COCOA RESEARCH CONSULTANT SERVICE TO MALAYSIA

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INTRODUCTION

The Malaysian Research and Development Institute (MARDI) requested this consultant service to accomplish the following objectives:

1. To evaluate and appraise the current cocoa research programme in terms of its objectives, scope and implications in meeting the needs of the country's agricultural development strategies.

2. To review the current research projects within the cocoa research programme and assess whether these projects are adequate in meeting the objectives and scope of the programme.

3. To appraise the extent to which current facilities, equipment, personnel and other infrastructure are adequate or sufficient for the cocoa research programme to be productive in the next 4 - 5 years.

4. To make recommendations or proposals for consideration by the Institute in terms of improving the cocoa research programme in order to meet the development needs of the country.

In order to accomplish these objectives a visit was made to Malaysia from July 17 to August 5, 1977 and the following activities were accomplished according to a Programme prepared by MARDI.

1. Visit to MARDI officials and briefing at Serdang.

2. Visit to the main cocoa producing areas of Peninsular Malaysia and Sabah: Cocoa plantations and small holdings.

3. Visit to other officials working cocoa small holding development schemes.

4. Visit to MARDI's cocoa experiment stations: Jerangau and Teluk Auson.
5. Personal interview with research staff of cocoa and coconut branch of MARDI and the research units of the main cocoa estates.
6. Written information about the "Five year cocoa research programme, 1976-1980" and the latest reviews to this programme which were made available.

Annex No. 1 contains the itinerary of the visits, the list of persons contacted in each locality and a condensed summary of my impressions about the cocoa research or situation in each area visited.

COCOCA PRODUCTION IN MALAYSIA

According to Figure No. 1, by 1976 Malaysia was producing 19.000 Tons of cocoa beans. After a modest start of 0.5T in 1963, 1T in 65-67 a sudden increase was started from 1970 up to the present time. This is a reflection of the rate of new plantings asestates and small holdings.

According to official figures (Table No. 1), by 1975 these were: 20.173,44 ha. in small holdings under cocoa and coconut intercropping system and 19.079,26 ha. in estates, predominantly under monocrop system. Cocoa is produced in 5 States of Peninsular Malaysia: Perak, Selangor, Johore, Trenganu and Penang, and two of East Malaysia: Sabah and Sarawak.

The government policy with cocoa is to increase by 1985 to 150.000 with cocoa, most of the increase will be by intercropping cocoa with coconuts, as a joint effort to rehabilitate and replant traditional old coconut areas with new coconut varieties, taking advantage of a big scale drainage scheme financed by the government.

Because of the priority given by the government to increase areas and improve cocoa and coconut production under small holdings with the cocoa and coconut cropping systems, MARDI has decided to concentrate the majority of its research effort in this area.

It is expected that in few years Malaysia will become one of the leading exporters of cocoa beans in the world.

CROPPING SYSTEMS

After visiting the cocoa areas of Malaysia, two cropping systems are very clear and are related with the kind of farmers of cocoa enterprise size: a) Cocoa as a monocrop, with or without permanent shade. This system is almost esclusively under large plantations and high management; b) Cocoa and coconut intercrop. The majority of this cropping system is practiced by small holders of the Peninsula. A few large estates on the State of Perak also use this system.

COCOA GROWING AREAS IN MALAYSIA

The visit covered 4 main cocoa growing areas in the Peninsula and one in Sabah.

Peninsula:

1. State of Johor: Sagil (Dunlop State), Rangit and Batu Pahat small holders).

   General climatic conditions in this area meet good requirements for cocoa growing. Rain amount and distribution together with temperature (daily and year ranges) are the main climatic determinants for cocoa growing. Data from Dunlop State (25 years average) show an average of 81 inches of rain per year and a two modal distribution, one high peak from March to June and other (the highest) from September to November. There are two low rainfall periods, the lowest from December to February with a minimum of average of 4 inches in February and the other from September to December with an average low of 6 inches per month, from October to November. With average temperatures of 24-26° C during the year and daily fluctuations below the 9° C required for cocoa, this area meets the best climatic requirements for cacao growing.

This bimodal distribution of rain determines the occurrence of 2 main peaks of cocoa harvesting, one from July to September and a second from February to April.

Soils. In Dunlop soils were mainly deep oxisols and ultisols with low pHs (4.3 to 5.2), very low organic matter and high base fixation values. Production of cocoa under these conditions is only possible under good fertilizer and water management. Soils in Batu Pahat and Rangit areas (Johor) were in general similar to Dunlop's, with considerable areas of acid sulfate soils, which are more delicate to manage, because of the present and potential lower acidities, if water levels and fertilizers are not well managed. Potential irreversible base fixation problems could be developed under poor management of drainage and fertilizers.

Diseases and Pests. Diseases seem to be less limiting factors for cocoa than pests. The more imnortant were capsids (Helopeltis sp.) attacking the young cherelles and leaf eating insects (Odoratus compressus, Apagonia expeditionis, Valanga migricornia). Serious defoliations and cherelle losses could occur if there is not a good control.

Vascular Streak Disease (VSD) complex is not an important problem, with exception of directly sun exposed areas particularly during wet spells. Nor Phytophthora palmivora is considered a serious disease in this area, although occasionally symptoms ate observed. Also some thread blights could appear in wet and heavy shaded areas.

2. Perak State

The Southwest coast of the State of Perak is at the present, one of the most important cocoa producing areas of Malaysia. The whole area is under the intercropping system of cocoa and coconut. Climatic conditions in general are reasonably well suited for cocoa growing. Data from Bagan Pasir (average of 40 years) give an annual mean of 79 inches, 96 inches for Teluk Auson (62 years average) and 123,4 inches for Klah (35 years average). Graph No. 1 shows a bimodal distribution of rain for Bagan Pasir and Teluk Anson. The low rainfall from May to July could be a limiting factor for growth and production (cherelle with a small fruit and seed size), particularly if dry spells are longer than 3 months and water table is low, as seen during the visit in some small holdings in the Southern areas. The rest of the year, rainfall is adequate for a good growth of cocoa. Temperatures are within the optimum for cacao, not below 20° C as low minimum average and not higher than 32° C as the highest maximum. These are two peaks of crop, very similar to the Johor area.

Soils. Apparently the majority of soils in the areas visited are marine clay and alluvials. Acidity was reported to be low (4.3 to 5.4). which was apparent by the presence of ferms among the weeds in some cocoa areas. During the visit (July - August), because of the drought, cracking of the soil was a common occurrence in the area. Cocoa plants were showing wilting symptoms due to shortage of water. Some acid sulfate soils were reported near the coast. Cocoa is grown in these soils only with fertilizers.

Diseases and Pests. In general diseases are not a significat limiting factor for production so far in the area. The more common are: CVD (Onobasidium theobromae) thread blight (Marasmius sp.), black pod and stem canker (Phytophthora palmivora), pink disease (Cortitium salmonicolor) and several root diseases. Although all of them can be found in the area, only CVD has relative importance in shaded areas and wet spells.

Very little insect damage was observed during the visit to the lower Perak area. The main insects reported are: leafeaters (Apagonia sp.; Valanga sp.; Cheatadoretus sp.), capsids attacking young twigs and fruits (Helopeltis sp.), mealy bugs; and other minor pests.

3. Pahang State - Sungai Tekan, FELDA Station.

Although no climatic records were available, cocoa was being grown in the area and FELDA has a scheme to establish 4.500 cocoa acres in its first phase. Apparently rainfall and temperature are adecuate for cacao. Rainfall distribution is more similar to the Jerangau area with high monsoon rain from September to December and a low peak in March-April. Cocoa growth was less vigorous than in the other areas.

Soils. The mayority of soils of the area were oxisols and ultisols with low pHs, from 4.0 to 4.7.

Diseases and Pests. VSD and stem canker (P. Palmivora) were cited as the most important actual and potential problems. Other diseases reported in the area were Bothrodiplodia sp., that becomes important when insect attacks are present; root diseases caused by Fomes sp. (white and brown) can cause up to 1%/year of tree deaths during wet periods.

Stem borers (Lepidopterae) were cited as the most important pest together with capsids (Helopeltis sp.). Rats and squirrels are the main pests for cacao. Together with damages caused by deer and fox, up to 20% pod losses can be accounted per year.

4. State of Trenganu

The main cacao producing area is located in the Jerangau region. Temperatures seem to fall within the optimum for cocoa. The annual mean of rainfall for 20 years (1952-72) was 150 inches.

The monthly distribution presented in Graph No. 1 indicates that 56% of the total rainfall occurs in the period from October to January (monsoon), with a lower rainfall period for February to April (8 to 5.5'), but with enough rain to meet the demands of cocoa, followed by an intermediate peak from May to September, with monthly averages from 8 to 10', which are as high as the high peak rainfall in the other areas. The area has perhaps excesive rain and cloudy or overcast days from October to January, giving optimum conditions for some diseases.

Cropping Systems. Cocoa is grown mainly as monocrop under permanent shade of *Glyricidia sepium* and in large plantations.

Soils. Most of the cocoa area was under Jerangau and Rengan series (sandy-clay) with low pHs, ranging from 4.0 to 4.5. Most cocoa is grown in ondulating lands, but drainages are needed in flat low lands. All cocoa is grown with fertilizers.

Diseases and Pests. VSD (*Onichobasidium theobromae*) is a limiting factor in this area because of the high rainfall during almost the whole year. This is the most critical area in Malaysia for VSD. Black and brown thread blights (*Marasmsius sp.*) were quite common in shaded areas and its importance needs to be evaluated. Black pod and stem canker (*P. palmivora*) was reported occasionally, but is not considered of economic importance.

5. Quion Hill Station and BAL Estate - Sabah

Sabah has several areas with excellent climatic and soil conditions for cocoa. The visit covered the surrounding areas to Tawau: Quion Hill Station and BAL Estate. Rainfall data for Tawau show an average of 72 inches per year (average of 32 years), which in total is less than in any of the cocoa areas in Peninsular Malaysia, but is better distributed during the year. As in BAL Estate, 80' per year are reported as shown in Graph No. 1. Also the high peak of rain in Sabah coincide with the low peaks in Peninsula which in its turn will produce opposite harvesting peaks in both areas. Temperatures in the area ranges from 24° to 34° C, and an average of 5.5 hours of sunshine per day. These climatic conditions are well suited for cocoa.

Cropping Systems. Cocoa is grown almost exclusively as monocrop, with or without permanent shade and in large plantations. This is one of the areas perhaps with the highest production of cocoa per hectare in the world.

Soils. Sabah is the only place in Malaysia that has good typical cocoal soils, as defined in West African and Tropical American Standards. They are deep, originated from basaltic lava flow, well drained and inherently fertile, with pH of 5.5 to 6.5, which also had been considered as the most suited for cocoa growth. Fertilizers are applied regularly, twice a year. But no response to fertilizers had been found yet in fertilizers trials.

Pests and Diseases. Capsids (*Helopeltis sp.* and *Platygomiriodes sp.*) attach young shoots and fruits as well as some leaf eating beetles (*Rhyparida iridipennis*) and carterpillar larvae (*Naeabuda normani*) constitute the main insect pests. Regular

control is applied in the estates. Mamalian pests, particularly squirrels, rats and monkeys cause also considerable damages. Also some species of mistletoes (Lorantus ferrungineous and Dendrophthoe sp.) can be a problem and need control.
Among the diseases, the more important perhaps is brown root disease (Phellinus noxius), pink diseases (Cortitium salmonicolor), occasional dieback (Onchobasidium theobromae) and thread blights (Marasmius sp.) are minor diseases.

PLANTING MATERIAL IN MALAYSIA

After early introductions of Trinitario and West African Amelonado (1930-40) and small scale variety trials (1050), in spite of Cheesmans (1948) report of Malaysians soils unsuitability for cocoa, West African Amelonado was planted in limited commercial scale in the mid 50's at BAL estate (Sabah) and Jerangau. At the same time upper Amazon progenies and the parent clones that were reported as producing high yielding F_1 progrenies in Ghana were imported to Sabah (Quion and BAL estate). The best F_1s crosses involving mainly several Pa, Na and Amelonado clones started to be used for extensive plantings. At the present, the bulk of seeds for all estate and small holding plantings in Peninsula Malaysia and Sabah-Sarawk come from Upper Amazon x Upper Amazon, UA x Amel., UA x UIT (1-2) crosses which are produced by Quion Hill BAL estate and privately by many of the cocoa plantations. West African Amelonado has almost been eliminated for plantings.

SPECIAL REMARKS

The following aspects were of special interest and perhaps new to my cocoa experience in Tropical America, regarding cocoa production in Malaysia.

1. Cocoa being successfully grown in soils, which in our standars are non-recommended for cocoa, like oxisols, ultisols, acid marine clays and acid sulfate soils. These soils have a very low pH and have a low natural fertility. The Malayan experience and technologies to manage successfully fertilizers for rubber and oil palm in these soils, have to be accounted for the cocoa success. The Brasileans have demonstrated also that cocoa gives high yields in oxisols with good fertilizer management, provided that the physical conditions, and depth of the soils is adecuate for cocoa. This seems to be the Malayan case.

2. It is strikingly evident the low incidence of serious diseases and pests to limit production. The production in Tropical America is limited mainly by devastating diseases like "Witche's broom" (<u>Crinipellis perniciosus</u>), Monilia (<u>Monilia roreri</u>), <u>Ceratocystis fimbriata</u> and black pod (<u>Phythophthora palmivora</u>). In Malaysia, even black pod is not important, due perhaps to the fact that the rainy season is during the hotest part of the year and the cooler period during the dry months; the combination of these conditions is possibly not favourable for <u>P. palmivora</u> epiphytolies.

The production in Africa is limited by serious insect attacks, mainly capsids and diseases as bla-'k pod (P. palmivora) and swollen shoot virus.

It is not yet clear if this low incidence of diseases and pests in Malaysia is: a) because cocoa is a new crop and there is not yet a build up of inoculum (time factor); b) climatic conditions are not favourable for serious outbreaks; c) local races of diseases and pests are mild to cocoa, or there is an ideal biological balance of predators. Improper use of chemical controls could be a potential threat to trigger occurrences of serious pests and diseases.

3. The extensive intrcropping system of cocoa and coconut under good fertilizer, water and soil management is a new and promissing cropping system for the other tropics.

4. Finally most of the cocoa produced under the monocrop system of the large plantations has the highest technical management of the rest of cocoa growing areas I know.

COCOA RESEARCH IN MALAYSIA

Cocoa research in Malaysia is conducted: 1) officially by MARDI in the Peninsula and the Department of Agriculture of Sabah (Quion Hill Station and Duarang) and 2) Privately by several estates. The research of the estates is geared to produce practical and economic recommendations on nursery handling, planting methods, varieties for planting, fertilizers, space and shade management, pest and disease control and fermentation and curing of cocoa for each plantation.

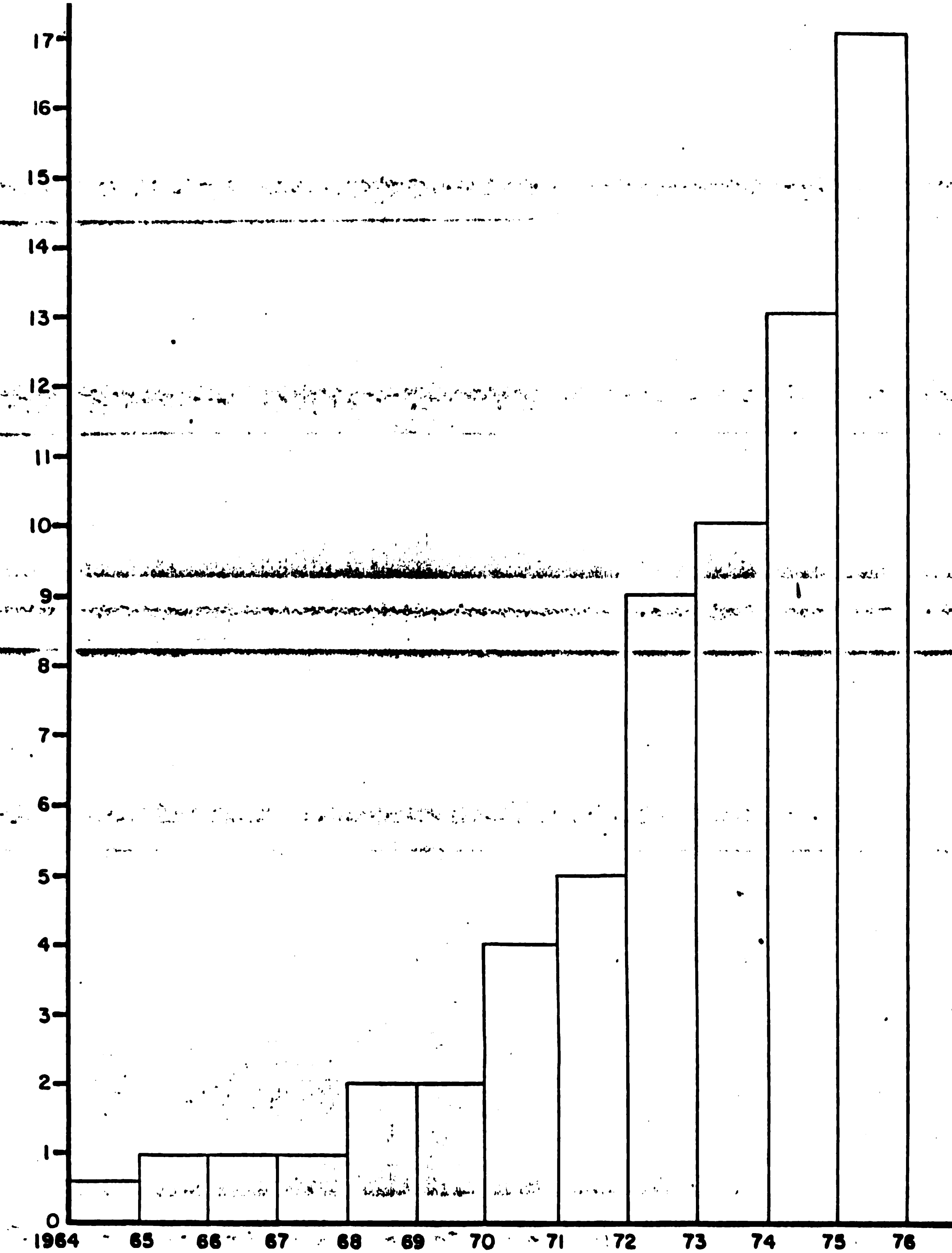
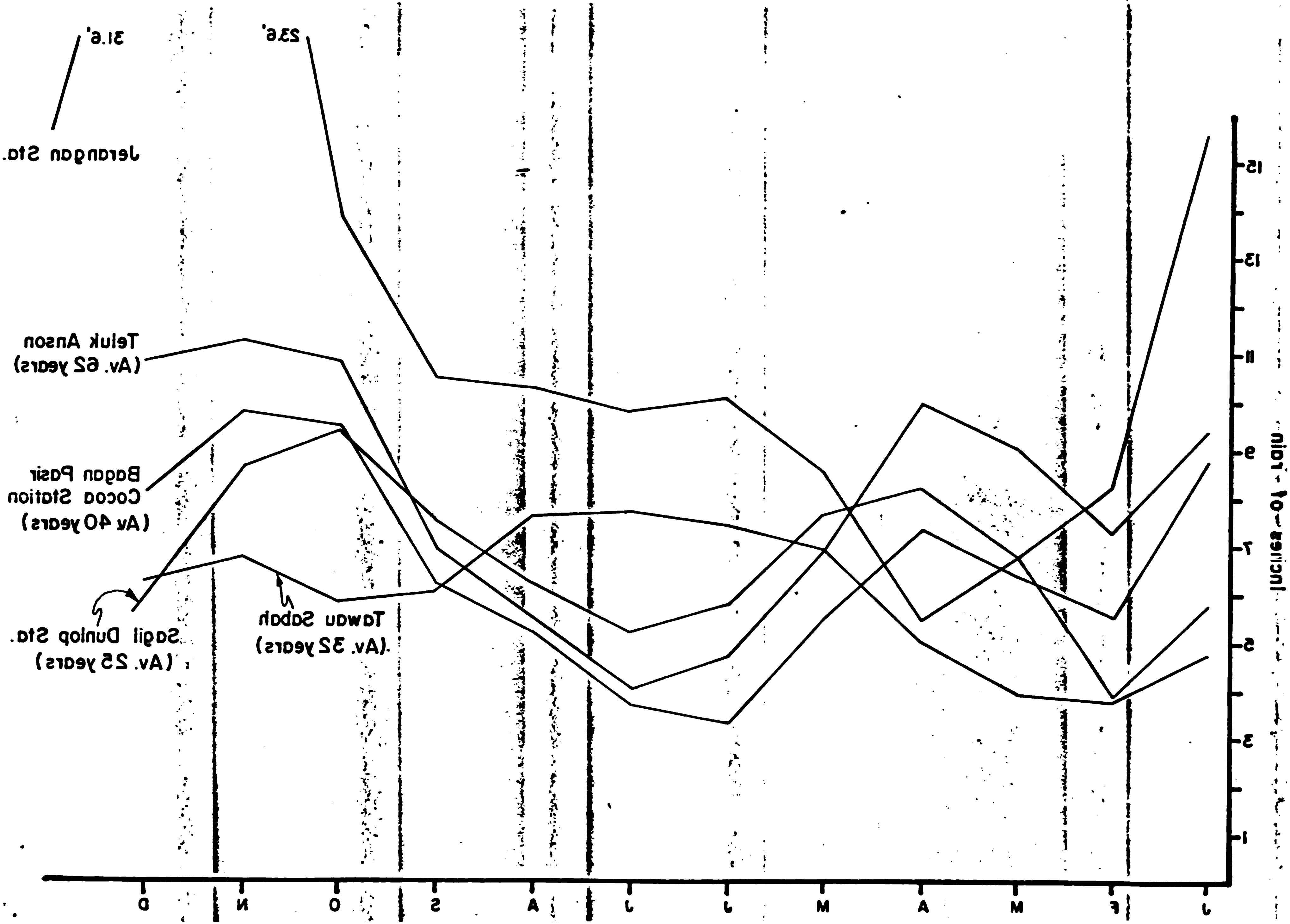


Fig. I Production of cocoa beans in Malaysia

Source: Gill & Duffus - Cocoa Market Report Nº 275, July 1977



Jerangau Sta.
31.6'
23.6'
Teluk Anson
(Av. 62 years)
Bagan Pasir
Cocoa Station
(Av 40 years)
Sagil Dunlop Sta.
(Av. 25 years)
Tawau Sabah
(Av. 32 years).
Inches - of - rain
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TABLE 1. LAND AREA UNDER COCOA IN MALAYSIA (1975)

Region	State	Estates (ha)	Small holdings (ha)	Total (ha)
	Trengganu	759.11		759.11
	Penang	192.31	426.32	618.63
Peninsular Malaysia	Perak	8,906.48	3,368.02	12,274.50
	Selangor	2,208.00	8,418.22	10,626.22
	Johore	829.96	1,473.68	2,303.63
	Sub-Total	12,895.86	13,686.24	26,582.10
East Malaysia	Sabah	6,183.40+	3,642.72+	9,827.12[2]
	Sarawak[3]		2,843.48	2,843.48
	Sub-Total	6,183.40	6,487.20	12,670.60
	TOTAL	19,079.26	20,173.44	39,252.70

1 Dept. of Agriculture Peninsular Malaysia

2 Dept. of Agriculture, Sabah

3 Dept. of Agriculture, Sarawak

+ Estimated

EVALUATION

Objective 1.

Current cocoa research: Its objectives, scope and implications to meet the needs of the country's agricultural development strategies.

1. In general, "The Five Year Cocoa Research Programme 1976-1980", is well conceived and planned to meet the general cocoa research needs for Malaysia. However as recently the government of Malaysia and MARDI have placed high priority to support the agricultural production and development of the low income small holders, in rural areas, the cocoa and coconut branch in its review of the "Five year Cocoa Research Programme, 1976-1980", has made adjustments to the general programme, taking consideration on this policy. My remarks on this line are:

1. MARDI should concentrate the majority of its efforts to apply to research, leading to solve the problems that limit production in the intercropping system of cocoa - coconut as first priority, as this cropping system is practiced almost exclusively by small holders. Applied research on the monocrop system is underway and quite well done by Quion Hill station in Sabah and the research units of several large estate (Dunlop, BAL; Landas, FELDA). MARDI should put less effort in this area, but should have access to their results, to recommend other farmers growing cocoa in the monocrop system (including FELDA).

2. MARDI should be responsible for basic research aimed to help finding practical solutions to the problems faced by small holders in mixcropping

system and also the monocrop system under plantations. MARDI should make the basic research needed to support both types of cropping systems.

3. Much of the applied experimental work should be on basis of the existing problems in small farmers lands, with their cooperation and participation. This will make easier the transference of technology and produce results directly applicable to every ecological condition.

4. Experimental work should be under the system approach, trying to improve production of both cocoa and coconut.

Objective 2.

Review of the relevance of current cocoa research to meet the objectives and scope of the Programme.

As the research projects and most activities meet well with the objectives and scope of the programme, I will only limit my suggestions to the priorities, new projects or modifications to the existing ones. All my suggestions will refer and follow the review descriptions of "The Five Year Research Programme". The Projects and activities non cited or referred should be consiedered as accepted.

1. BREEDING AND SELECTION

i) Introduction of Germplasm

For a faster breeding success and because of the importance of hybrids vigour based on wide difference of genetic origin, a wide Germplasm basis is important at Hilir Perak, should be imported. 372 outside were reported in Sabah.

Several well known clones for combining abilities and other characteristics should be included as clones in MARDI's collection. Examples:

High yields: IMC-67, P-7, P-12, P-19 (Trinidad)

High yields and large bean size: CC-10, UF-12, UF-29, UF-296, UF-613, UF-650, UF-667, UF-668, UF-676, UF-677 (Costa Rica)

Oc-60, Oc-61, Oc-73, Oc-77, Cho-28, Cho-42, Cho-44, Cho-163 Cumba-160, Cuira-38, Pgto-87 (Venezuela)

R-2, R-10, R-19, R-48, R-54, R-105, R-177 (Mexico)

EET-19, 48, 62, 95, 96, 102, 162, 238, 332, 333, 374, 399, 400 (Ecuador)

Resistance to <u>Phytophthora palmivora</u>: P-7, CC-42, UF-613, EET-59, EET-376 (Costa Rica)

SIC-802, SIC-806, SIC-844, EEG-8 (Brasil)

ICS-1, ICS-95, C-34, P-10, C-34 P-25, C-34 P-45, C-34, P-50, C-34 P-176, MX-68-24, 68-32, 69-21, 70-29, 73-38, 75-2, 75-12, 78-25, 79-2, 82-62, 97-7, 97-10, 97-17 (Trinidad)

S-27, U-6, Acu 85, Y-44, D-70, T-85/799, T60/1889, T-87, T-79/501, T-60, T-12/11, T9/15, T-24/12, T-19/9, T-86/2, T-65/7, T9/15 (Ghana)

SNK-12, 13, 16, 30, 416, 64, 12 B (Cameroon).

Resistance to <u>Ceratocystis frimbriata</u> (For tests against VSD): IMC-67, P-12, Pa-121, SPA-9, Oc-71, Pgto-87 (Venezuela)

EET-48, 58, 59, 61, 96, 272, 121, 129, 400, 407, 409 (Ecuador)

ii) Selection of progenies adapted to local conditions, high yielding capacity and good characters.

Selection of parental clones for transmission of the mentioned characteristics should be based on top crosses of the clones selected as desirable parents with 2-3 well known good combiners in Malaysia. Example Na-33, Pa-7, UIT-1, etc. Large number of progenies could be tested in simple lattice designs with 2-4 replicated of 9-16 trees/plot. It has been demonstrated that there is no need of guard rows if all progenies are seedlings.

The resulting best hybrids could be already recommended for plantings and the clones with higher combining ability should be used in a following phase of further breeding, either in single, 3 way and double crossings. At this stage, I don't recommend going to multiple crosses. The success of three way crosses like A-63 (UIT-1 x Na-32) x SCA-6 at BAL and double crosses are highly predictable, when the combining ability of the parents is known.

Breeding for a good size of beans is a character of high importance for Malaysia, particularly because most of the existing material tend to be in the small size. If the existing Pa and Na clones are crossed to SCA-6 & 12 as it is being done already, the small size of beans of the progenies could face international market problems, particularly in low price periods. Bean size is apparently a quantitative trait and many trinitario clones (Costa Rica, Trinidad, Ecuador, Indonesia, Ghana, Cameroon) could be used as large size sources.

iii) Selection of Clones

Establishment of selection limits for Malaysia needs. Selection in any population (open pollinated clonal seedling or F_1 crosses) should be based on several selection criteria. Limits of selection should be established on basis of the existing variability in the progenies or populations and the pressure of selection that one wants to apply. So, the breeder on basis of the analysed data and checking with the country market needs could decide that he will select for example only trees with individual dry weight yields per year of at least 2-3 Kg/year, pod index of 12-16, seed size from 1.2 to 1.8 x tolerance to VSD, x resistance to drought and of so much vigour, etc. Final selection is made after all selected plants are tested in replicated trials.

Both hybrid and clonal progenies should be tested in different localities or climatic conditions. A practical procedure is to put 2-3 replicates of the same trial in each one of the localities.

iv) Screening for VSD. Progenies of the clones listed in section (1) of this project, plus CC-9 and UF-296 (Costa Rica) should be included as promissing material.

v) Incompatibilities . It is advisable to identify the incompatibility genotypes of the clones used as parents of the present and future hybrids, distributed to the farmers. This aspect becomes very important when upper Amazon clones are used as one or both parents. To accomplish this introduce the genetic marker clones from Kew Gardens, England.

2. <u>CROPS PHYSIOLOGY</u>

i) Vegetative propagation

a) <u>Garden for production of propagation material.</u> Overhead shading towards overshading was found in Trinidad the best condition to produce optimum fan material. Also pollarding of seedling and any chupon is the best method to induce new chupon material

b) Propagation methodology. Reduce efforts in studies on morphological, physiological and genetic factor as affecting rooting. Evans and Pyke in Trinidad, and Alvim in Costa Rica, worked out these factor in the 1930 to 1950. Trials on useful adaptations of economic and simple methods of rooting, based on McKelvie's and Nichols methodologies should be continued.

Budding-influence and compatibility of root stock on scion growth and performance should be continued.

e) Field management of clones derived from fan materials.

Training fan material, by keeping straight growth of a branch tied to a pole, while the innate pleiotropic nature is maintained is more a curiosity than a practical approach. Besides being a more expensive practice, the new lateral branches will mantain the pleiotropic growth.

This type of trials should be discontinued. In fact the experimental results, already available at MARDI show that it is cheaper and produces best formed plants by selecting and prunning a balanced distribution of 3 to 4 fan branches, either from cuttings or buddings. Research people and farmers have to get used to the natural shape of a fan material planting. In spite of some initial tree shape disadvantages (up to 5 years of age) as compared to seedlings, harvesting and spraying against fruit diseases and pests are easier in well

established clonal plantings. Appropriate distances and prunning are necessary for a good management of clonal fan buddings and cuttings. This should be experimented in different localities and with different clones.
The other alternative to have seedling looking plants is by obtaining chuppon cuttings or buddings. However, chuppon material is undobtedly much more scarse and difficult to obtain than fan material. Experimental results of comparing cuttings, chuppon and fan buddings and seedlings show that earlier and higher yields are produced by cuttings, followed by fan and chuppon buddings. Later on there is a tendency to level up production, but cuttings maintained the lead.

d) Frequency of prunning. In orther cocoa areas of the wold experimental work indicates that 4 - 6 month prunning periods are the best. Including non prunning at all and slight prunning (shaping the tree only) give the best growth and yields. On this basis a review of treatments of these trials is advisable.

ii) Growth and Development Physiology

a) Artificial pollination. Reduce emphasis in these studies as there is a lot of information on this subject and pollen viability.

b) Natural pollination. This is an important topic, but should be carried out in close cooperation with the entomologist and the plant breeder. Natural pollination depends on the frequency of pollinating insects, genetic incompatibility or compatibility reaction in the population and the influence of environnmental conditions. This project should be reviewed as a team research programme.

c) Phenological studies on flushing, flowering and fruiting. This is an important information needed for use and correlation studies with climatic conditions and control practices of diseases and pests and for application of fertilizers. This project should be reviewed to adjust the information derived to the needs of the other fields.

d) Pod growth and development. Basic studies of fruit growth and development are already reported in the literature and needs less efforts as compared to other problems.

e) Seedling studies; growth analysis. Many authors have reported high correlations between trunk girth (1 to 1.5 years of age) and future high yielding ability. No good correlations have been found yet with leaf area and net assimilation rate. Review this project, taking into account the literature on this subject. Same thing for urea, sugar gibberelic acid and other hormonal effects on growth and development on cocoa seedlings.

III) Shade studies

There is a lot of information for cocoa grown as monocrop about overhead shade relationships with growth and production. Cocoa can be grown even without shade, provided that soil and water supply and fertilizer management are kept at an optimum.

In the cocoa and coconut intercropping system, 2 main factors need to be studied: 1) Interelationships of overhead shade provided by palm fronds of different ages, varieties and planting distances to cocoa, 2) Root distribution and competition of cocoa and coconut for room, water and nutrients.

My recommendation is to concentrate efforts in the studies on these two points in the field and give second priority to some of the basic studies of shade - hormone - nitrogen relationships in seedlings in greenhouse.

Relationships of overhead palm frond shade, should be studied under 2 conditions: 1) Under existing old coconut plantings. This, because the majority of the new areas of cocoa expansion will be planted under these conditions, and 2) under establishment of an inter crop as a new planting. Here the use of new coconut varieties and age might introduce different shade conditions and interelationships between the 2 crops.

Far old coconut plantings use surveys of existing densities and try palm renoval rates that will permit to obtain predetermined amounts or proportions of light to the cocoa underneath, having other factors fixed, namely fertilizers and cocoa densities.

Shade-nutrient interaction studies are necessary, particularly in dealing with a cropping system in which we are interested in improving the production of both crops. This should be done in field and greenhouse conditions, simulating paralelle conditions.

Nutrient competition studies should go together with root competition. Root distribution and water table studies should be made together with the soils section. This information will be useful in planning nutrient competition. As examples: different densities of cocoa and distances between cocoa and coconut, against fixed densities of coconut and the opposite, against fixed or variable amounts of fertilizers and shade levels.

AGRONOMY

1. Shade and nutrient relationships. See section (iii) of physiological studies. This area is an interdisciplinary problem.

Training and prunning experiments are already a necessity in some small holders plantings in Southern Perak, particularly in close distance plantings and with progenies of low branching parents (SCA-6 among others). With low branching or elongated lateral branches, a second horquete induction could represent a good salution; also number of branches to be left at the horquete should be investigated in seedlings and number of basal branches for fan buddings and cuttings.

2. Soil analogues for cocoa. During the visits to the Johore and lower Perak areas it was observed that cocoa was growing and performing differently in spite of the same climatic conditions and soil origin (marine-clay, and acid sulphate). This indicates that other soil related factors are playing an important role in the success or failure for cocoa growth

under coconut. A good characterization of the soils Physical, chemcial, depth, water table, pH's, etc.) in areas with optimum growth of cocoa under coconut will help determining and mapping all recommended and potential areas with suitable soils conditions for expansion of cocoa and coconut intercrop. This information will help also for the planning of future fertilizer experiments of cocoa.

Good fertilizer management will always be the key factor for cocoa production ik Malaysia due to: low pH's in relation to standard cocoa soils, poor inherent soil fertility of the types of soils planted with cocoa (except Sabah & Sarawak) and fluctuations of water table due to new drainages.

Fertilizer experiments on small holders lands, mainly on fertilizer rates, rations and the adequate chemicals to avoid excesive base fixation problems and lowering more the already low pH's. Possible defficiencies of minor elements hould be always checked. The microplot techniques could be used for this purpose. The experience on rubber and oil palm should be of basic importance. Of high priority are also experiments on placement and timing of fertilizer applications. The latter should go in connection with the information with the phenology of fruit development and rainfall. Due to the extensive drainage systems constructed by the government in coconut areas, water table levels seem to become critical for water supply to the crops and soil acidity effects (acid sulfate soils) during dry spells. Research on critical levels of water table and the use of dams in the main channals to control adecuate levels should be studied.

3. <u>Pest Control Programme</u>

(1) Insect pests

Pests are not a major limiting factor for cocoa production in Malaysia. The 3 main projects are good. However, I would like to suggest in project (ii) to include the study of biology and ecology of some leaf eaters (*Apogonia sp.*, *Cheatodoretus sp.* and *Valanga sp.*), as occasional significant reductions of leaf area can affect production. Also the biology and ecology of the pollinator insects should be included. The beneficial insects should be studied also.

(ii) Mammalian Pests

No suggestions

(iii) Screening of insectisides and control experiments

Take care not to affect the beneficial species; for this, continuous check ups of their propulations should be practiced.

4. Disease control

There is not serious diseases limiting cocoa production in Malaysia.

1. Studies on Vascular Streak Dieback (VSD)

   First, transmission mechanisms and an artifitial inoculation method should be made available to secreen cocoa germplasm for resistance to VSD. For this purpose, see section (i) of the selection and breeding program of this report.

2. Studies on black pod and stem canker.

   Use Dr. Lawrence's stem inoculation test (copy of report left with Mr. Tey Ching Chong) to screen cocoa germplasm. Obtain resistant cultivars already reported as resistant. See section (i) of the selection and breeding program of this report.

5. <u>Curing of cocoa beans</u>.

A general complaint about export beans in Malaysia was a low pH. Incomplete fermentation was observed also during my visit to small holder's fermentaries as well as some estate fermentaries and dryers. There was a variety of fermentary types, length of duration of the fermentation process and of drying methods. Estates in general have better fermentation and drying facilities, produce better fermented beans than small holders, but still they have a low pH and in some cases fermentation was incomplete. Small farmers beans were poorly fermented and incompletely dried, which affects quality and promotes development of moulds and odd flavours.

The creation of a research program and a technical unit to check and correct the fermentation and drying defficiencies existing now and to develop or adapt fermentation and drying systems suited for small holders is recommended.

<u>Objectives 3 and 4</u>

Appraisal and recommendations about facilities, equipment, personnel and other aspects to improve MARDI's cocoa research program in the next 4 - 5 years.

<u>Facilities and Equipment</u>

The cocoa and coconut branch station of Hilir Perak is quite new and has at present 400 acres and additional land is under negotiation to complete up to 2.000 acres. The present area is enough for the present and next five years needs, in coastal clay soils for cocoa and coconut. However, if cocoa area is to be incremented in interior oxisols and ultisols, additional lands on this type of soils could be needed. However negotiations with some estates, like is the case at present for cocoa and coconut areas (United Plantations, Harrison and Crossfields) could provide the needed lands for research, eliminating the necessity to acquire new lands.

Central offices and installations are close to two years old and are apparently adecuate for present needs. It might need some office expansion and the consideration to construct a guest house for MARDI support scientists and consultants comming to spend a few days in the station.

Most of the laboratory facilities were already installed or in the process of being installed. I did not have time to take a close and detailed look of every laboratory, but the information I got from the staff and the fast visit led me to believe that the equipment was adequate for present needs. Some equipment was being still imported.

Personnel

The main fields of plant breeding, plant physiology, soils and crop management, pest and disease control are covered in the Program. I suggest the need of completing the program with cocoa technology for fermentation and curing and the field of economics. The latter will evaluate and give economic assessment to all research recommendations and will help developing farm management practices for small holders. Also it will be useful in periodical evaluations of the improvement of income and well being of the cocoa and coconut growers.

I was gratified and enhanced to find that most of the staff in the station are young, well qualified and enthusiastic with their duties and problems. Their academic qualifications were very good. There was a Ph.D., Plant Physiology (Head of Branch), 2 M. S., one in Plant breeding and other on Plant Physiology. The rest had B.S. . from the University of Malaysia-Serdan or diplomes from agricultural schools. In spite of their good academic background, many of the senior officers were relatively new on cocoa research, have short experience on cocoa research and are enthusiastically learning and gaining experience the hard way, by themselves. A good recommendation to fasten their cocoa training is by permiting well qualified and productive technitians of each discipline to visit from 1977-1978, a few well known cocoa research stations in other parts of the world, to spend a few weeks observing research on their fields and discuss their programmes with the foreign colleagues. MARDI should also estimulate participation of its staff in international cocoa conferences abroad, as a means of widening technical contacts with other research centers in the world and for exchange of information.

Other important recommendation related to improving the expertise of the personnel in their own fields, is by providing funds to the library to acquire the more important cocoa literature of other parts of the world and to maintain suscriptions of cocoa journals or journals that publish often cocoa information. It will be important to offer reading proficiency courses for Spanish, Portuguese and French as a lot of the world cocoa literature is in these languages, and this literature is virtually absent in MARDI's library.

Further graduate training toward the Ph.D. or M. S. degrees in each area should be a good policy in MARDI, to maintain a good and independent leadership in each field, sending to different schools abroad the more able technitians 'of the cocoa and coconut branch.

GENERAL RECOMMENDATIONS

1. As research in Sabah and in private estates apparently is not under direct MARDI's supervision, is quite desirable that MARDI is maontained informed of all results and could increase cooperation and coordination with their research. It also is desirable that Quion Hill and other official experimental stations of the Department of Agriculture of Sabah and Sarawak eventually be coordinated by MARDI.

2. FELDA cocoa research should be coordinated with MARDI.

   It might be better that FELDA research is a cooperative activity with MARDI.

3. The Jerangau experiment station should be better staffed and concentrate its research activities mainly on VSD research and agronomy experiments: Fertilizers, densities, methods to propagate vegetative propagation, etc.

ACKNOWLEDGEMENTS

I would like to express my gratitude and appreciation to Drs. Muhamed Jusof Hashim, Assistant Director of Development for offering me the opportunity for this consultancy; to Dr. Sharif Bin Ahmad, Head of the Cocoa and Coconut Branch, for his constant and kind assistance and company during my visit; to Mr. Ibrahim B. Abdullah, Cocoa Breeder and Mr. K. Ramadasam for their company and permanent assistance with technical information during my trips and finally to all the Cocoa and Coconut Branch Technical Staff and the Managers and Research Officers of the following estates: Dunlop, United Plantations, Harrisons & Crossfields, Landas and BAL. My gratitude is expressed also to Dr. Lee Ming Tong, Director of Quion Hill Station and its staff for their kind hospitality and attentions. Thanks to my driver who always made my trips easy and pleasant.

COCOA CONSULTING SERVICE TO MARDI-MALAYSIA

1. Date - July 17 to August 6, 1977
2. Places and persons visited

July 18 - Serdang:

Dr. Mohd Jusof Hashim

Dr. W. P. Ting, Assisting Director of Crop Production

Dr. Sharif Bin Ahmad, Head Cocoa & Coconut Branch

Dr. Santiago Obien, MARDI Consultant

July 19 - Malacca

Dunlop State - Sagil

Mr. K. C. Thong

July 20 - Batu Pahat and Rangit

Mr. Khairi H. Mohamed, Project Director, West Johor Agricultural Development Project, Batu Pahat, Johor

Mr. Ismail H. Othman, Deputy Project Director

July 21 - Serdang

Dr. Hashim A. Wahab, Assistant Director of Research

Dr. N. T. Arasu, Head Plant Science

July 22 - Telok Gorg, Kuala Selangor, Tok Khalipals, Kampong Skendi

Mr. Ng King Org, Agricultural Extensionist

July 23 - Kuala Lumpur

Mr. Hasan Lebai Mat, Crop Protection Branch of DOA

Mrs. Shamshiah Muhamed, Crop Protection Branch of DOA

Mrs. Phang Chang Imn, Crop Protection Branch of DOA

July 24 - Kota Kinabalu, Sabah

July 25 - Tawau, Quion Hill Station, Sabah

Dr. Lee Ming Tong, Director of Station

Mr. N. Chong, Assistant Agronomist

July 26 - BAL Estate, Sabah

Mr. K. B. Armstrong, Manager

Mr. David H, K. Lim, Senior Research Officer

Mr. Philip Chim, Research Officer

July 27 - Trip to Kota Kinabalu & Kuala Lumpur

July 28 - Kuala Lumpur

July 29 - FELDA Research Center - Sungai Tekan

Mr. Tam Kok Yeang, Head of Research

Mr. Tang Keng Lai, Director of Operation

Mr. Lee Aik Kien, Research Officer

July 30 - Trip to Kuala Trenganu

July 31 - Jerangau Station

Landang Koko Lands Mr. Wan Hanan Lein Ahmed

Mr. Lat Awang

August 1 - Trip to Kuala Lampur

August 2 - Trip to Teluk Anson

Officers Coca/Coconut Branch:

August 3 - Flemington State

Mr. Taylor, Manager

Bagan Datoli Estate

Mr. Colling, Manager

Small Holdings

August 4 - Teluk Anson

Discussion with Cocoa/Coconut Research Officers: See Annex 2

August 5 - Kuala Lumpur - Serdang

Visit to Director General, Mr. Datuk Tamin b. Yeop

Head of cocoa/Coconut Branch Dr. Sharif Bin Ahmad

3. SUMMARY OF OBSERVATIONS IN EACH AREA

July 19, 1977 - Visit to Dunlop State at Sagil

The cocoa nursery was under shade of old rubber trees, planted at 22 x 11 feet. Apparently there was enough shade.

Cocoa seeds were planted directly in plastic bags, widely spaced, 18 x 18 inches appart. Good health conditions of the seedlings. Plants are kept for 4 - 5 months before going to field. Use of soil mixed with organic matter and rubber processing residues on the surface. Regular applications of fertilizers, pesticides and water. At the time of visit they had ± 300.000 seedlings.

First cocoa plantings were established in 1969, under old coconut trees shade, planted at 9 x 9 ft. First yield 300 lb/acre. After removal of most coconut, cocoa produced up to 1.000 lb/acre (one year up to 1.600 lbs/acre). Falling of old coconut trees, damaged cocoa trees and produced openings. At the time of the visit trees with second horquette plantings appeared to be too crowded. Seen other plots planted from 1970 on, at 3 x 3 m.and of various ages. Good conditions under Glyricidia sepium shade.

In the same row, Glyricidia, cuttings were planted at 2 x 2 m.

alternated with 2-3 plants of Sasbania punctata (a legume). Cocoa was planted at 3 x 3 m. in the inter-rows of the shade plants. Cocoa is planted at 4-5 months of age after the shade has been planted. Dunlop has plans to plant up to 10% of its estate in cocoa, that means 60.000 acres.

Plant material: Hybrid seeds produce by Dunlop or hybrids comming from Sabah. Some new hybrids made by Dunlop will be tested under trials.

Most of cocoa is planted in deep oxisols and ultisols. In all cases good fertilizer management was being applied.

A small area of cocoa was growing in coarse-sandy-clay. Cocoa in general was suffering (as well as Glyricidia) of water shortage during dry spellings.

Shade is provided mainly by Glyricidia sepium. Too much shade was observed at the visit time. It was recommended to leave 35-40% of original plants, well spaced.

Coconut seems not to affect cocoa. Rubber also did not affect, but falling of trees damaged cocoa plants.

Fermentation: is made in large sweat boxes: 13 groups of 2 boxes; seeds are kept one day in each box. Dry seeds have pH. 4,9 to 5,4 which is quite low. A suggestion was made to leave 48 hours in the first box and proceed with the daily shifting up to the end of six day.

Beans, were small and some incompletely fermented. Drying is done artificially. Perhaps drying is done very fast which could leave some acidity.

July 20 - Visit to small holders of coconut and cocoa intercropping in Rangit, Johor.

First place: Rangit

Along the road to Rangit poor drainage systems in the farms were observed. Farmers were unhappy with their cocoa plantings. Cocoa in poor shape, the owner has given his best attention, no improvements, poor yield. Severe damages by capsids and leaf eating beetles to fruits and top of plantings. Soil very shallow. (Selangor series, shallow phase) sandy clay, bad surface drainage during heavy rains, but dries fast in dry periods due to gravely sandy subsoil. Apparent acid reaction, as seen by ferns growing between coconuts. There is not much cocoa interplanted in this area. Coffea liberica is the most common intercrop and it does better than cocoa.

Recommendations: All the area with this type of soil with heavy old coconut shade should not be interplanted with cocoa. Leave for Coffea liberica - coconut cropping system.

Second Place Visited near Benut

Good looking cocoa under old coconut. Areas 10 acres. Cocoa 6 years old, seeds were hybrids from sabah. Farmer is happy with cocoa production which according to him was more profitable than coconut. He considered cocoa as the main crop. Drainage systems were deeper, soils also deeper than in first phase (Parit Butak series?). Sandy clay, better water retention, cocoa grows very well, had a good load of young fruits all of Amazon types. It was observed a lot of damage of capsids to fruits and beetles to leaves. Dieback caused by capsids and fungi in open areas. Coconut shade a little bit excesive. Farmer will accept renoval up to 10% of coconut trees.

Farmer applies insecticide every month, he did not know the kind of insecticide. Also he is using fertilizers. Cocoa seeds were sold fresh to local fermentaries. Several other farms were seen along the area. It seems that on these soil series the intercropping could be recommended more safely. No black pod seen so far.

July 22. Visit to small holdings to Sabak Bernam & Kuala Langat area.

In Telok Gorg and Kelang, two very different situations were seen: a) along the main road fairly good growth & establishement of cocoa; but half/Km inside towards the sea, cocoa could not be established. because of too dry hard soils, a very low water table, and clear indications of high acidity (ferns). Deep channels along the area have lowed down too much the water table. In general, surface of soil was very dry. According to farmers and local technitians, long drought in the last 2 - 3 years have been abnormal.

In Kuala Selangor area, very good cocoa, well taken care, mainly by chinese & Jabanese farmers. In Kok Klalipals, poor growth of cocoa, good coconut shade, low water table, indications of high soil acidity (ferns) and good soil depth. In Kampong Sekendi, very good cocoa in chinese holdings. Very rudimentary fermentary box, giving poor fermentation, seeds were sundried.

July 25. Visit to Quion Hill station, Sabah.

Objective or research: To develop agricultural techniques for cocoa production and to produce cocoa seeds for farmers. Personnel: Director, 9 agricultural officers in various field, clerk assistants, 60 field workers.

Station: 300 acres in agronomy & breeding trials, 40 acres in seed gardens and 200 acres in mature commercial cocoa. Good laboratory and office facilities. Clonal collection with approximately 200 clones, mostly upper Amazon origin, like several Pa, Na, WA, UA, ICS, Indonesia, local selections from F_1 of WA hybrids, UIT-1 (likely an ICS clone of the series 40) and UIT-2 (likely IMC-67?). Other 172 clones are in quarentine at Duarang, near Kota Kinabalu. Two series of hybrid trials: Series 1, crosses of Amelonado x Upper Amazons (Na 32, Pa 35, Pa 7 and UIT 1) and crosses of upper Amazon x Upper Amazon clones (UIT 2 x Pa 7, Pa 35 x Na 32, UIT 1 x Na 34, Pa 35 x Na 31, UIT 1 x Na 32, Pa 7 x Na 32, UIT 1 x Na 33; three way crosses of selected F_1 UA x UA clones (Na 32 x Pa 7) x UIT 1; (Na 32 x UIT 1) x Pa 7, (Na 31 x Pa 35) x UIT 2; (Na 32 x Pa 35) x UIT 1; (UIT 1 x Na 34) x Pa 35, Amelonado, UA plant clones and UA x UA F_1s. Six F_1 hybrids selected to distribute to farmers (UIT 1 x Na 33, Pa 7 x Na 32, Aml x Pa 7, Aml x Pa 35, UIT 1 x Na 32, UIT 1 x Na 34).

Series II, crosses of UIT 1 and UIT 2 by Na 32, Na 33, Na 34, SCA 6, Sca 12, Pa 7 plus Pa 7 x Na 32, Aml x Pa 7 and Pa 35 x Na 32. The best yields in UIT 2 x SCA 12, UIT 1 x SCA 6, UIT 2 x SCA 6, (Average dry bean yields 2.155 lb/acre/year) and UIT 1 x SCA 12 (average bean yields of 1819 lb/beans /acre/year). Evident high combining ability of SCA and UIT clones. In spite of small size of seeds and fruits of SCA clones, F_1 hybrids with UIT clones gave good bean size and prolific flowering and growth characteristics, which are the basis for recommendations of these hybrids.

Seed Gardens. 40 acres. Parent clones planted in blocks of 9-10 rows, alternated with paired rows of pollen parents. The pollen parents of neighboring blocks alternate in 3 to 5 paired rows.

Prunning trials: Testing one to several stems per picket and leaving 1 and 2 horquettes. Local technicians prefer one stem and one horquette.

Space trials: Several distances: 6' x 6', 7' x 7' , 8' x 8', 9' x 9', 10' x 10'. Local technicians prefer and recommend 10' x 10'.

July 26. Visit to Bal Estate- Sabah.

BAL-Estate, is a private enterprise with 3.000 acres of cacao as monocrops, most under sparce and irregularly distributed shade of Glyricidia Albiteia sp & Parquia sp. Poor shape of shade trees. Very good chemical & physical conditions of soils, deep, basalt lava origin (volcanic), pH. 5.5 - 6.0. Rain ± 85 inch/year, well distributed, 2 rainy periods, January, February June-July. No serious disease and pest problems, temperature 24° to 32° C. Ideal conditions for cocoa. Healthy looking plantings, uniform stands very well closed canopies. Even with very light shade there were no problems. Cocoa is a new crop, perhaps this is the main reason for lack of pest problems and lack of built up of problems yet.

The majority of plantings with Amazon hybrids. Excelent yields, ± 1 ton/acre/year. Even West African Amelonado close to 1 ton/year. Good yield, mainly soil effects, Good soils no response to fertilizers in experiments Estate has a research unit. Several progeny trials confirm Quion Hill results, showing even higher yields (40% higher). They have also trials with 3 ways crosses and clones of F_1 selected trees. Of particular interest is the cross of A 63 (UIT 1 x Na 32) x SCA 12 with outstanding yields; this 3 way cross is planted in BAL Estate as commercial progeny.

In clonal propagation trial, cuttings overyielded fan & chuppon buddings & seedlings. Some buddings reacted differently to root stocks.

Trials on planting distances and number of stems. Best results with plantings at 13 x 12 feet between plants and one stem with second horquette after 2 years of yield. Several other treatments are included in the trials. Research needed in distances, thining, number of horquetts per hybrids and prunning intensities.

They should intensity selections of F_1 trees in progenies from clonal plantings.

Normal transplanting age is near 4 months for seedlings grown in polyethylene bags. They have good size. They do not plant at stake as in other areas.

July 29. Visit to FELDA RESEARCH CENTER at Sungai Tekan.

FELDA is a development scheme for small farmers undre the Ministery of land and federal territories. FELDA under his scheme opens government lands, using contractors to clear out jungle areas, using heavy machinary, burning the trees. This practice is leaving the soil with no organic matter. The contractors should plant temporary and permanent shade, and cocoa plants but most of shade was very poorly stablished. In first phase 1.000 acres were established with cocoa, under irregular shade of *Glyricidia* and some durians. In general there was a poor shade management. New area of aproximately 500 acres had a very poor establishment of shade and cocoa.

FELDA has a research unit for cocoa and has several progeny trials with seeds obtained from Sabah crosses of Na, Pa, x ICS clones. Crosses of WA x WA, WA x Amelonado. The best crosses were crosses of UA x Trinitario clones. They have also new fertilizer trials but no results were available yet.

Most of the areas on production had little shade and received 3 applications of fertilizers per year. One at flowering (Feb. - March); second on

June - July and the third in September - October.

Soils are acid, mostly oxisols.

For all Schemes of plantings are using mixed hybrids from Sabah. Cocoa even under shade showed stunt growth. Perhaps with good shade, good fertilizer recommendations and better prunning management, production might improve. They are applying high dosis of fertilizers, up to 900 g/plant/year, at production age.

MARDI Pathologist thinks that P. palmivora canker is of some importance in the area. Amelonado is more tolerant than Upper Amazons. I suggest the use of branch inoculation method to select resistant plants to canker.

July 31. Visit to Jerangau Station.

There is no active cocoa research at present. Trials abandoned three years ago. No maintenance to trials. In general, poor shape of plantings. Rengam/Jerangau soil series. Progeny trials C-36, C-38, C-45.

Progenies of Selfincompatible Trinitarios x Selfcompatible Trinitarios, Selfincompatible Trinitarios x Amelonado UA x Amel. and Amelonado control. Plot 12 trees/progeny, 8' x 8' planting distance. Results on Dr. Arazu's paper. Shade provided by jungle trees, poorly distributed. Cocoa trees very slender, ± 15.20 cm diameter, tall, various horquets. Best progenies UA x Trin. or UA x Criollo. Pure UA low pod and seed values.

Clonal trials. C 39 with 100 clones budded on amelonado trees, 6 trees/plot, 2 replicates, 8' x 8' distance. Tall slender trees, looking like seedlings were Planted on August 1956.

Clonal trials C-35 with 90 clones, budded on Amelonado. Include some selections from Indonesia, Trinidad and West Africa, the best were the Trinitarios and Westafrican clones (1.000-1.500 lbs/acre/year of dry beans). Best trinitarios, ICS-1, 95 and 98. Best trinitarios performed better than best WACRI clones. Trial 40 & 42: 8 clones propagated as cuttings and buddings produced the best yields.

Bad shade and bad maintenance at the visit.

Diseases: Vascular Streak Disease (VSD) everywhere. Apparently this disease is a real problem and potential limiting factor for the area.

Thread bligh *Marasmius* sp. is quite common. Need of assessment of its importance.

Insects: Capsid attack to young cherelles, quite clear and abundant.

August 2, 1977 Visit to Hilir Perak Station

Briefing by Dr. Sharif Bin Ahmad, and Station Staff (List attached) Head of Cocoa & Coconut Branch on Objectives, organization, staff and general cocoa research programme. Team effort.

Visit to Experiments on:

Greenhouse

1. Budding studies: Trials on various dates of detopping, bending, bending + detopping, half ring. Initial results, bending treatments the best.
2. Effect on seedlings socking seeds in hormonal solutions. Benzylademine produced multiple shoots, NAA large biomass of roots and Gibberelic acid, stem elongation.
3. Rooting of cuttings under modified polyethylene sheets. No acceptable success yet.

Field trials

4. Training experiments on buddings of 5 clones

5. Budding with and without training, prunning and nonprunning

6. Observations on top and base buddings: fan and cupon material: Earlier bearing on base chuppon budding.

7. Root training - Use of narrow, deep bags. Doubtfull results

8. Reverse ringing. Results show no differences with normal.

9. Prunning in 3 clones: 3 - 4 branches and frequency of prunning. Best every six months.

10. Fan compatibility of chuppon budding on different root stocks.

11. Spacing trial under coconuts: 12 spacings; single, double and triple rows.

Flemington State

12. Budded progeny observation plots (2 blocks = 25 acres) under coconut, with 1.152 selected plants from Costa Rican and Brasilian seedling introductions: 8 - 9 plants/progeny. Plants selected for vigour. Buddings tied to stakes (training).

13. United plantations 0 1967 Hybrid trial. Hybrids obtained from Sabah: combinations of ICS x UA; UA x Amel; UIT (1, 2, 3,) x UA. Best yield ICS-6 x Na-32. ICS x UA F_1, good size of seeds.

14. Serdang hybrids trial. Progeny rows, no replicates.

15. Germplasm collection. (At Hilir Perak). The more important upper Amazon clones imported to Sabah: Several Na, Pa. Several Trinitarios ICS and 3 UIT clones: Serdang selections (Serdang and Jerangau). Several UF and CC clonal seedlings from Costa Rica; EEG, SIC and SIAL

clonal seedlings from Brasil; R seedlings from Mexico, SC and SPA clonal seedlings from Colombia; SGU clonal seedlings from Guatemala; RB from Brasil, EET clonal seedlings from Ecuador; P (Pound) clonal seedlings from Trinidad. A lot of variability and many vigorous progenies were observed among to introductions.

ANNEX 2

LIST OF STAFF

Chief Co-ordinator/Branch Head	Sharif Bin Ahmad
Sub - Programme I	Research Officer
Breeding and Selection	- Ibrahim b. Abdullah
Sub - Programme II	
Plant Physiology	- K. Ramadasan
Sub - Programme III	
Soils and Crop Management	- Teoh Kok Choon
	Syed Kamaruddin Syed Wazir
	Nashbah Tahir
Sub - Programme IV	
Plant Protection	- Chan Chee Leong
	Khoo Chin Kok
	Tey Chin Chong

Proposed Vacancies

Post	1976	1977	1978	1979	1980
Agronomist	2	1	1	-	-
Plant Physiologist	-	-	-	1	-
Plant Breeder	1	-	2	1	-
Plant Pathologist	-	-	-	1	-
Entomologist	1	-	-	1	-
Mammalogist	-	-	-	-	-
Research Assist.	15	4	6	7	-

Proposed Vacancies

Post	1976	1977	1978	1979	1980
Junior Research Assist.	17	4	6	7	-
Lower Research Assist	20	2	6	6	-
Labourers	35	20	15	15	15