferior to that of the "normal" beans because of a chemical reaction between the acid juice of the pulp and some metal parts of the pod-breaking machine. English summary. Tables. 5 refs.

Cáceres Ramos, H. Cacao: bibliografía de las publicaciones que se encuentran en la Biblioteca Conmemorativa Orton. (Cacao: bibliography of publications available in the Orton Memorial Library). Turrialba (Costa Rica), Instituto Interamericano de Ciencias Agricolas de la OEA, 1966. Bibl. 2, Suppl. 2. VI, 132 p. (mimeogr.).

This bibliography lists the titles of publications on cocoa, grouped according to subjects, that can be found in the library of the Inter-American Institute of Agricultural Sciences at Turrialba, Costa Rica. The first list, by A. Martinez and C. Noel James, contained 1,748 entries and was published in 1954; the 1st supplement, compiled by the same authors and containing 1,026 entries, appeared in 1958. The 2nd supplement contains 1,215 entries. Each list is followed by an author index. The preface and the table of countries are in English and Spanish.

June, 1967

Saunders, J. L., et al. Endosulfan and lindane residues on the trunk bark of Theobroma cacao for the control of Xyleborus ferrugineus. J. Econ. Entomol. 60, 1, p. 79–82 (1967).

In Costa Rica, the residual effects of endosulfan and lindane against the borer beetle *Xyleborus ferrugineus* were compared in three cocoa fields; the basal 60–90 cm of the trunks were sprayed at a rate of ½l of fluid per tree. Residual toxicity was determined by exposing *Drosophila* flies to pieces of sprayed bark. Spraying with 1% endosulfan left appreciable residues after 20 weeks though tree-to-tree variation due to differences in exposure to rain was large. Spraying with 1% lindane resulted in a higher initial toxicity but the residual action did not last for much more than four weeks. A 1% endosulfan concentration was more effective than a 0·33% concentration; addition of 0·2% of a sticker or of 2% diesel oil did not greatly affect its action. Tables. Graphs. Photos. 4 refs.

July, 1967.

Glendinning, D. R. Technical aspects of the breeding programme at the Cocoa Research Institute, Tafo, Ghana. I. Breeding methods. Euphytica 16, 1, p. 76–82 (1967).

Cocoa selection in Ghana is directed towards high-yielding seedling progenies similar to amelonado in bean characters, and tolerant of swollen shoot virus, black pod, and drought. This goal is being approached by crossing Amazon with amelonado and trinitario varieties. Preliminary selection within each type to obtain superior parent clones is becoming increasingly necessary. Within the Amazon type, Nanay and Scavina clones impart more hybrid vigour than does Parinari. Incompatibility, which anyhow may be slightly unstable, may be overcome by mixing a little compatible pollen carrying a marker gene with the incompatible pollen. Efforts to obtain haploids or di-monoploids have not yet been successful; interspecific hybrids and induced polyploidy appear to be of little value. 33 refs.

Imle, E. P. Plant material distribution and quarantine measures for cocoa. FAO Plant Prot. Bull. 14, 6, p. 134–40 (1966).

Cocoa breeding work will increasingly need introductions of foreign types, in particular of disease-resistant material. Resistance to *Phytophthora*, *Monilia*, *Marasmius perniciosus*, *Ceratocystis fimbriata*, gall diseases, and certain insects has already been found in certain cocoa strains. However, their dissemination carries the risk of introducing other diseases and pests. Pollen shipments are not always safe since fungal spores may survive freeze-drying; consequently, shipment of seeds and budwood cannot be avoided, and this method may be the safest if a strict quarantine is maintained. A germ-plasm collection has been established foı this purpose at Mayaguez in Puerto Rico as a complement to the cocoa budwood garden at Miami, Florida (U.S.A.), both being under the control of the U.S. Dep. of Agr. Continued international support is necessary. 20 refs.

Tarjot, M. Etude de la résistance des cacaoyers à la pourriture des cabosses due au Phytophthora palmivora (Butl.) Butl. en Cote d'Ivoire. Deuxième partie: Inoculations experimentales au laboratoire par dépôt d'une goutte de suspension de zoospores sur la cabosse sans blessure. (A study of the resistance of cocoa trees to pod rot caused by *Phytophthora palmivora* in the Ivory Coast. Part 2: Experimental inoculations in the laboratory by depositing a drop of zoospore suspension on the pod without wounding). Café Cacao Thé 11, 1, p. 3–13 (1967).
In the Ivory Coast, inoculations of healthy cocoa pods with a culture of *Phytophthora palmivora* indicated the existence of a mechanism for resistance to the fungus in the outer layers of the pod of some Upper Amazon, trinitario, and hybrid trees. English, German and Spanish summaries. Tables. Photos. 6 refs.

Wood, G. A. R. Cocoa—a new crop in South India. Planters' Chron. 42, 2, p. 45–6 (1967).

A brief account is presented of the possibilities of growing cocoa in various parts of India. The total area of the scattered plantings in South India is less than 40 ha. A demonstration centre covering some 70 ha was established in Wynaad in 1965. It is hoped that through demonstrations, advice, the supply of planting material, etc., the growing of cocoa in India will be encouraged in order to reduce the actual imports of cocoa powder and chocolate. Photo.

August, 1967

Enríquez C., G. A., and Soria V., J. A study of the variability of certain leaf characteristics of cacao (Theobroma cacao L.). Trop. Agr., Trinidad 44, 2, p. 117–23 (1967).

A study of several metric characteristics of cocoa leaves from trees growing in Costa Rica was made to determine their value as an aid in describing cocoa clones. It was found that width and length of the leaf blade were not as good descriptive characteristics as their ratios. Basal and apical angles of the second, third and fourth mature leaf from the second oldest flushing of branches in the central part of a tree were also good differentiating characteristics to describe clones. The minimum sample size for each characteristic was estimated. Authors' summary. Tables. 7 refs.

Medeiros, A. G., and Alvim, P. de T. Influência do gas carbónico e da umidade do ar na esporulaçao do Phytophthora palmivora (Butl.) Butl. (Influence of carbonic acid and air humidity on sporulation of *Phytophthora palmivora*). Turrialba, Rev. Interam. Ciencias Agr. 17, 1, p. 18–22 (1967).

In the State of Bahia (Brazil), cocoa husks inoculated with *Phytophthora palmivora* were incubated in air of 70, 80, 90 or 100% relative humidity. In an atmosphere without CO_2, mycelium growth was reduced by a r.h. below 100%; in an atmosphere rich in CO_2 it was only reduced by a r.h. below 80%, indicating that

CO_2 stimulates mycelium growth. Without CO_2, the formation of zoosporangia showed a maximum at a r.h. of 80% and was zero at a r.h. of 100 %; sporulation was completely inhibited by CO_2. A field trial showed that sporulation is inhibited in the interior of heaps of husks. English summary. Table. Figs. 13 refs.

Saunders, J. L., and Knoke, J. K. Persistence of endosulfan, endrin, lindane, and malathion on cacao seedlings when formulated with Plyac and Estab. J. Econ. Entomol. 60, 2, p. 588–9 (1967).

Attack of cocoa trees by *Xyleborus* beetles may be prevented by painting the basal 60-90 cm of the trunk with an insecticide such as 1% endosulfan. Trials with 10-week-old cocoa seedlings painted with 1% or 0·1% concentrations of four insecticides, conducted in the U.S.A., showed that the toxicity of the treated bark, as assessed by bioassays using *Drosophila melanogaster*, could be considerably extended by dissolving the insecticides in 100 or 10% concentrations of two proprietary plastic-based stickers. One of the stickers reduced initial toxicity, but high mortalities after 224 days were still obtained using 1% malathion, lindane or endrin in 100% of this sticker. Table. 4 refs.

Shelton, B. Artificial drying of cocoa beans. Trop. Agr., Trinidad 44, 2, p. 125–32 (1967).

An apparatus simulating a commercial cocoa drier was set up at Lagos, Nigeria, and two factorial trials were conducted varying the air temperature, the air-flow rate, and the thickness of the layer of beans through which the hot air had to pass. The highest thermal efficiency was attained under conditions resulting in a rather long drying time and, consequently, a low machine efficiency. In practice a compromise will have to be struck between optimum thermal efficiency and minimum drying time. Theoretically, the two stages of the drying process: evaporation from the pulp and bean surface, and removal of water from the interior of the beans, would require different drying systems; however, the results of the trials cast doubt upon the economic desirability of a 2-stage drying process. Tables. Graphs. Four refs.

September, 1967

Jones, M. General review of the cocoa situation and outlook. In: Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca.) 66/1, p. 1–7.

The large world cocoa crop of 1964/65, of 1,528,000 tons, being much in excess of the then level of usage, has caused in 1965 a sharp price decline; world market price in 1965 averaged only U.S. $0·354 per kg against $0·495 in 1964. However, total export earnings from cocoa were not much affected, being about $500 million in 1965 as against $517 million in 1964. As a result of the decline of the world crop of 1965/66 to 1,262,000 tons, and of the increased world grindings in 1965 and 1966, the price level in the 2nd quarter of 1966 increased again to $0·51 per kg, while the large increase in world cocoa stocks is likely to be removed. World production and demand in 1975 are projected at 1·83 million and 1·75 million tons, respectively, implying that there will be then no major structural surplus or shortage. French and Spanish summaries.

Murray, D. B. Production trends in the cocoa industry of Trinidad. In: Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/4, p. 1–3.

Cocoa production in Trinidad declined from its peak of 34,000 tons in 1920/21 to a low of 3,000 tons in 1946/47. Measures for the rehabilitation of the industry, introduced since 1947, have resulted in a slow recovery. Production in the period 1950–60 fluctuated around some 8,000 tons, but has fallen off again since 1960. This decline must be associated with a long cycle of severe dry seasons, while the damage inflicted since 1958 by *Ceratocystis fimbriata* as well as in 1963 by a hurricane have aggravated the situation. At present about 40,000 ha are planted with cocoa, but not more than 32,000 ha are considered suitable for economic cocoa production at a yield level of at least 560–670 kg/ha. Graphs. French and Spanish summaries.

Weiss, J. S. A spectral analysis approach to Brazilian cocoa supply structure (with related market and policy discussions). In: Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/19, p. 1–5.

On the basis of a spectral analysis of monthly prices of Brazilian cocoa, indications were obtained that there exists a cocoa price cycle of an average length of 14 years, thought to be due to a cobweb-like relationship between price and production. A peak in the estimated spectrum indicated a biennial cycle in price thought to be either due to a relationship between price lagged one year and demand or price lagged one year and supply. The lagged price elasticity of supply of Brazilian cocoa is low, varying from 0·19 to 0·39. A national buffer system is suggested to stabilize income. Finally, a brief analysis of the process of Brazilian cocoa assembly is given. French and Spanish summaries. 12 refs.

Owen Jones, J. B. Underplanting coconut stands with cocoa on Kuala Perak Estate with special reference to planting methods and manufacturing procedures. Planter 43, 3, p. 95–8 (1967).

Methods of growing and processing cocoa on an estate in Malaya are outlined. Trials started in 1956 indicated that the coastal alluvial soils of the region were best suited to the crop. Most of the cocoa has, therefore, been sown at stake under coconut palms at a spacing of $3 \times 1{\cdot}2$ m, leaving every 2nd inter-row free to facilitate harvesting. Sowing is preceded by a passage of a rotary hoe; young plants are first shaded by palm fronds; young fields are kept weed-free by circle-spraying with paraquat. The pruning system aims at forming trees with two storeys. Leaf-eating beetles and *Helopeltis* are easily controlled with insecticides but rats remain a problem. The amelonado type planted in the first years was rather prone to die-back and has been superseded by Upper Amazon material. Photos.

Gunawardena, K. J. Yield characters of some foreign and local cocoa clones and their susceptibility to pod rot. In: Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 September, 1966. Working Paper (Ca) 66/2, p. 1–5.

The estimated yields of dry cocoa are given for a number of clones and lines either selected in Ceylon or introduced in that country from Trinidad, Malaya and New Guinea. The highest yields were obtained with the Upper Amazon clone Na 32. In Ceylon, some 20 to 30% of the pods appear to be attacked by pod rot (*Phytophthora palmivora*). The Upper Amazon clones Pa 35 and Na 32 were found to be least affected by pod rot, while the incidence of cherelle wilt was also lowest with these clones, especially with Pa 35. French and Spanish summaries. Tables.

Glendinning, D. R. Further developments in the breeding programme at the Cocoa Research Institute, Tafo. Ghana J. Sci. 6, 1–2, p. 52–62 (1966).

The recently commenced cycle in the breeding programme at the Cocoa Research Institute at Tafo, Ghana, aiming at the production of varieties to be grown from seed, is described. In 1963 the first plantings were made of four new series of varieties, these being: (1) series III, comprising general purpose varieties meant to be an improvement on the Tafo hybrid varieties (series II) first planted in 1952-54; (2) series IV, aiming at the selection of varieties tolerant of swollen shoot disease; (3) series V, representing varieties thought to be resistant to black pod disease; (4) series VI, comprising varieties with a certain hoped-for tolerance of drought. The reasoning behind the selection of parents for the crossings made in this breeding programme is outlined, and the most relevant characteristics of these parents are provided. Seed of these new varieties may become available to the farmers in the early 1970s. Tables. 13 refs.

Kenten, R. H. Loss of anthocyanins during the storage of dry fermented cocoa. Ghana J. Sci. 5, 3–4, p. 240–2 (1965; received 1967).

The anthocyanin content of amelonado cocoa fermented for 1–4 days was spectrophotometrically determined in Ghana during storage over a 4- to 5-month period. The amount of anthocyanins generally decreased with the increase of the time in storage; in most of the samples 30–55 % of the anthocyanins was lost over 4-5 months. As the amount of residual anthocyanins and quality in amelonado cocoa are closely correlated, quality assessments for studies of new methods of processing or of taint testing of cocoa by insecticides should take due account of the changes in anthocyanin content during storage. The interval between processing of raw cocoa and making up into chocolate for quality assessment should not be too short. Table. 8 refs.

Kenten, R. H., and Legg, J. T. Observations on the purification and properties of cocoa swollen shoot virus. Ghana J. Sci. 5, 3–4, p. 221–5 (1965; received 1967).

In Ghana, cocoa swollen shoot virus preparations obtained from cocoa seedlings grown under heavy shade proved more infective than those from plants growing in strong light. The virus can be well separated by ultra-centrifugation at 75,000 g for 60 min. or by precipitation with ammonium sulphate, using moderate concentrations of 125/150 g/l whereby precipitation of much inactive material is avoided. Much of the residual inactive plant material can be precipitated from ultracentrifuged preparations by treatment with ethanol or carbon tetrachloride and ether, but treatment with n-butanol inactivated the virus. Most of the infectivity of slurries or unclarified extracts was lost during storage at —25°C. for nine days, but this loss was less substantial with clarified juice. Tables. 11 refs.

Rocha, H. M. A bibliographical survey of cocoa varieties resistant to black pod disease. In: Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/16, p. 1–9.

Various methods used in tests for resistance of cocoa cultivars to black pod disease (*Phytophthora palmivora*) are reviewed. A list of cocoa species and cultivars found resistant, tolerant or susceptible to the disease in tests conducted in a number of countries is given. The necessity of establishing a standard method for the testing of resistance is stressed in view of the conflicting results obtained with different methods under different conditions. French and Spanish summaries. Table. 27 refs.

Vernon, A. J. The incidence of black pod at Tafo in 1965. In: Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/28, p. 1–16.

The incidence of black pod disease (*Phytophthora palmivora*) was studied in various experimental cocoa plantings at Tafo, Ghana, during the exceptionally wet 1965/66 season. The incidence of the disease was significantly higher in the shaded plots than in the unshaded ones, while there was also a general tendency for the incidence to increase with closer spacing. Furthermore there were indications that pods of the Amazon cocoa type are more attacked by the disease than pods of the amelonado type. The relationship between yield, spacing and shading with respect to the incidence of black pod disease are discussed. French and Spanish summaries. Table. Appenices. 17 refs.

Weststeijn, G. Susceptibility of Theobroma cacao L. to Phytophthora pod-rot disease. I. Field observations on clonal cocoa. In: Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/29, p. 1–20.

The relationship between the incidence of cocoa pod-rot (*Phytophthora palmivora*) and rainfall was studied in Western Nigeria. The incidence is low in the first three months of the rainy season (April-June), and rises rapidly in July to a peak in August/September when the main rains fall and the main crop is harvested. When the rains stop in Nov., the incidence falls rapidly to virtually nil. For a number of clones it was found that, independent of their susceptibility to the disease, seasonal yield periodicity had a marked influence on the disease incidence, as pods ripening in the dry season or early months of the rainy season mostly escape infection. On the basis of susceptibility and seasonal yield periodicity, 6 categories of clones could be distinguished. French and Spanish summaries. Tables. Graphs. 14 refs.

Spence, J. A., and Bartley, B. G. Testing of breeding material of Theobroma cacao for resistance of black pod disease (Phytophthora palmivora). In: Papers 2nc Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/6, p. 1–6.

Various methods of testing cocoa breeding material for resistance to black pod disease (*Phytophthora palmivora*) are discussed. The Prendergast tissue block method was found most suitable. Several clones and progenies of particular crosses were tested with this method in Trinidad, using a locally isolated strain of *Ph. palmivora*. The clone SCA 6 was found to be resistant, whereas a number of progenies with SCA 6 as a parent also gave a resistant reaction. Catongo cocoa, which is reported resistant in Brazil, was found susceptible to the Trinidad strain of the fungus. Some of the problems of combining resistance with other desirable characters are considered. French and Spanish summaries. Tables. 14 refs.

Rocha, H. M., and Jiménez S., E. Mecanismo fisiológico de la resistencia del cacao (Theobroma cacao L.) a Phytophthora palmivora (Butl.) Butl. The physiological mechanism of resistance of cacao to *Phytophtora palmivora.* In: Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/17, p. 1–15.

The content and fungitoxic effect of the phenolic substances present in the pod husks of three cocoa clones as well as the fungitoxic effect of some known phenolic substances on the germination and growth of the germ tubes of *Phytophthora palmivora* zoospores were studied in Brazil. The mechanism of resistance to the disease in cocoa pods appears to be physiological in nature, depending primarily on the presence in the epicarp of certain specific, partially identified phenolic substances. Pods of *Theobroma mammosum*, which are immune to *Ph. palmivora*, had a much higher content of total polyphenols and ortho-dihydroxyphenols than the pods of the three *Th. cacao* clones. English and French summaries. Tables. 22 refs.

Capriles de Reyes, L., et al. Resistencia de cultivares de cacao a Ceratocystis fimbriata. (Resistance of cocoa cultivars to *Ceratocystis fimbriata*). In: Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/7 p. 1–2.

Trunk canker caused by *Ceratocystis fimbriata* is at present the most serious cocoa disease in Venezuela; about half a million trees of the criollo cocoa type have been killed in the central cocoa zone. The method described by Delgado, whereby pieces of cocoa bark are inoculated with spores of the fungus, was found appropriate to test planting material for resistance to the disease. Some 150 cultivars have been tested; four categories were established with respect to the degree of resistance. The Amazon clones IMC–67 and Pound 12 as well as the Venezuelan selections Panaquirito–87 and Santa Cruz–10 were found highly resistant. English and French summaries. 3 refs.

October, 1967

Braudeau, J. Etat des travaux de recherches entrepris au Cameroun en vue de l'amélioration de la production cacaoyère. (The position of research work conducted in the Cameroon Republic on improvement of cocoa production). Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/8, p. 1–6 (1966).

Research on improvement of cocoa production in the Cameroon Rep. has led to the massive distribution of cuttings of 35 local and 15 introduced clones. Selection of hybrids with Upper Amazon cocoa is in progress. A spacing of $2{\cdot}5 \times 2{\cdot}5$ m appears most appropriate; fertilizing under present conditions is uneconomic. Damage caused by pod rot (*Phytophthora palmivora*) can be considerably reduced by spraying. The biology and ecology of *Sahlbergella singularis* and *Distantiella theobroma* and the nature of resistance to these mirids shown by some trees are being studied. Tray fermentation did not give satisfactory results. English and Spanish summaries.

Gutiérrez G., J. 21 años de investigaciones en el mejoramiento y la horticultura del cacao en el Ecuador. (Twenty-one years of research on improvement and cultivation of cocoa in Ecuador). Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/21, p. 1–6 (1966).

Out of 281 cocoa clones evaluated in Ecuador in 1951-66, 11 clones with yields of 860-1,600 kg dry cocoa/ha at an age of 6-9 years were selected. Among 133 progenies of crosses between Upper Amazon and local clones, eight progenies in the first three years yielded 400-600 kg/ha and were fairly resistant to witch broom disease (*Marasmius perniciosus*). N is the only macronutrient limiting production. Yields were significantly higher at a spacing of 2×5 m than at spacings of 3×5 or 4×5 m; there were no significant yield differences between cuttings and buddings of the same clone. Fermentation was better in trays than in heaps or boxes. English and French summaries. Tables. 6 refs.

Silva, L. F. da, and Cabala R., F. P. Posible expansión del area cacaotera de Bahia y Espirito Santo con el empleo de fertilizantes. (Possible expansion of the cocoa area in Bahia and Espirito Santo through the use of fertilizers). Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/20, p. 1–11 (1966).

The cocoa area in the states of Bahia and Espirito Santo (Brazil) has soils of good or medium fertility, but there is little scope for expansion of the crop. There are, however, about 2·5 million ha with tertiary sedimentary, so-called "tabuleiros" soils, with excellent physical properties but with a rather low chemical fertility. Yields of unshaded cocoa on these soils were considerably increased by the application of a complete fertilizer. In view of the high concentration of exchangeable Al and the low Ca and Mg contents, a basic dressing of lime and Mg appears indicated. English and French summaries. Tables. Graph. Map. 7 refs.

Opeke, L. K., and Toxopeus, H. Preliminary report on the yield and establishment ability of WACRI Series I and II cocoa varieties in Western Nigeria. Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/14, p. 1–11 (1966).

The yield and establishment ability of 29 progenies of WACRI Series I (inter-Upper Amazon cocoa crosses) and Series II (crosses between local and Upper Amazon cocoa selections) was compared to that of F_3 Amazon cocoa progenies in field trials conducted in W. Nigeria. With some exceptions, the Series I progenies were found as productive as the F_3 Amazon progenies, while the Series II progenies in general were superior in yield. Progeny S II H was most outstanding for yield, while progenies S II F and S II K were outstandingly superior in establishment ability. As to the combination of the two criteria, progeny S II F appeared the best. French and Spanish summaries. Tables. Fig. 7 refs.

Lems, G. Gegevens over drie legitieme cacao families. (Data about three legitimate cocoa progenies). Surinaamse Landbouw 15, 1, p. 11–22 (1967).

In Surinam, the productivity and the resistance to *Marasmius perniciosus* of legitimate cocoa progenies from the interclonal crosses SCA $6 \times$ IMC 67, SCA $12 \times$ ICS 98 and SCA $6 \times$ DR 1 were found to decrease in the order given. Data are presented on various pod characteristics. The existence in the SCA $12 \times$ ICS 98 progeny of two groups genetically different in their behaviour to *M. perniciosus* is indicated. Within the SCA 6 progenies the resistance to this disease was significantly correlated to low pod weight; this correlation was highest for the SCA $6 \times$ IMC 67 progeny, while here the resistance was also correlated with low pod content and bean weight. In the SCA 12 × ICS 98 progeny it was, however, correlated with a high number of pods and productivity, which may be partly caused by the direct influence of the disease. English summary. Tables. 4 refs.

Gunawardena, K. J. Cocoa planting subsidy schemes in Ceylon. Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/3, p. 1–3 (1966).

Under the first cocoa planting subsidy scheme, initiated in Ceylon in 1956, subsidies of about Rs 1,125 to Rs 1,500 per ha (U.S. \$1 = Rs 4·75) were granted for planting cocoa under marginal rubber. At the end of 1966 only about 800 ha had been planted. A second subsidy scheme, introduced in 1964, aims at the replanting of old derelict cocoa plantings. Under this scheme the farmer has to comply with certain conditions with respect to land clearing practices, shade establishment, erosion control, and planting and husbandry techniques, while the subsidy granted in six instalments over a period of 6–7 years amounts to about Rs 2,125 per ha. French and Spanish summaries.

Murray, D. B. Rehabilitation problems in Trinidad and Tobago. Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/5, p. 1–2 (1966).

Two subsidy schemes for rehabilitation of the cocoa industry were introduced in Trinidad and Tobago, the first aiming at complete replanting and the second at partial replanting of the old cocoa plantings. Due to limitations in the granted subsidies, the second scheme was favoured by the farmers. Experience has shown, however, that partial replanting merely maintains the low yield level while complete replanting resulted in highly increased yields, which quickly made up for the production losses in the first year after clear felling of the old trees. In view of its high costs, complete replanting must be confined to those areas where ecological conditions allow a yield level of at least 670 kg/ha. French and Spanish summaries. Table.

Vasconcelos, A., and Alvim, P. de T. Programa de replantación de cacaotales viejos en Bahia. (Replanting programme for old cocoa fields in Bahia). Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/18, p. 1–7 (1966).
The history of the development of the cocoa industry in Bahia (Brazil) is briefly described. Of the 400,000 ha planted with cocoa, 240,000 ha (60 %) carry trees more than 40 years old; average yields amount to 350–400 kg per ha only. To stimulate replanting, an executive committee (CEPLAC), having at its disposal and research centre (CEPEC) and an extension department (DEPEX), has been established. Under the planned rejuvenation programme, 35,000 ha will be replanted in the 5-year period 1967-71. The financial consequences and recommended methods of replanting are discussed. For replanting during this period, seedlings of the Catongo variety will be mainly used in the near future, but the planting of progenies of interclonal crosses now being selected is envisaged. English and French summaries. Tables.

Vernon, A. J. Yield and light relationship in cocoa. Trop. Agr., Trinidad 44, 3, p. 223–8 (1967).
Data from three shade experiments with cocoa in Ghana were combined to plot Y = the yield expressed as a percentage of that in full daylight, against L = the light intensity expressed as a percentage of full daylight. Within the range of L between 30 and 60% the relationship was well expressed by the regression equation $Y = 9{\cdot}6 + 2{\cdot}5L - 0{\cdot}013L^2$. This equation would put zero yield at L = 4%. An almost identical quadratic equation included yields in full daylight, but the exact shape of the part of the curve between L = 60% and L = 100% indicated by the equation is not substantiated by experimental data. Tables. Graph. 8 refs.

Jiménez Sáenz, E. Effect of the cacao pod breaking system on the flavour of chocolate. Cacao; Inter-Am. Inst. Agr. Sci. 11, 4, p. 8–9 (1966).
The use of the mechanical cocoa pod breaker developed in Costa Rica has already been shown to result in equally good fermentation as that of beans from pods manually opened with a knife. Subsequently, organoleptic tests made by six large chocolate manufacturing firms demonstrated that the internal quality of beans from mechanically broken pods was somewhat inferior to that of beans from manually opened pods. However, the difference vanished when the mass of beans coming out of the machine was submitted to rapid washing and removal of husk fragments by hand. Table. 2 refs.

Are, L., and Afonja, B. Correlation studies on some chupon-main stem characters of virus infected mature cocoa trees. Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca)66/13, p. 1–12 (1966).
The correlation between yield, stem and chupon girth, canopy and tree condition of 40-year-old cocoa trees infected with swollen shoot virus was studied in W. Nigeria. Yield per tree was found to increase with increase in number of chupons, greater girth, and better canopy, while the canopy improved with an increased number of chupons. It is suggested that the use of number of chupons and canopy score as calibrating variates additional to stem girth could bring about a reduction in variability of yield. The growth of chupons should be encouraged for the rehabilitation of virus-infected cocoa stands damaged by mirids. French and Spanish summaries. Tables. 11 refs.

Helfenberger, A., and Hutchins, L. M. Control of greenpoint gall of cacao on artificially inoculated cacao seedlings under greenhouse conditions. Cacao; Inter-Am. Inst. Agr. Sci. 11, 4, p. 1–7 (1966).
In Costa Rica, cocoa seedlings developing greenpoint galls in their cotyledonary axils as a result of inoculation of the seeds with *Calonectria rigidiuscula* were painted with fungicidal pastes 20, 27 or 60 days after planting, i.e., in the pre-emergent, incipient, and fully formed stages of the galls, respectively. During the next two months, two pastes containing yellow and red mercuric oxide, respectively, gave up to 90% control of gall formation, their activity diminishing slightly as their application was delayed. A paste containing nabam was effective only when applied to fully formed galls; mixtures of an organic copper compound with sulphur, and of captan with quintozene, were but little effective. Tables. Graph. Photos. 1 ref.

Newhall, A. G., and Díaz, F. A note on Phytophthora palmivora infected flower cushions on cacao at La Lola, Costa Rica. Turrialba, Rev. Interam. Ciencias Agr. 17, 2, p. 232–3 (1967).

Observations in an 8-year-old cocoa trial field in Costa Rica indicated that a considerable proportion of pods affected by pod rot had become infected through the pedicel. Evidently a large number of flower cushions were already infected with *Phytophthora palmivora* in this young field. The incidence of infected cushions was much higher in shaded than in unshaded plots, and was somewhat reduced by spraying with copper fungicides. Similar evidence on the importance of flower cushions as a source of inoculum has been collected elsewhere; it was found in Nigeria that such cushions may remain infective for 3 years. 11 refs.

Delgado, J.C., and Ampuero, E. Investigaciones que se efectuan actualmente en la Estacion Experimental Pichilingue en el combate de las principales enfermedades del cacao. (Research being conducted at the Pichilingue experiment station on the control of the main cocoa diseases.) Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/22, p. 1–4 (1966).

Pichilingue, Ecuador, cocoa clones Silecia 1, 5, and 8 have shown resistance to witch broom disease caused by *Marasmius perniciosus;* 30 other selections are under observation for possible resistance. The available clones are evaluated with respect to their resistance to pod rot caused by *Monilia roreri*, while promising results have been obtained with spraying of some commercial fungicide formulations. Using a newly developed technique, the selections are also tested for resistance to trunk canker caused by *Ceratocystis fimbriata*. English and French summaries. 7 refs.

Cabanilla L., H. Acción del congelamiento-secamiento sobre la viabilidad de las esporas de Monilia roreri, Cif. y Par. (The effect of freeze-drying on the viability of spores of *Monilia roreri*.) Papers 2nd Sess. Techn. Working Party on Cocoa Prod., Rome, 19–23 Sept., 1966. Working Paper (Ca) 66/23, p. 1–4 (1966).

In an experiment conducted in Ecuador, spores of *Monilia roreri* that were kept freeze-dried for 15, 75, 135, or 315 days proved able to retain their pathogenicity to cocoa for long periods, and considerably better than did untreated spores. Even after 315 days, 60% infection of cocoa pods was obtained with freeze-dried spores as against 20% with untreated spores. English and French summaries. Table. 5 refs.

Santos, M. A Cultura do cacau no Estado da Bahia. (Cocoa growing in the State of Bahia). Bol. Inst. Joaquim Nabuco Pesquisas Sociais 13–14, p. 149–95 (1964/1965; received 1967).

The development and present situation of the cocoa industry in the Brazilian State of Bahia are discussed from the point of view of the geographer. The first chapter analyses the factors that led to immigration of poor farmers growing cocoa and subsistence crops on State-owned land, and to the subsequent transition to a monoculture associated with concentration of ownership. The actual distribution of farm sizes is indicated, the financial position of the farmers discussed, and marketing of the product and trade organisations described. Chapter 2 discusses the competition between road, rail, and river transport, the growth of the cocoa belt from nuclei along rivers to its present extent as road communications were improved, and the rise of urban centres. Chapter 3 compares the Bahia cocoa industry with that of the Ivory Coast.

Taboada, E. Pèrdidas de peso durante la fermentación y el secado del cacao. (Weight losses during the fermentation and drying of cocoa beans.) Agricultura Técn. Mexico 2, 6, p. 242–9 (1966).

Published data from Trinidad concerning total fresh-weight losses of cocoa beans during processing in the dry and wet seasons are subjected to an elaborate mathematical treatment to calculate daily weight losses during the fermentation and sun-drying stages. The results, expressed in the form of regression equations, graphs, and tables demonstrate the inverse relation of fermentation time to drying time and the higher weight loss during fermentation in the wet season. Slow initial drying is considered desirable to obtain the best quality cocoa. Tables. Graphs. 2 refs.

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