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Brigadier Sir Donald Cleland, C.B.E., O.St.J.

Director of Agriculture, Stock and Fisheries :

F. C. Henderson, Esq., B.Sc. Agr.

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NOTES ON THE BOTANY, BREEDING AND ESTABLISHMENT OF OIL PALMS AND PRODUCTION OF PALM OIL

K. NEWTON.*

These notes were compiled following a tour in 1959 of oil palm centres in Ghana, Nigeria and the Belgian Congo.

INTRODUCTION.

ALTHOUGH the species of oil palm, *Elaeis guineensis* (Jacq.) is now grown for commercial production both in West and Central Africa, Indonesia and Malaya, the palm is indigenous to the humid forest region of Africa in an area roughly 15 degrees North to 10 degrees South of the equator. In this zone it occurs naturally in fresh-water swamp forest, often associated with Raphia with the greatest abundance in the West African coastal belt 100 to 150 miles in depth extending from Sierra Leone to the Cameroons. The palm cannot maintain itself independently under the heavy shade of closed forest canopy and the "wild" or native palmeries in West Africa are due to the influence of man by whom palms have been protected in various ways.

Two kinds of oil are obtained from the fruit:—

(*a*) *Palm Oil.*

This is extracted from the mesocarp or "husk" which contains 45 to 48 per cent. of a yellow-orange-red oil consisting mainly of the glycerides of palmitic and oleic acids. The oil is used mainly in soap manufacture but also in lubricating oils and if of high quality or refined, in the manufacture of edible fats. A high carotene content increases its importance in the local diet in West Africa. Extraction is carried out in the areas of production and the oil is exported in drums or bulk.

(*b*) *Palm Kernel Oil.*

This is extracted from the kernel or seed which contains approximately 56 per cent. oil consisting mainly of the glyceride of lauric acid. Its principal use is in the manufacture of margarine and other edible fats for which purpose the kernels are exported whole from the producing countries for extraction of the oil in the manufacturing countries. The residual cake is used as cattle food.

Until 1920 the world export of palm oil and palm kernels was from West Africa which still remains the main source of supply, the fruit being obtained from wild or semi-wild palms. Ghana and Nigeria together export approximately one-third of the total world export of 670,000 tons of palm oil and approximately one half of the world export of 930,000 tons of kernels. In Nigeria, which is the only West African country exporting large amounts of palm oil, plantations total less than 50,000 acres, whereas wild palms are estimated to cover four million acres. However, the fact that the oil palm in West Africa is primarily a food crop, with the result that local consumption is high (estimated at 100 lb. per head per annum in Nigeria) and also the fact that production is dependent mainly on wild palms, results in a weakness in the industry in Nigeria which is unlikely to improve in production or efficiency without the development of plantations.

In the Congo most of the palm oil still comes from wild palms but there has been considerable development of plantations. This has resulted in a steady rise in Congo exports and in view of the enormous plantings there, the Congo could be dominant in future world trade.

The development of the oil palm industry in the Far East dates back to the introduction of four plants to Java in 1848, two from Reunion and two from a conservatory in Amsterdam, all of the same racial stock. From there palms were introduced to Singapore Botanic Gardens in

* Agronomist, Lowlands Agricultural Experiment Station, New Britain.

1870 followed by a further movement in 1875 to Deli in Sumatra where Hallet in 1910 made the first large scale plantation with "Deli" seed. All palms in the Far East are said to have originated from this source and the first commercial planting was begun in Malaya in 1917. Hence, from about 1920, exports from Malaya began to enter the world market and the industry there was favoured by both its establishment as a plantation industry with very few small holdings and by the fact that there is virtually no local consumption of oil.

A certain amount of interest in the oil palm has been shown by some Central and South American countries and the United Fruit Company at one stage established 300 acres of oil palm in Costa Rica to replace the banana estates which had been hit by Panama Disease.

BOTANY.

The species belongs to the family Palmae, tribe Cocoineae. There are several other species of the genus *Elaeis* and one of these, *E. melanococca* (Gaertn.) a palm indigenous to tropical America, has been utilized for hybridization trials in the Congo because of its dwarf habits.

Morphology and Pollination.

The oil palm has a typically monocotyledonous root system, concentrated essentially in the surface three feet of soil but with a number of anchoring primary roots descending deep below the base of the palm. Roots are hydrophilus with a thick hypodermis, air spaces in the parenchyma and pneumathodes. Absorption occurs behind the root tip. Development of the trunk is not obvious until some three years after planting when the apical bud has attained full diameter. The palm carries 20 to 40 leaves at one time and as old leaves are shed, the leaf base remains attached to the palm for some considerable time. At the base of each leaf or frond of the palm an inflorescence develops, which is either male or female. The flowering begins when the palm is four to six years old and although either male or female inflorescences develop, they do so at different stages, so that fertilization is by cross-pollination, the pollen being mainly wind born. In all breeding work controlled cross-pollination is, of course, essential and to do this, the female inflorescence is usually covered by a large cloth bag well soaked in oil to render it pollen proof and with a small celluloid observation window through which the stage of development of the inflorescence can be observed and the pollen introduced. Flowering begins at the base of the female inflorescence, most flowers opening within 24 hours and remaining receptive for nearly two days. For cross-pollination work, pollen can be stored at five degrees C. and relative humidity 25 per cent. to 35 per cent. for some months without loss of viability. However, it is usual to check viability before use by germinating pollen grains for five hours on agar with fresh pollen grains as a control check. Agar used at W.A.I.F.O.R. is prepared from 0.5 gm. of maltose in 0.35 gm. of agar. This is heated, a drop placed on a slide, pollen blown on to the agar and the slide then stored for five hours in a moist atmosphere in a container or on wet filter paper in a petri dish before examination.

Sex Ratio.

As mentioned earlier, male and female phases alternate with one another on the one palm, the term sex ratio being applied to the ratio of female to male plus female inflorescences. Naturally, this ratio is of great importance in plantation production as it determines the potential number of fruit bunches developed on the palm. Fluctuations in annual bunch yields are largely due to variations in the sex ratio and, therefore, it becomes important to select palms with a naturally high sex ratio and also to devise cultural and manurial treatments which encourage it. It has now been shown that light is a most important operative factor in determination of sex ratio and that high hours of daily sunshine favour formation of female inflorescences. Male flowering originates in rainy seasons when light is a limiting factor. This effect is exemplified by the fact that in Malaya, where daily sunshine is high and rainfall well distributed, the female cycle is up to twice as long as the male cycle. Also, in Nigeria, female flowering is initiated in the dry season of two years previous when daily sunshine is in its highest period for the year. Sparnaaij (1959*a*) at W.A.I.F.O.R., considers that where light or sun are not optimum for the production of female inflorescences, as for example, in the Nigerian wet season, then nitrogen also becomes an important operative factor in determination of sex ratio. It has been established by British, Belgian and French research workers, that the inter-cropping of oil palms with food crops during the early years of establishment significantly increases

yields for the following 15 to 20 years (Sparnaaij, 1959*a*). The reason for this increase is thought to be due to a reduction in the levels of soil nitrogen leading to an increase in the sex ratio. Further, the soil analyses for total nitrogen on several experimental plots at W.A.I.F.O.R. have shown a consistent and significant negative correlation between total nitrogen and sex ratio. These indications are supported also by the fact that nitrogenous fertilizers when applied to oil palms at the end of the wet season subsequently lead to a reduction in yields (Sparnaaij, 1960).

Classification.

Classification of varieties within the species has been principally based on either external or internal appearance of the fruit, as follows:—

A. Classification of external appearance based on colour of the exocarp—

1. *Nigrescens*:
   The unripe fruit is mostly deep violet or black with a colourless section at the base. On ripening, the fruit becomes either red in colour with a brown cap or orange in colour with a large black cap. These are two distinct sub-types, the red being the most common form.
2. *Virescens*:
   Fruit is green until just before ripening when colour slowly changes to red. The ripe fruit retains a small green tip. This variety is reasonably well known but rare in occurrence.
3. *Albescens*:
   Immature fruit is whitish in colour and ripens to a golden yellow or ivory. The type is exceedingly rare in nature and a simple recessive.
4. *Poissoni*:
   A variety which can occur as any of the above forms with the addition of a mantle of six sterile supplementary carpels containing oil as in the mesocarp. Occurrence is very rare.

B. Classification on internal appearance based on proportions of mesocarp, shell and kernel in the fruit.

1. *Dura*:
   Essentially a thick shelled form with a large kernel and thin mesocarp. The common type of wild palm in West Africa. Within the type a certain range of variation in both shell and mesocarp thickness occurs. The extreme form with very little mesocarp and very thick shell has been called "*macrocarya*" and occurs generally throughout Sierra Leone and in certain creek areas in Nigeria.
2. *Tenera*:
   A contrasting form to *dura* characterized by a thick mesocarp, which produces large amounts of oil, thin shell and small kernel. In some cases, separation of varieties into the *dura* or *tenera* class is difficult but the latter is always recognized by the presence of a ring of fine fibres in the mesocarp a little way from the shell.
3. *Pisifera*:
   This third form has no shell at all, only a very small pea-shaped kernel and is characterized by the common failure of the fruit to mature, the whole bunch going rotten despite normal fertilization and early fruit development (infertile *pisifera*). In some cases (fertile *pisifera*) fruit bunches do mature more or less normally but are very poor.

Early in World War II, the inheritance of the characters of the above three forms was demonstrated in the Congo and has since been confirmed to a large extent by studies in Nigeria (*West African Institute for Oil Palm Research*, 1954). Briefly, it has been shown that the *tenera* palm (AB) is a monofactorial hybrid between *dura* (AA) and *pisifera* (BB). Hence, self pollinated *tenera* palms give *dura*, *tenera* and *pisifera* progeny in the ratio 1:2:1.

Sparnaaij (1959*a*) considers that fertile and infertile *pisifera* forms may be mutant forms of *macrocarya* and *dura* respectively. This view is based on the fact that when a fertile *pisifera* is crossed with *dura* it invariably produces a very thick shelled *tenera* and when an infertile *pisifera* is crossed with *dura* the normal *tenera* is produced. Poels (1959) tentatively agrees with the above hypothesis but the point is not yet proven at either W.A.I.F.O.R. or Yangambi. However, Poels considers that just as *dura* types vary in shell thickness over a certain range so do *pisifera* types vary from those having slight shell (fertile) to those having no shell (infertile). Hence, in crosses between *pisifera* and *dura* a range of *tenera* types are produced as shown in Figure 1.

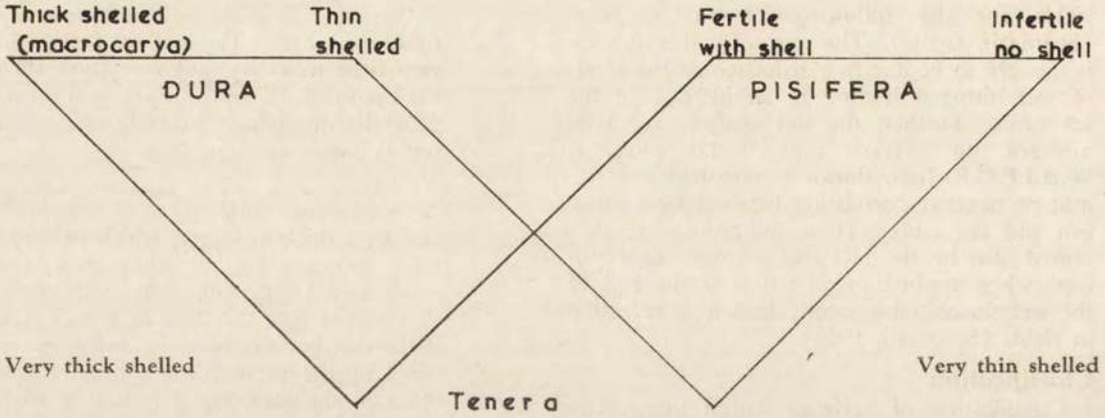

Fig. 1.—Results of *Dura* x *Pisifera* crosses.

The two crosses shown give the extremes of the variation which may occur. At Yangambi, it is generally considered better to select *dura* with average shell thickness and cross these with infertile *pisifera* for production of good *tenera* types. The possibility that this may result in production of infertile *tenera* types has been suggested but Poels considers that the chances of this are less than one per cent.

Sparnaaij (1959*a*) has also suggested that there may be a connection between fertility in *pisifera* forms and sex ratio. He points out that the sex ratio in fertile *pisifera* forms is fairly normal whereas the sex ratio of infertile *pisifera* forms is abnormal in that production of female inflorescences is high. Therefore, it is probable that the palm cannot support nutritionally such a large number of fruit bunches with the result that they abort before maturity and rot.

4. *The Deli Palm*:

As pointed out earlier, the Deli palm is a form peculiar to the Far East, its origin being traced back to the introduction of four plants to Java in 1848. Essentially it is classed with the West African *dura* forms and behaves like *dura* when crossed but is differentiated from the latter by several distinct morphological and physiological characters as listed below. Sparnaaij (1959*a*) considers that the Deli palm can be distinguished visually from the African *dura* but Poels (1959) maintains that a fruit analysis is necessary to separate the two forms.

(1) In Malaya the fruit contains 60 per cent. mesocarp compared with 45 per cent. or less in West African *dura*.

(2) Mesocarp of the Deli fruit contains 45 per cent. palm oil compared with 48 per cent. in Nigerian *dura*.

(3) Leaves of the Deli are dark green and produced at a slower rate indicating a difference in photosynthetic activity.

(4) Vegetative tissue is softer and thus easier to harvest.

(5) Larger bunch size with few very heavy bunches rather than a large number of small ones.

(6) Bunches are less spiny and therefore easier to handle.

(7) The ripe fruit loosens more easily from the bunch.

(8) There is a tendency to low sex ratio and high abortion rate.

(9) Easier to germinate.

(10) More susceptible to crown disease (apparently physiological) and stem rot, but less susceptible to *Fusarium* wilt and deficiency chloroses.

(11) The Deli palm in Malaya produces bunches which contain approximately 61 per cent. fruit, whereas *dura* bunches contain approximately 66 per cent. fruit. However, because of the higher percentages of mesocarp, in the Deli fruit, the palm oil recovery from it is higher (28 per cent.) than from *dura* fruit (22 per cent.).

Although much higher yields of palm oil per acre are obtained from the Deli palm in the Far East than are obtained from the *dura* palm in Africa, the performance of the Deli palm in West Africa has been variable. In the Congo, however, the percentage recovery of oil from the Deli fruit, has remained superior to that from the *dura* fruit. (Poels, 1959).

5. *The Dumpy Palm.*

This is another *dura* type palm peculiar to the Far East which could be described as a " Dwarf Deli " and was discovered growing on a plantation near Kepong in Malaya in the 1930's as a low growing thick stemmed palm with the measurements shown in Table I (Jagoe, 1952).

***Table* I.**

—	Girth at 4 ft.	Height at 15 years.	Height at 21 years 1941.
E 206	113 in.	11 ft.	13.7 ft.
Normal Deli	89 in.	17 ft.	22.5 ft.

When selfed, the Dumpy palm bred remarkably true to type with progeny showing a slow rate of height increase, vigour of growth, a high rate of inflorescence and fruit production and a high percentage of mesocarp (64.5 per cent.). However, percentage of clean fruit per bunch was low (54 per cent.). The dwarf character is desirable for easier and, therefore, cheaper harvesting and may extend the economic life of the palm. When crossed with tall Deli palms, the F_1's were found to be intermediate in growth and thickness and gave a high fruit figure per bunch of 67.8 per cent. It is now hoped to transfer this character to the Dumpy by backcrossing as well as producing *tenera* Dumpies by crossing with *pisifera*.

BREEDING.

The complexity of breeding programmes undertaken by oil palm research centres both in Africa and the Far East, is such that they cannot be dealt with other than briefly in these notes. An excellent outline of the work being undertaken at W.A.I.F.O.R. has recently been published (Sparnaaij, 1959*b*). It consists of three sections. In the main breeding programme, work is concentrated on the selfing and inter-crossing of selected *dura* and *tenera* palms, the progeny being planted out in *dura* x *dura, tenera* x *tenera* and *dura* x *tenera* progeny trials. Parent palms for the second generation of the breeding programme will be chosen from the most promising progenies, both crosses and selfings. In addition to the main breeding programme and linked to it, is the Deli breeding programme. Originally the aim here was to reproduce the most promising Deli palms only, but the programme has now become extended to include a number of Deli x *tenera* and Deli x *pisifera* crosses. This extension was decided upon as a result of evidence that combination of Deli and local material held more promise than pure adaption of the Deli palm to West African conditions.

In contrast to the primary emphasis in Nigeria on breeding within *dura* and *tenera* selections, research workers and planters in the Congo, the French Territories in Africa, Malaya and Indonesia are concentrating on the production of Deli *tenera* palms from a cross between the Deli palm and *pisifera* palms. The progeny from this cross has been shown to retain the high yield and vigour of the Deli palm but produces fruit with a much thinner shell and higher percentage mesocarp.

Should there be any interest in local planting of the oil palm in the next few years, the best approach would be the importation of high-grade seed from Malaya. The present recommendation of the Malayan Department of Agriculture is that commercial plantings should comprise half *dura* and half *tenera* palms, pending further proof of *tenera* types grown in pure stands. The required seed is available from Malaya, being the product of crosses between proved *dura* and *tenera* palms.

In order to meet possible future demands, the Department of Agriculture, Stock and Fisheries, has established seed gardens from imported seed comprising Deli, *dura, tenera* and *pisifera* palms and also the dwarf Deli (Dumpy palms). These gardens were grown from seed from proved high-yielding sources in Malaya and from about 1965 the Department will be able to produce sufficient seed of any type desired for planting about 1,000 acres a year. By that time, as a result of Malayan experience, it may be possible to recommend pure stands of *tenera* palms produced by crossing *dura* and *pisifera*.

A further breeding programme could be undertaken if there were sufficient justification for it in the Territory. Selected seed from all progeny lines in the breeding programme at W.A.I.F.O.R. is available if it can be established in a progeny trial. Alternatively, W.A.I.F.O.R. are prepared to supply mixed material from high-yielding lines and crosses for establishment of a mixed palm population with high-quality genetic constitution.

FIELD AND LABORATORY METHODS.

The laboratory procedure used at W.A.I.F.O.R. for fruit analysis is, briefly, as follows:—

1. The whole bunch is first sterilized in an autoclave.
2. Whilst still warm, fruit is picked out from the bunch and pounded carefully in a wooden mortar so that mesocarp is separated from the nuts but the nuts are not broken.
3. Pounded material from the mortar is then placed for extraction of oil into a "Carver Laboratory Press".
4. From the residue remaining after oil extraction, the ratio of fibre to nut is determined for the sample.
5. Oil is clarified in a Sharples Super Centrifuge.
6. An alternative procedure to the determination of mesocarp oil content by press extration is the utilization of data giving percentage moisture content of the mesocarp and relating this to oil content. The method relies fundamentally on the assumption that the mesocarp consists of oil, water and dry matter, and assumes a constant dry matter content of the pulp. Hence, the oil content of the mesocarp can be found at once when the moisture content is known. It is necessary, however, first to establish the correlation between mesocarp oil and water content for particular palm types such as *dura*. To do this, several direct determinations of oil content by Soxhlet extraction must be made and the negative correlation between oil and water content firmly established. When this has been done, oil content can be rapidly determined from moisture content. Both W.A.I.F.O.R. and I.N.E.A.C. workers have used the method successfully with a very low standard error (Chapas, Tinker and Ziboh, 1957).

ESTABLISHMENT.

Climate and Soils.

The crop requires relatively high temperatures and is cultivated only well within the tropics and usually below 1,000 feet above sea-level. Minimum rainfall requirements are set at 55 to 60 inches per annum but best yields are obtained with a rainfall of 80 to 120 inches per annum. An even distribution of rainfall is desirable and although this occurs in Indonesia and Malaya, these conditions do not obtain in West Africa where the crop is grown in areas with a pronounced dry season. In Nigeria, the dry season is associated with very limited rainfall and a fair amount of sunshine from November to March, whereas, the rainy season from May to October is characterized by limited hours of sunshine per day. These factors of hours of sunshine per day, annual rainfall and rainfall distribution, play an important part, in association with one another, in the determination of the number of female inflorescences and hence bunches of fruit which develop on the palm, as high hours of bright sunlight have a favourable influence on the production of female flowers.

With regard to soils, it is now known that the oil palm will grow on a wide range of soils provided there is no serious impediment to root development and that drainage is reasonably good. A high percentage of oil palms under cultivation are growing on poor soils and the full yield potential is commonly not achieved because of the low nutrient status. In Malaya and Indonesia high yields are obtained on moderately acid, heavy alluvial clays and on lateritic red earths. In Nigeria, much of the area on which oil palms are grown consists of acid sands which have loose brownish topsoil over a great depth of featureless non-mottled, non-gravelly, porous subsoil with coarse sand the predominant fraction and a clay content rarely exceeding 35 per cent.

A large area of soils on which oil palms occur in Ghana have been classified as Forest Ochrosols. These have developed from the intense weathering of granites and phyllites (Adu 1959). They consist mainly of a surface horizon of humus, sandy loam with pH 7.0

which overlies at three inches a brown loam or silty-light clay with pH 6.5. At eight inches this merges into a red-brown, light silty-clay to light clay in which there is at first abundant ironstone gravel decreasing with depth and a pH range of 6.0 to 5.5. The horizon continues to a depth of four to five feet.

Germination.

The oil palm seed is extremely slow to germinate and has a low rate of germination as a result of which germination has remained one of the persistent problems in the establishment of oil palms in West Africa. The presence in the seed of a rather tough testa together with a thin layer of thickened endosperm cells between embryo and the micropyle results both in a mechanical resistence to embryo development and retardation of the entry of air and water to the embryo in dry seeds. Hence it is generally found that germination is low, slow and erratic unless seeds are kept constantly moist and warm. Research work on the above problems has been carried out at several centres in Africa and the Far East although germination is apparently never such a problem in the latter area as in West Africa because of both climatic conditions and the fact that the Deli seed used in the Far East has better germination than *dura* seed.

Following on from attempts to improve germination by using whole fruits, cracked nuts, bored nuts, naked kernels and soaking seed in water and acid, various methods of germination have been evolved and elaborated. These techniques, which are all based on sowing the seed in a moderately moist, adequately aerated medium maintained at temperatures of 35 to 40 degrees C. have been well summarized by Gault (1953).

Malayan methods of germination are based on the use of open sand beds 30 inches in depth, the effectiveness of which can be increased by underlaying with compost and covering for a few hours in the middle of the day with glass frames to retain heat and moisture. Seed is not stored for longer than three months as beyond this period an appreciable decrease in viability occurs. Seed is sown three inches by three inches by one inch deep and watered twice daily giving a germination of 50 to 60 per cent. in nine months with seed of the Deli variety. Transplanting to the field nursery is carried out when the first leaf appears. Some Sumatran estates use steam germinators which may give up to 85 per cent. germination.

Methods used in both Ghana and Nigeria were found to be fairly similar, based on the use of special germinating chambers and following closely W.A.I.F.O.R. recommendations. Contrary to the experience in Malaya it has been found that seeds can be extracted from ripe fruit and stored for up to one year with little loss in viability before germination. Trials at W.A.I.F.O.R. have shown that 20 per cent. germination is obtained after holding for one month, 50 per cent. after five months and 58 per cent. after seven to nine months. Also seed stored for up to one year will sometimes give a burst of germination as soon as it is placed in the germinator. Consequently seed is usually collected throughout the year and in September placed in a germinating chamber. This enables most of the seed to be transplanted to a field nursery at the beginning of the rainy season in April. A thorough mixing of the seed with charcoal is necessary as exposed seed will not germinate well. Charcoal must be kept constantly moist but not wet or soggy and in many germinating chambers a can of water is placed near the seed trays both to assist in maintenance of humidity and to provide water at the correct temperature for watering seed boxes twice weekly. Each week, boxes are examined for germinated seed by either picking over the seed or separating the seed from the charcoal on a coarse mesh sieve. As soon as the radicle shows, seeds are removed and planted in a pre-nursery. Although germination of individual lots shows most unpredictable variations most seed germinates in the third, fourth or fifth months.

A diagram of a typical germinating chamber is shown in Diagram 1. Built, usually with concrete, it consists essentially of two chambers one above the other, separated by a concrete division. In the upper chamber, a wooden framework is housed to carry the wooden germinating boxes which can be run in through the door openings on either side of the chamber. The lower chamber remains empty and functions as a fire box for the unit.

Various optimum temperatures for germination have been advised by different research centres but for the typical germinator as described above the chambers should be maintained

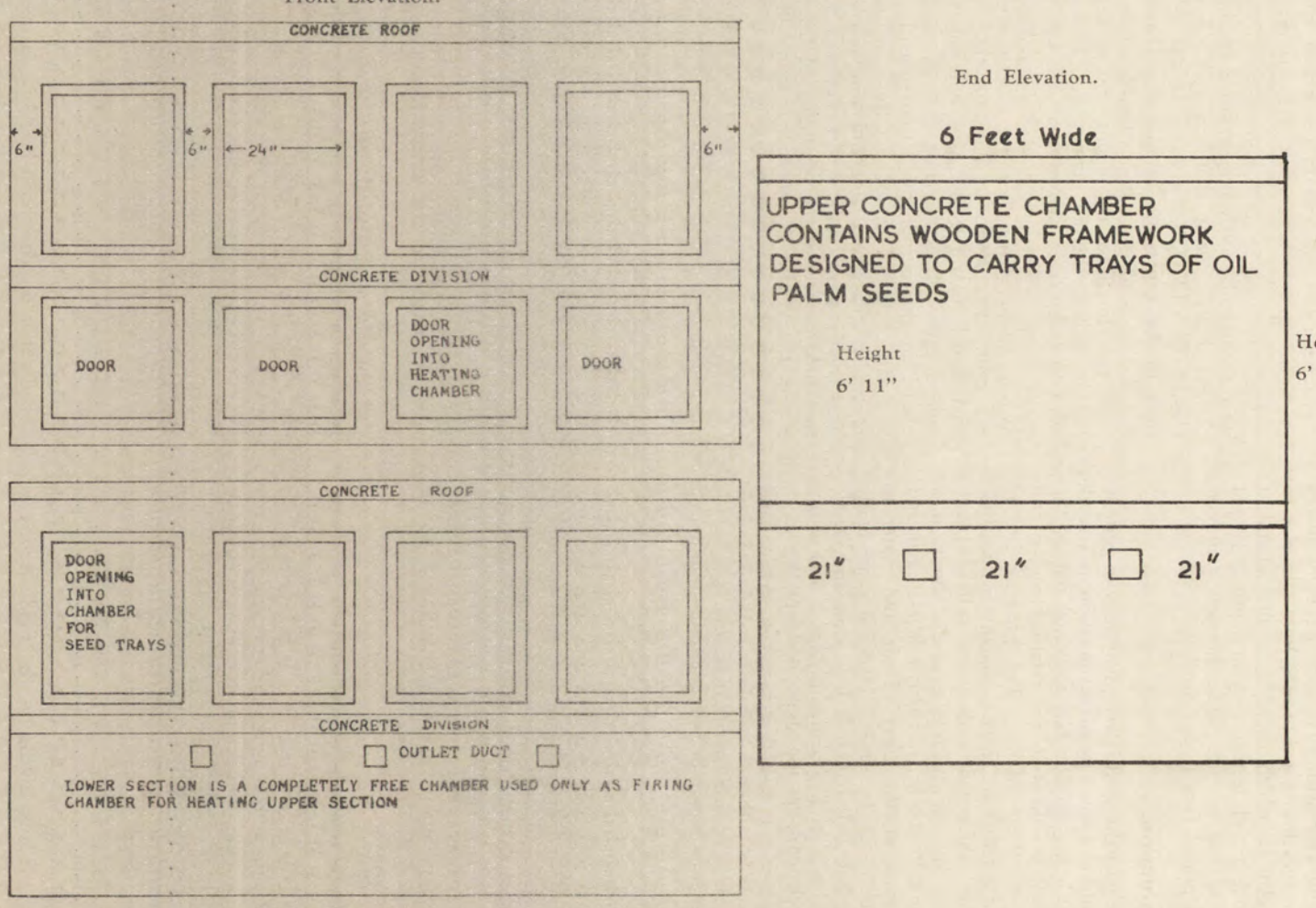

Diagram I.—Seed Germination Chamber used at Bunso, Ghana.

at 93 to 97 degrees F. One such unit inspected in Ghana operated at the temperature range of 90 to 104 degrees F. and suffered from lack of supervision.

Mulch germinators are in use in some areas. They are similar in construction to cocoa propagating bins and fitted usually with aluminium covers. Oil palm seed mixed with charcoal in the same manner as already outlined is packed into cubic wooden boxes which are placed in the concrete bin and packed around on all sides with finely chopped fresh green material. Grass is commonly used but a leguminous cover crop such as pueraria is considered superior. The mulch must be changed every two weeks with a light watering at time of renewal. A temperature variation of 86 to 94 degrees F. develops in this type of germinator.

Similar equipment to the above with some further modifications has been studied at I.N.E.A.C. Yangambi, a summary of the technique used being presented in a paper by Marynen and Bredas (1955).

Recent trends in research work at W.A.I.F.O.R. have been into the use of electrically controlled germinating chambers and the germination of seed in polythene bags in ovens. A large electric germinator has been built at the above Station and used for some time with considerable success (Rees, 1959*a*).

Development of the polythene bag technique began with the use of metal trays on to which seeds were placed without charcoal, covered with polythene sheet and watered with a fine spray. Temperature during germination has been found to be optimum at 110 degrees F. and moisture content of the seeds optimum at 17 to 19 per cent. for *dura* and 22 per cent. for *tenera*. The method facilitates watering, inspection, handling and accurate moisture control. Following on from this, it has been shown by Rees (1959*b*) that over 80 per cent. germination can be obtained by placing seeds in polythene bags and holding them at 39.5 degrees C. for ten weeks in an electric oven.

Pre-Nursery Beds ("Raised Trays").

Earlier mention has been made of the fact that in the Far East, oil palm seedlings are germinated in open sand beds and then transferred to field nurseries as soon as the first leaf appears above ground. In West Africa the nursery practice differs and seed, once germinated, is transferred to pre-nurseries or raised trays where they remain for a period of four to five months before transplanting to the field nursery. The raised trays vary in size, the variation depending to some extent on whether they are constructed of wood and to be movable or whether they are of fixed concrete construction. At Bunso Station in Ghana, wooden trays five feet by one foot by six inches and perforated at the base to allow drainage, are in use. These were filled with a 50/50 mixture of river sand and compost material all of which had first been sterilized by boiling in water. Sterilization of the planting medium in raised trays has been universally adopted in Africa to assist in the control of seedling diseases. In both Ghana and Nigeria the planting of germinated seed in raised trays is usually completed in December. They remain in here until the beginning of the wet season in April at which stage they are transferred to field nurseries, seedlings then having three to four leaves. A three inch by three inch spacing and one inch depth of planting is now commonly used as this gives more robust seedlings and also reduces losses from seedling diseases such as Anthracnose. The one and one-half inches by one and one-half inches spacing previously used has been discontinued. Trays require fairly frequent watering from at least twice weekly up to twice daily under severe Harmattan conditions and usually are given 50 per cent. shade. This is slowly reduced over a hardening period of six weeks prior to planting in the field nursery.

Pre-nursery beds are used in some areas as an alternative to raised trays. These are prepared by removing topsoil to a depth of four inches to six inches and refilling with a 12-inch layer of sterilized 50/50 mixture of sand and organic medium which raises the bed above ground level. Nursery beds are favoured where seedlings are to be transplanted to an immediately adjacent field nursery but where transportation to a field nursery is involved, the raised trays are more commonly used. At the I.N.E.A.C Station, Yangambi, in the Congo, pre-nursery beds were prepared rather more elaborately than in West Africa, soil being removed to a depth of 18 inches and replaced with rich organic topsoil collected from beneath established palm stands to form a raised bed. Seedlings in these beds were extremely vigorous

with a good dark green colour. However, the Belgians apparently preferred to use baskets for pre-nursery seedlings rather than beds or raised trays and have done so with great success.

Two noticeably effective treatments used at the main W.A.I.F.O.R. Station in Nigeria were the application of a light mulch to seedlings at the two leaf stage and the spraying of seedlings with a solution of ammonium sulphate (half ounce/gallon each fortnight to each 45-inch by 21-inch tray).

Field Nurseries.

The Malayan technique of germinating seed in open sand beds has been outlined. Following germination, seedlings are transferred at the one leaf stage to field nurseries where they are spaced three feet by three feet and remain for 18 months.

The field nursery in West Africa comes into use after seedlings have been raised to the three to four leaf stage in pre-nurseries as described. Main objectives in the field nursery are:—

1. The production of strong, well-developed, disease-free seedlings which can be transplanted to the field with minimum loss.
2. Elimination of the cost of ring weeding pre-nursery seedlings in the field for a period of 12 months.
3. Protection of seedlings from field rodents and from drought, both factors being important in West Africa.

Notes on the establishment of oil palm nurseries and the effect of cultural treatments on losses in the nursery at the W.A.I.F.O.R. have been outlined by Anon. (1953*a*) and Allen (1954) respectively.

Shade is not used on field nursery beds in Malaya. Also, in Ghana and Nigeria where seedlings in nursery beds are mulched from one month after planting until they are lifted, no shade is used but great care is taken to see that seedlings receive at least one gallon of water per week. Unmulched nursery beds are usually shaded. At Bunso Station in Ghana pre-nursery seedlings are planted out in unshaded 12 feet to 14 feet wide field nursery beds at a spacing of two feet by two feet giving five rows of seedlings down the bed. Here they remain for 12 months until transplanted as balled-earth seedlings to the field.

Belgian Congo workers, on the other hand, use light shade over field nurseries for the first six to eight weeks after establishment.

Selection in the Nursery.

Workers at I.N.E.A.C., Yangambi (Poels, 1959), claim a close correlation between leaf size and number in the nursery and bunch and leaf production in the field. W.A.I.F.O.R. results have not confirmed this with the result that only the elimination of damaged or diseased seedlings is practised (Sparnaaij, 1955). No improvement in performance in the field has resulted from nursery selection. Nursery selection is considered essential in Malaya where up to 30 per cent. of the seedlings may be discarded.

Transplanting to the Field.

Ball-of-earth planting is recognized both in Africa and the Far East as being the only safe method of transplanting oil palm seedlings. Details of the technique have been outlined by Toovey (1953). Before planting in the field older leaves are usually trimmed, particularly under dry conditions. However, although this method may reduce field losses to as low as one per cent. as against up to 50 per cent. loss when the alternative "naked root" system is used, this latter method is generally practised in West Africa where oil palm seedlings are to be distributed to peasant farmers. Most peasant farmers have to transport their seedlings over considerable distances from the distributing centres to the planting areas with the result that it is completely impracticable for them to receive seedlings in the balled-earth form. To overcome this difficulty, workers at W.A.I.F.O.R. have developed a technique for distribution of naked root seedlings which, although still inferior, solves the problem to a certain extent (Anon., 1959).

In the Congo palms are removed as ball-of-earth seedlings with the aid of an iron collar which is fitted over the seedling and pressed down into the nursery bed to cut the roots.

Under peasant farming conditions in West Africa, preparation of land (clearing, lining, holing) for seedlings is haphazard, the bulk of the farmers' palms being grown in association with foodcrops, cacao and in some areas Kola nut (*Cola nitida*, A. Chev.) and natural vegetation.

Areas cleared under supervision in Ghana are clear felled and burnt prior to planting if the oil palm stand is to be intercropped with foodcrops. Where no inter-cropping is intended burning is usually not practised. Balled earth seedlings are planted in holes three feet by three feet by three feet filled with topsoil. Data on the cost of establishing an oil palm plantation have been prepared (Anon., 1953*b*). These show that in Nigeria 96 man days per acre are absorbed in establishment in heavy forest to which can be added a further 12 man days per acre for germination, pre-nursery and nursery work. Figures quoted from the Belgian Congo on cost of establishment (excluding all nursery work) are:—

Heavy forest—95 man days per acre.

Medium forest—83 man days per acre.

Light forest—70 man days per acre.

Replanting.

The necessity for replanting on oil palm estates may arise as a result of one or more of the following factors.

(*a*) Low yield as a result of senility. This usually becomes an important factor after 30 to 40 years.

(*b*) Increased harvesting costs as a result of palm height. Height increases lead to difficulty in reaching the bunches with harvesting tools and also a tendency for bunches to burst when dropped to the ground thus increasing costs of gathering.

(*c*) Replacement of low yielding palms with higher yielding types such as *tenera*.

Investigations into the problem of replanting old palm stands have begun in both Nigeria and the Belgian Congo and are described in detail in the literature. (Gunn, 1958*a*; Gunn, 1960 and Marynen and Gillot, 1957.)

The following points have emerged from results:—

1. The system of "live felling" old palms which is used in Malaya has shown sufficient promise to warrant further investigation.
2. In Malaya it is common practice to fell 50 per cent. of the palms initially and the remainder in a later period, but it is recognized that interplanting alternate rows of old palms with seedlings causes a reduction in yield from the seedling palms if the older palms are allowed to remain too long in the stand.

   A reasonable percentage kill of old palms can be obtained by introducing six ounces sodium arsenite per palm into a hole bored with a brace and bit. It is suggested that a quicker kill may be obtained with less sodium arsenite in larger holes, although I.N.E.A.C. workers gained a ninety-seven per cent. kill at the higher concentration (Marynen and Gillot, 1957). Application during the wet season has proved more satisfactory than in the dry season or during early rains.
3. The most satisfactory method of replanting old palm stands which has emerged from an experiment at the W.A.I.F.O.R. main station is to fell alternate East to West rows of old palms one year after planting young palms and then fell the remaining rows of old palms after a further three years cropping (Gunn, 1960). Young palms have come into bearing at this stage. Poels (1959) also recommends the above as the best method for replanting but suggests poisoning of palms rather than felling.

Harvesting.

Plantation palms begin bearing in the third, fourth or fifth year but some wild palms in West Africa rarely start to bear before they are 20 years old. The rate of leaf production, which is paralleled fairly closely by production of inflorescences increases rapidly until six to seven years, remains constant for some years and eventually slowly decreases. The number and weight of bunches increases fairly rapidly to 10 to 15 years, and remains constant until the 20th year and then falls away slowly. Very little fruit is produced after 60 years and generally replanting is carried out after 30 to 40 years. The optimum time for harvesting bunches is when the majority of fruit in the bunch is just ripe. This will occur five to six months after pollination and is indicated by both a change in colour of the fruit from purplish black to orange red and the loosening of the fruit in the crown of the bunch. On some estates bunches are harvested when four to five fruits have fallen from the bunch to the ground. Harvesting at the correct stage of ripeness is most important as early harvesting results in both

loss of fruit fallen to the ground and an increase in the free fatty acid content of the fruit due to the action of an enzyme in the mesocarp which splits the oil into free fatty acids and gylcerol.

Normal estate practice is to harvest every seven to 10 days. This frequency together with good factory extraction techniques gives an oil with 2.0-2.1 per cent. F.F.A. In some cases the harvesting frequency is extended to 10 to 14 days with a resultant increase in F.F.A. content to 2.7-2.9 per cent.

As may be expected, harvesting techniques vary from place to place and between peasant farmers and estate labourers. Generally, however, harvesting on estates is done with sickles on long bamboo poles with which one subtending leaf and the fruit bunch are cut off. In some cases estate labourers and in nearly all cases peasant farmers climb the palm to harvest the fruit bunch using a rope support to do so. On reaching the crown of the palm the frond subtending the fruit bunch and then the bunch are cut with a variety of shaped bladed tools.

Pruning.

General estate practice is to remove only the frond subtending the fruit bunch during harvesting operations and to remove any dead or dying leaves twice yearly. W.A.I.F.O.R. experiments have shown this routine to be beneficial but any more intense pruning of palms has a deleterious effect (Gunn, 1958*b*).

PRODUCTION.

Processing by African Farmers.

Two methods are used:—

Hard Oil Process.

After harvesting, bunches are heaped, covered with bags and allowed to ferment for seven to 10 days until fruit can be easily shaken from the bunch. Fruit is then transferred to wooden or stone pits where it is pounded during the first day of the extraction process. Addition of boiling water together with further pounding on the second day results in extraction of the bulk of the oil which, together with water, is run off down a slope from the container or mortar for collection. Finally, the pounded fruit is covered with cold water and thoroughly macerated by treading, the oil rising to the surface of the cold water where it is collected The method can yield up to 15 or 16 per cent. oil on weight of fruit but free fatty acid content is always high.

Soft Oil Process.

Under this method of extraction fruit is softened and loosened from the bunch by boiling with water in pots or drums, the heat leading to enzyme death and hence a check to the development of free fatty acids. Softened fruit is pounded immediately upon removal from the boiler, nuts are extracted by hand and the residual fibre squeezed to obtain the oil. Recovery of oil by this process is about 12 per cent. on the weight of fruit but the free fatty acid content is much lower in comparison with the first method.

Both processes are improved in certain instances by the use of hand operated oil presses giving a higher percentage recovery of oil. If these are used in conjunction with recommended procedures for preparation of fruit before pressing, oil with less than five per cent. free fatty acid is produced. Oil quality depends primarily on ripeness of the fruit at harvesting and on boiling the fruit soon after harvesting.

At the Bunso Research Station in Ghana a refined soft oil process is employed for extraction of oil from experimental plot bunches as follows:—

1. Bunches are first chopped into small sections and left heaped for one to two days depending on the ripeness of the fruit.
2. Fruit is separated from bunch sections by beating with a foot fork.
3. After sieving on quarter to half-inch mesh to remove small foreign matter the whole fruit is boiled for a minimum boiling time of 50 minutes. In practice, boiling continues throughout the morning, the fruit being removed in batches for pounding in a large mortar to loosen the mesocarp from the nut. In this way a continual supply of hot fruit is available for pounding which is consequently made easier and more efficient. Boiling time is not greatly important, although as it is extended so the uptake of water by the mesocarp increases and the water content of oil subsequently extracted increases. In turn this necessitates an extension of the final purification stage.

4. From the mortar, pounded and macerated material is transferred to a press for oil extraction. At Bunso a "Deutcher" press is used, the type being manufactured with either a one cubic foot or two cubic feet capacity. The smaller model will handle approximately 600 lb. of fruit in three hours with two pressings. Residual material (fibre and nuts) from the first pressing is spread on trays to allow hand picking of

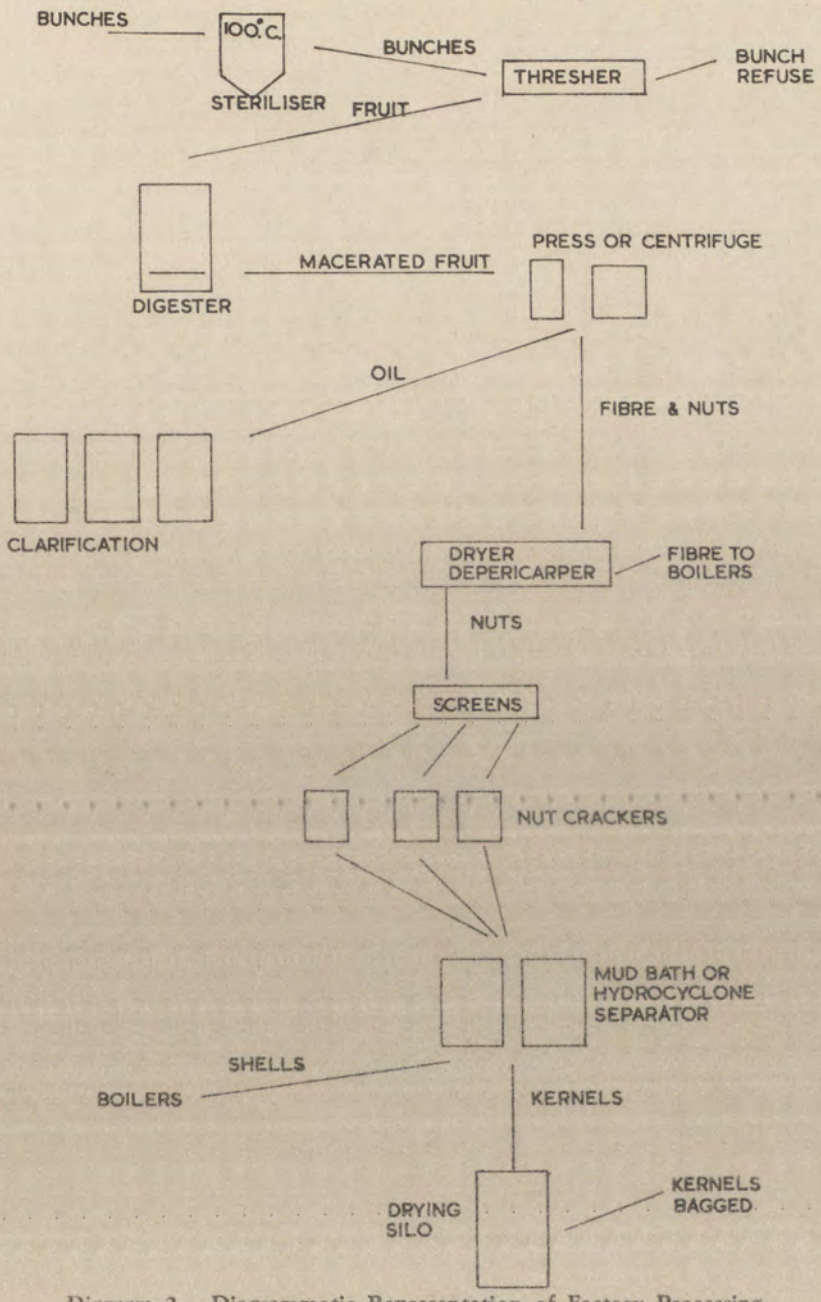

Diagram 2.—Diagrammatic Representation of Factory Processing.

nuts and the remaining fibre is then "fried" in a drum over a fire for two to five minutes before returning to the press for a second pressing. Recovery of oil after two pressings is 10 to 12 per cent. of fruit weight.

5. Purification of the red extracted oil is achieved by boiling for five to 10 minutes to remove excess water and sieving through a fine mesh to remove foreign matter.

6. Nuts are sun dried for two or three weeks prior to cracking in a mechanical cracker for kernel extraction and the mud bath separator is used for separation of kernels and shell by flotation. Density of the bath has usually to be adjusted before best separation can be obtained but the figure generally lies between 1.1 and 1.2. Sea water can be used as a substitute.

7. Four to seven days sun drying of the kernels is normally adequate before grading and bagging for export.

Factory Processing.

Factory processing of the oil palm fruit on the plantation is aimed at both the extraction and clarification of oil from the pericarp for export and the production and preparation of kernels from which oil is extracted in larger factories situated for example in the United Kingdom.

A diagrammatic representation of the essential stages of processing is shown in Diagram 2.

In West Africa much of the processing is carried out in Pioneer Oil Mills—small oil extraction factories which have become established in recent years and are capable of extracting 20 to 21 per cent. oil on weight of fruit and giving oil of good quality. As will

Plate I.—*'Stork' Factory.*

be shown these units have certain defects and are not popular with producers who consider prices paid too low. Sale and installation of Pioneer Mills is controlled by the United Africa Company who can provide factories of two sizes, the "Minor" and the "Major". These factories have not been designed and manufactured by any individual engineering company but consist of a combination of equipment purchased from various sources. The efficiency of processing suffers accordingly. In 1959, the smaller type of Pioneer "Minor" could be purchased for £18,000 sterling. It requires a minimum supply of 1,900 tons of bunches per annum. For optimum efficiency and economy of production, some 3,800 tons of bunches per annum must be handled. One of these units installed at W.A.I.F.O.R. has been run for some time at a total cost of £900 to £1,000 sterling per month including depreciation at 10 per cent. and costing of bunches supplied to the factory at £6 per ton and labour at 4s. per day. Gross return from the factory including kernels has varied between £1,300 to £1,500 sterling per month.

Larger estates, particularly in the Congo, have installed different sized models of a very efficient and compactly designed type of factory almost wholly manufactured in Holland by Gebr. Stork & Co.

Unfortunately, none of these "Stork" factories are in the same price range as the Pioneer "Minor", the smallest type costing £52,000 sterling (See Plate I) and requiring a minimum supply of 10,000 tons of bunches per annum. A unit of this size in operation at the W.A.I.F.O.R. is being run at a total cost of £1,300 per month including depreciation at 10 per cent. and costing of bunches at £6 per ton and labour at 4s. per day. This factory produces 45 to 50 tons of oil per month which, together with kernels, gives a gross return of £1,800 per month.

At the Lalome Estate in the Congo a much larger "Stork" factory costing £500,000 sterling was inspected. Production from this unit at the time was 700 tons of oil per month plus 125 tons of kernels but its maximum capacity was rated at 1,900 tons of oil per month plus 340 tons of kernels.

Details of Processing in a Small "Stork" Factory.

Sterilization.

Bunches delivered from the field to the factory are, firstly, steam sterilized for a period of one hour with the object of (*a*) arresting enzyme action in the fruit and killing micro-organisms (*b*) loosening the fruit in the bunch

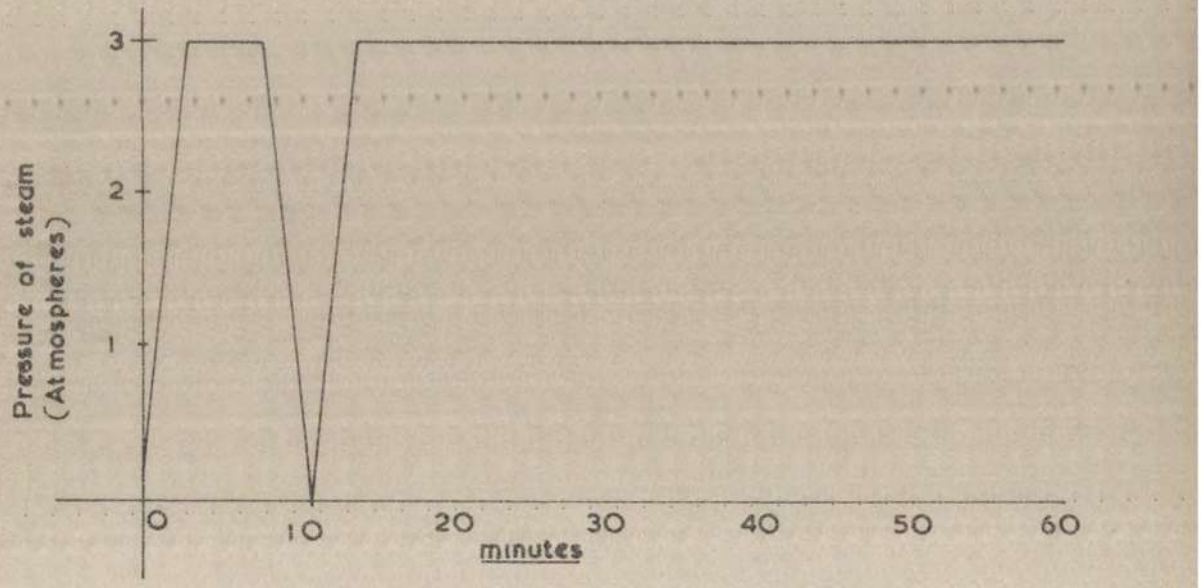

Fig. 2.—Standard Method of Air Expulsion used by W.A.I.F.O.R.

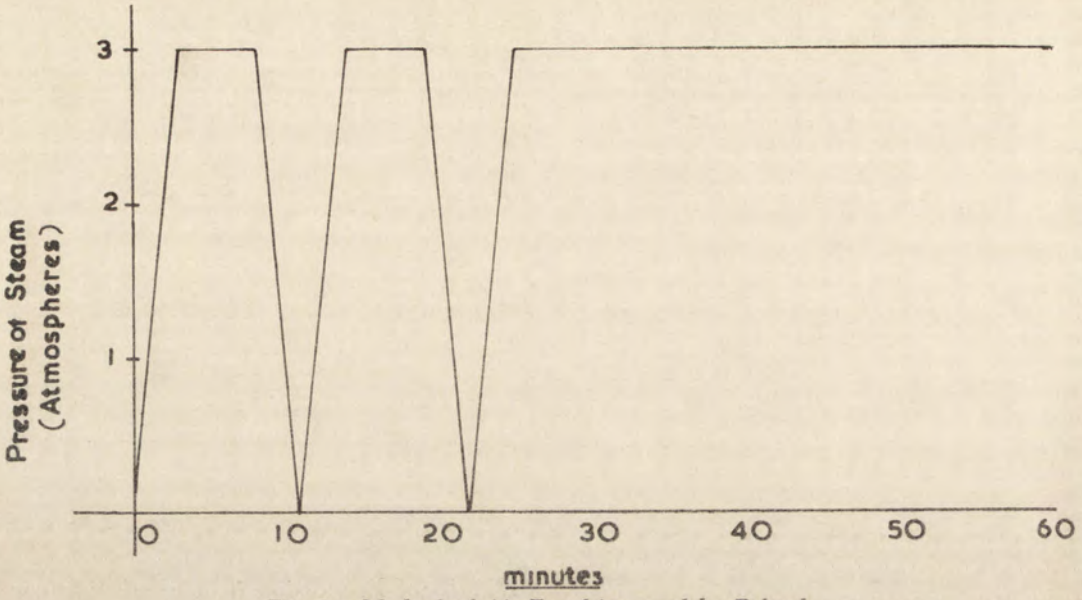

Fig. 3.—Method of Air Expulsion used by Palmol.

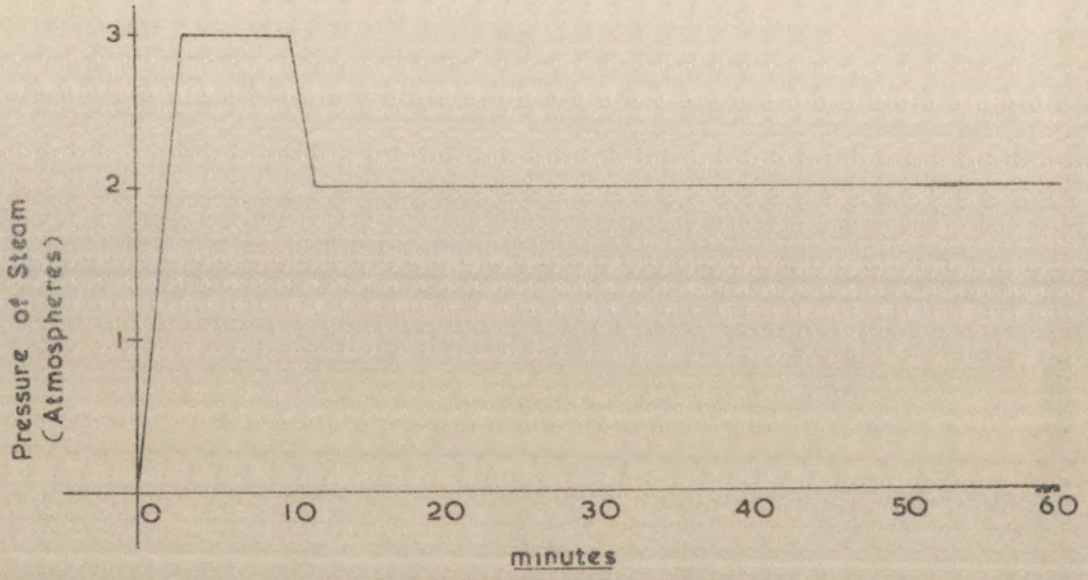

Fig. 4.—French Method of Air Expulsion.

to facilitate threshing and (*c*) coagulation of proteinaceous material. Smaller type sterilizers are usually heated by two or three jets of steam under pressure for a period which may vary from 40 to 90 minutes but which is usually initially set at 60 minutes and later adjusted as experience shows necessary. Within the steri-

lizer, a temperature-time application which is too low, results in hard bunches of fruit thus increasing the difficulty of threshing and if too high causes colour to run from the nuts into the pericarp imparting a dark brown colour to the oil extracted at a later stage. The aim in steriliza-

tion is to raise the temperature at the centre of the sterilizer to 100 degrees C. and hold it there but this is complicated by the necessity to remove air entrapped by the bunches.

Air must be expelled, as its presence during sterilization can lead to oxidation of the oil. Three techniques are commonly employed to eliminate air from the sterilizer.

Plate II.—Fruit bunches being loaded into top of sterilizer.

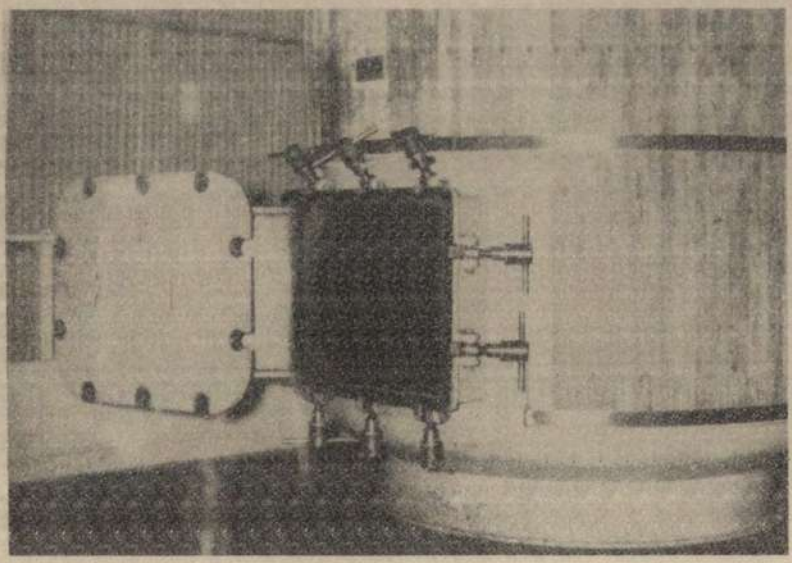

Plate III.—Bunch sterilizer of vertical construction.

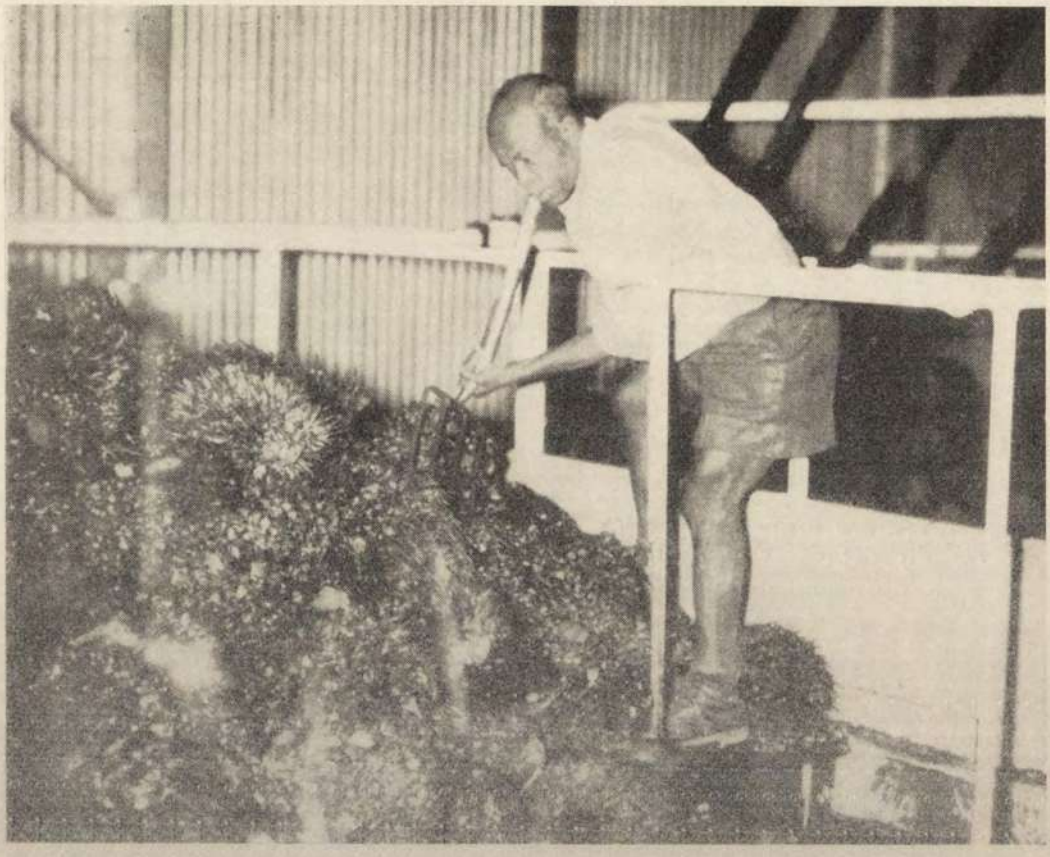

Plate IV.—Fruit bunches from sterilizer being fed into a stripper.

(*a*) Steam pressure is raised to three atmospheres, held for five minutes and then released through a valve. This results in emission of air together with steam. Pressure is again raised to three atmospheres and held for the remainder of the sixty minutes at this level.

(*b*) Steam pressure is raised to three atmospheres and held for five minutes before releasing as in method (*a*) but the procedure is repeated a second time before pressure is built up and held at three atmospheres for the remainder of the 60-minute period.

(*c*) Steam pressure is raised to three atmospheres and held there for five to 10 minutes before lowering to a pressure of two atmospheres which is maintained for the remainder of the 60-minute period.

There are two basic designs for sterilizers used in African factories:—

(*a*) *Vertical Sterilizer* (see Plates II and III).

This type is commonly used in Pioneer Mills and also in the smaller "Stork" factories and consists essentially of a reinforced vertical cylindrical chamber with a loading door at the top and an unloading door at the bottom. It has the disadvantage that during the sterilization process a certain degree of bumping and settling of the fruit can occur as pressure is released, which not only increases the difficulty of extracting the bunches from the bottom door on the sterilizer, but also causes fruit to separate from the bunch, thus increasing handling costs. A further disadvantage is that the bumping and compression leads to the premature extrac-

tion of some pericarp oil by pressure. However, the units are fairly satisfactory for the smaller type factory as they are designed in various sizes to handle up to five tons of bunches per hour and can be added to the factory production line as fruit intake increases.

(*b*) *Horizontal Sterilizer.*

The type of sterilizer used in large factories again consists essentially of a cylindrical chamber but in this case the chamber lies horizontally at ground level with one end consisting entirely of a door through which the bunches, carried in small steel rail-cars, are introduced. The bunches are thus held in the chamber without contact with the walls and bumping and settling are not the problem that they are in the vertical type sterilizer.

Threshing or Stripping.

From the sterilizer, bunches are conveyed directly to the thresher (see Plates IV, V and VI) where fruit is separated from the bunch either by a process of tumbling in a rotary drum tumbler or stripping by mechanical beating. Bunch refuse from this stage can be used as a potash fertilizer after burning, for preparation of compost or as a mulch for nursery seedlings.

Digestion.

The function of the digester, which is an upright steel cylinder unit with a false bottom for collection of oil and water (see Plate VII), is to

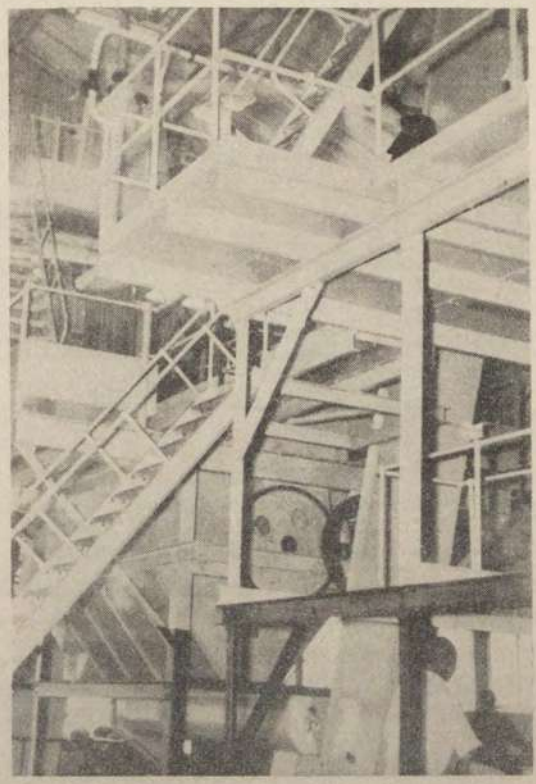

Plate V.—The thresher located below and to one side of the bunch steriliser with loading platform above.

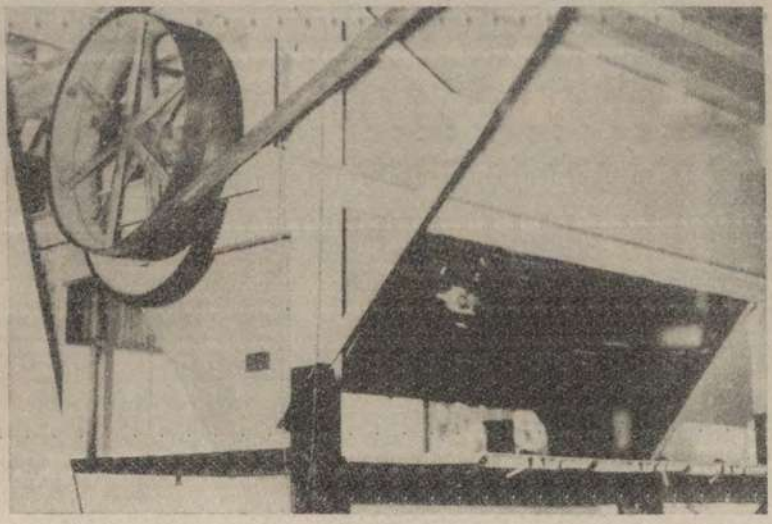

Plate VI.—Close-up of tumbler type thresher.

macerate the fruit, loosening the mesocarp from the kernel and to break up the oil cells by heat. It is essential that the unit be steam jacketed, steam injected and have provision for the addition of hot water for successful operation.

Macerated material from the digester is fed into either a press (see Plate VIII) or centrifuge for extraction of oil. The choice of the method of extraction to be used should be considered in the light of the following factors:—

(*a*) A greater quantity of oil can be extracted by use of a press but this oil is dirtier than oil extracted by centrifuging and generally speaking the amount of clarified oil obtained from either process is approximately the same.

(*b*) Oil extracted by pressing usually contains non-oily solids (fibre and sand), a fraction which is four to five per cent. greater than in oil extracted by centrifuge. An average figure for non-oily solid content of press oil is seven per cent. compared with the average figure for centrifuge oil of three per cent. However, this disparity is offset by the fact that residue after press extraction contains only eight to 12 per cent. of oil to dry fibre, whereas, residue after centrifuge extraction contains 12 to 15 per cent. of oil to dry fibre. Hence, although press oil contains a higher percentage of non-oily solids, a higher percentage of oil is extracted and the end result is that both methods produce about the same amount of oil.

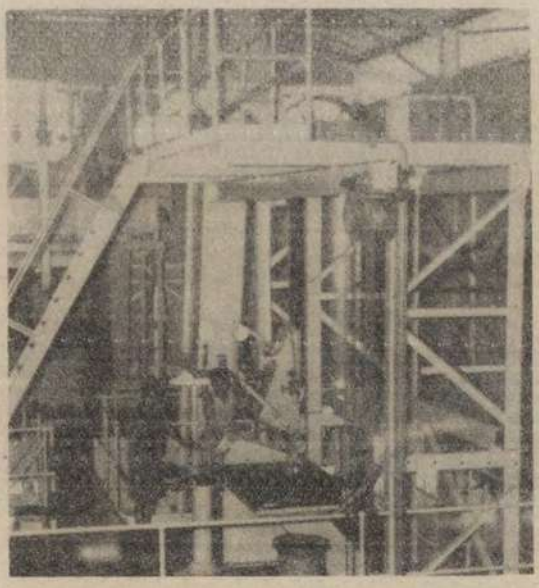

Plate VII.—**Tall cylindrical fruit digester.**

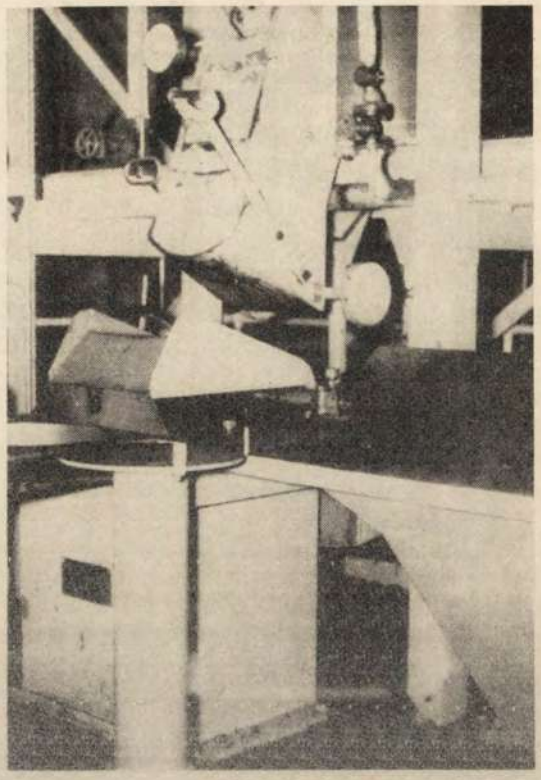

Plate VIII.—**Hydraulic press used for oil extraction.**

(*c*) Because of variation in fruit characteristics, certain types are more suited to pressing whereas other types are more suited to centrifuging. In relation to oil extraction, fruit may be classified into three main types:—

1. Fruit with a thick shell and thin pericarp;
2. Fruit with a thick shell and thick pericarp; and
3. Fruit with a thin shell and thick pericarp.

Fruit of the first class is best processed by centrifuging, as pressing tends to result in a high percentage of broken shell because

of the lack of any cushioning action by the thin pericarp. If a press is used for this type of fruit the problem can be overcome to a certain extent by mixing additional fibre with the material to give a greater cushioning effect. The second class of fruit is suited to either technique of extraction. With the third class of fruit there is the danger that the volume of nuts will be too small in relation to the volume of pericarp for press extraction as the nuts will not provide a sufficient number of pressure points. Centrifuge extraction is, therefore, recommended for this type but if press extraction is used more pressure points can be obtained in the material by addition of nuts to the material.

On plantations of mixed palm types the selection of either method is not usually a problem as difficulties only arise in processing fruit from pure stands of one palm type.

Clarification.

A system involving the use of settling tanks (see Plate IX) is used for clarification of extracted oil. Crude oil, collected from the presses or centrifuge, is pumped or blown to the first settling tank from which the upper 50 per cent. is later drawn off into a second tank. The residual sludge and oil in the first tank is then boiled by means of steam injection and after a further settling period the remaining oil is drawn off into the second settling tank. Here the oil is heated by means of a closed steam coil to 105 to 110 degrees C. which enables the water content to be reduced below one per cent. From this stage oil is finally passed through filter presses or centrifugal clarifiers for removal of the last traces of dirt before pumping into drums for shipment.

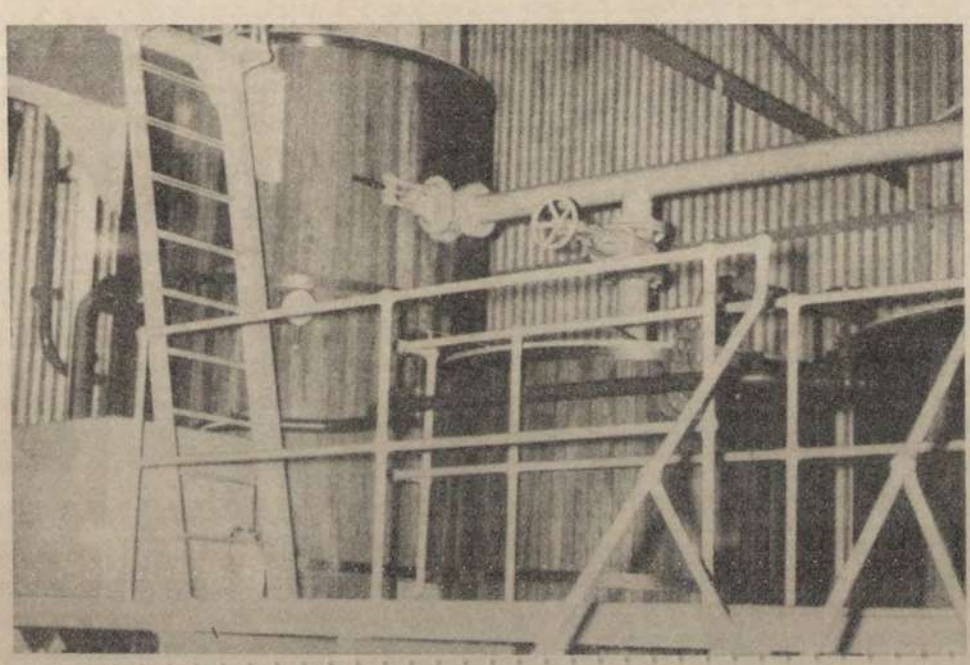

Plate IX.—Settling tanks used for clarification of oil.

Preparation of the Kernels.

Residual fibre and nuts from the press or centrifuge are conveyed to a dryer-depericarper (see Plate X) where nuts are separated from the dry fibre which is utilized for firing the factory boilers. Dried nuts are then processed in a nut cracker and kernels and shells separated in either a mud bath separater or a hydro-

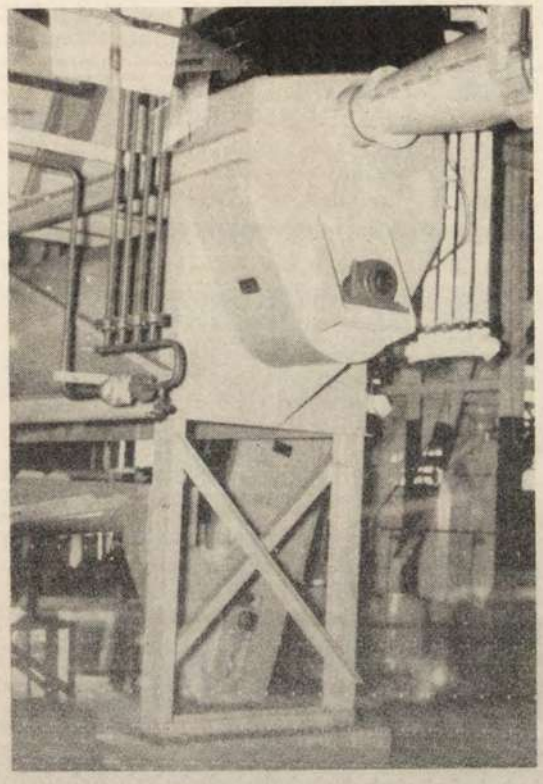

Plate X.—The Dryer-Depericarper.

cyclone separator (see Plate XI). As with the fibre, shells are used for firing the boilers (see Plate XII) while the kernels after thorough drying in a silo are bagged for shipment overseas.

Details of Processing in a Minor Model "Pioneer" Mill.

Sterilization.

A fruit sterilizer is used as compared with the bunch sterilizer used in "Stork" factories. For this process bunches must first be quartered and heaped for two days after which fruit can be separated by beating with a fork. The fruit sterilizer has a capacity of only four cwt. and the duration of the sterilization process is only 15 minutes at 20 to 30 lb. pressure of steam.

Digestion.

From the sterilizer, fruit is man-handled to a rather poorly designed digester in which it is macerated only. Absence of a steam jacket causes a failure of the oil cells to break down under the action of heat as in the "Stork" digester.

Centrifuging.

Macerated material from the digester is again man-handled to a centrifuge where it is processed for 11 to 14 minutes. The Pioneer centrifuge is not covered at the top as a result of

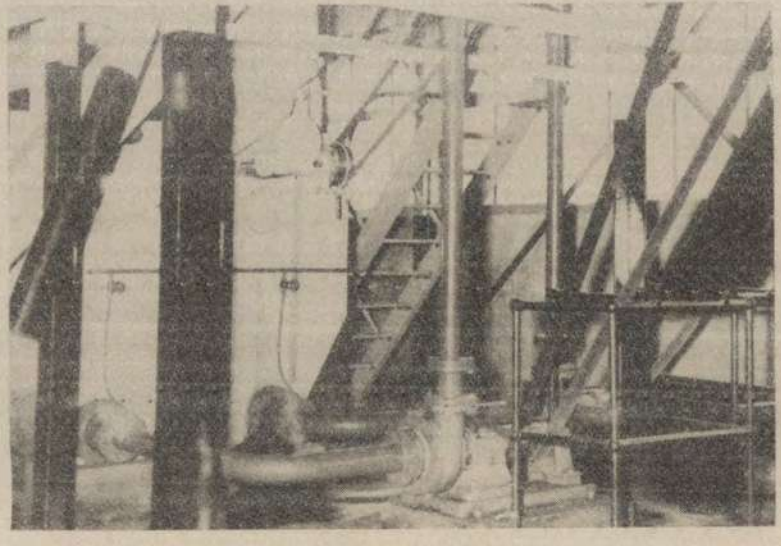

***Plate* XI.—The separator for removal of shells from kernals.**

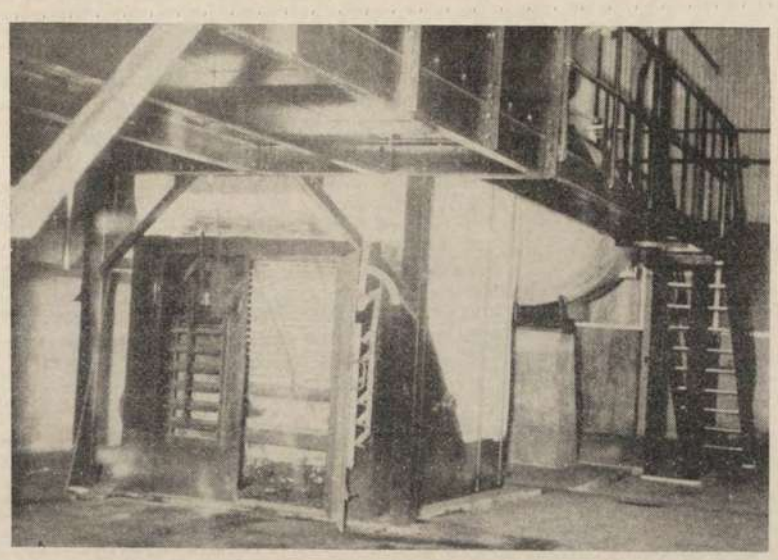

Plate XII.—Boiler units.

which air is dragged into the unit during centrifuging causing a drop in temperature from 70 degrees C. to 35 degrees C. Percentage recovery of oil is poor, the residual material containing 15 per cent. oil on a dry fibre basis compared with a figure of 12 per cent. for a more efficient type of centrifuge.

Clarification.

The process is similar to that used in a "Stork" factory.

Preparation of the Kernels.

Nuts and fibre from the centrifuge are transferred to a "fibre-separator", a rather inefficient machine of poor design based on the principle of a cotton gin. Following separation and drying, cracking takes place, the type of nut cracker used being similar in design to those used in a "Stork" mill. These units consist essentially of a hollow shaft rotating at high speed within a steel cylinder. Nuts, fed into the top of the hollow spinning shaft fall as far as an opening in the lower end of the shaft through which they are ejected at high speed striking the wall of the containing cylinder and breaking. In the "Stork" factory nuts are first graded into two or three sizes and then fed into nut crackers in which the speed of rotation of the shaft is varied according to the size of the nuts with the result that all nuts are broken. In the Pioneer Mill only one nut cracker is used with the result that the larger nuts are not broken as shaft speed is too slow and the smaller nuts are smashed because shaft speed is too fast. A further problem in this process which is common to all factories arises with *tenera* type nuts. These have a coating of fibre on the shell as well as a dense fibre mantle. *Tenera* nuts ejected from the rotating shaft nearly always strike the wall with the fibre mantle foremost and in many cases the shell fails to break. "Palmol" are trying to overcome this problem by doubling the distance between the wall of the cracker and the centre shaft so that the fibre mantle is forced around by air resistance allowing the rounded end of the nut to strike the wall.

One further problem in the Pioneer Mill in connection with nut cracking is to obtain sufficient heat to dry the nuts prior to cracking. Unless nuts are thoroughly dry before cracking the shell and kernel will not separate satisfactorily. In larger factories the problem is easily overcome as there are adequate heating facilities. However, in the Pioneer Mill nuts must be heaped for one or two months and a slight fermentation heat developed before satisfactory processing is obtained. Even so, separation is not good, some kernels adhering to the shell after cracking.

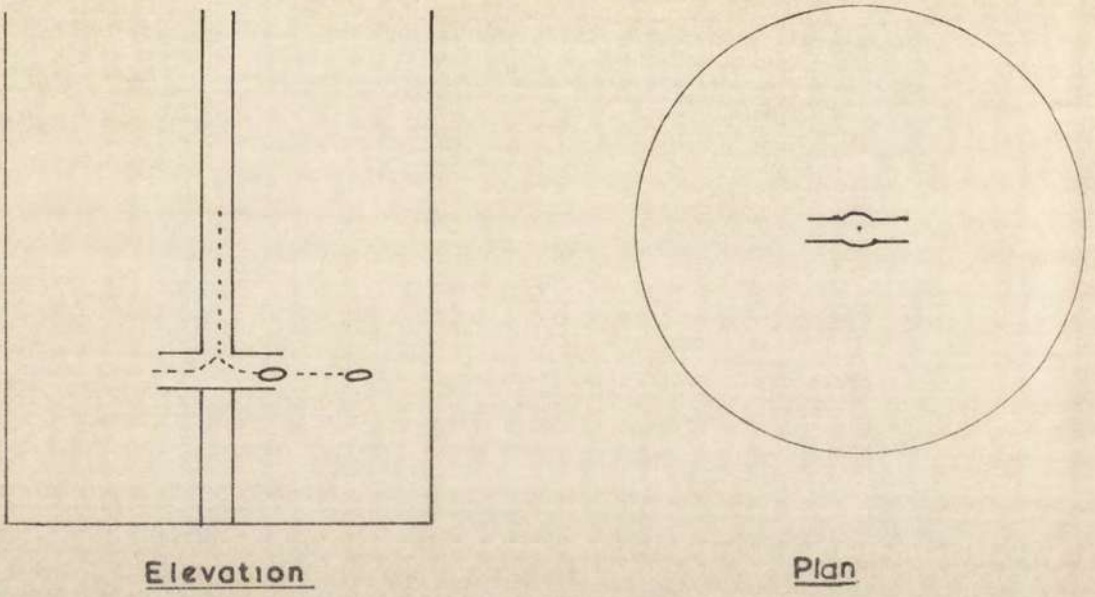

Fig. 5.—Palm kernel nut cracker.

Mud bath separation is used for extraction of kernels in the Pioneer Mill and here again a problem arises with *tenera* nuts which is common to all factories. Because of its fibre mantle, the specific gravity of the *tenera* shell is approximately the same as the specific gravity of the kernel and shell tends to float up with kernels during mud bath separation. "Stork" have tried to overcome this by including a fan on the feed into the mud bath from the cracking units.

Air from the fan catches the fibrous mantle on the *tenera* shells blowing this type of shell out but allowing normal shell and kernel to fall into the mud bath separator.

Further Disadvantages of the Pioneer Mill.

1. The mill design is spread out in a horizontal direction instead of being compressed by vertical expansion into a small area and no use is made of gravity feed from one processing machine to another.
2. A lack of conveying systems results in a high useage of hand labour.
3. Single items of equipment are in some cases quite good but are badly linked together.
4. The sterilizer is too small for the factory.
5. At least one more cracking unit is required.
6. Screen sizes are incorrect for the unit in which separation of dust, kernel plus shell and uncracked nuts is affected between the cracking and separation stages.

Some improvement could be obtained by correcting, where possible, the above faults and by replacing all the processing equipment up to the digester stage with "Stork" units.

Oil Quality.

Factory processed palm oil has a free fatty acid content of two to three per cent. Kernels when fresh have a free fatty content of one to one and one-half per cent. but this may rise on storage or if kernels are broken to eight per cent.

Yields.

Yields of semi-wild palms in West Africa vary enormously, usually within the range of 500 to 5,000 lb. of bunches per acre per annum. Estate yields in Malaya are not less than 11,000 lb. of bunches per acre giving not less than 15 cwt. of oil and three and one-third cwt. of kernels per acre per annum. Many estates average over one ton of palm oil per acre per annum. Some average yield figures are shown in Table II.

Table II.

Oil Palm Yields.

	lb. Bunches per acre.	Per Cent. Oil extraction.		Yield in tons oil per acre.
		Bunch.	Fruit.	
West African Wild Palms—				
Native soft oil extraction	2,000	8-1/3	12½	0.07
Pioneer Mill	2,000	13-1/3	20	0.12
West African Plantation Palms—				
Pioneer Mill	6,000	13-1/3	20	0.35
Malayan Deli Plantations	11,000	15-16	25	0.75

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REFERENCES

ADU, A. V. (1959). Division of Soil and Land-Use Survey, Kwadaso, Ghana. *Personal Communication.* June, 1959.

ALLEN, J. D. (1954). The effect of cultural treatments on losses in the nursery. *J. W. Afr. Inst. Oil Palm Res.* 1 (2) : 42-45.

ANON. (1953*a*). Notes on establishing an oil palm nursery. *J. W. Afr. Inst. Oil Palm Res.* 1 (1) : 88-92.

ANON. (1953*b*). The cost of establishing an oil palm plantation. *J. W. Afr. Inst. Oil Palm Res.* 1 (1) : 92-94.

ANON. (1959). The transplanting of oil palm seedlings. *W. Afr. Inst. Oil Palm Res. Advisory Sheet* 1.

CHAPAS, L. C., TINKER, P. B. H. and ZIBOH, C. O. (1957). The determination of the oil content of oil palm fruit. *J. W. Afr. Inst. Oil Palm Res.* 2 (7) : 230-236.

GAULT, R. (1953). Methods of germinating oil palm seeds. *J. W. Afr. Inst. Oil Palm Res.* 1 (1): 76-87.

GUNN, J. S. (1958*a*). Agronomy Division. *Sixth Annu. Rep. W. Afr. Inst. Oil Palm Res.* pp. 93-94.

GUNN, J. S. (1958*b*). Agronomy Division. *Sixth Annu. Rep. W. Afr. Inst. Oil Palm Res.* pp. 90-92.

GUNN, J. S. (1960). Agronomy Division. *Eighth Annu. Rep. W. Afri. Inst. Oil Palm Res.* pp. 72-74.

JAGOE, R. B. (1952). The "Dumpy" Oil Palm. *Malay agric J.* 35 : 12-21.

MARYNEN, T. and BREDAS, J. (1955). La germination des graines d'Elaeis. *Bull. Inf. I.N.E.A.C.* 4 (3): 156-176.

MARYNEN, T. and GILLOT, J. (1957). L'elimination des vieux palmiers par empoisonnement. *Bul. Inf. I.N.E.A.C.* 6 (3) : 167-174.

POELS, G. (1959). Institute National Pour l'Etude. Agronomique du Congo Belge. Yangambi, Belgian Congo. *Personal communication.* July, 1959.

REES, A. R. (1959*a*). Germination of Oil Palm seed. Large scale germination. *J. W. Afr. Inst. Oil Palm Res.* 3 (9) : 83-95.

REES, A. R. (1959*b*). The germination of oil palm seed: The cooling effect. *J. W. Afr. Inst. Oil Palm Res.* 3 (9) : 77-82.

SPARNAAIJ, L. D. (1955). Seedling selection in oil palm nurseries. *J. W. Afr. Inst. Oil Palm Res.* 1 (3) : 51-63.

SPARNAAIJ, L. D. (1959*a*). West African Institute for Oil Palm Research. Nigeria. *Personal Communication.* July, 1959.

SPARNAAIJ, L. D. (1959*b*). Plant Breeding Division. *W. Afr. Inst. Oil Palm Res. Seventh Annu. Rep.* pp. 70-85.

SPARNAAIJ, L. D. (1960). The analysis of bunch production in the oil palm. Part IV. *J. W. Afr. Inst. Oil Palm Res.* 3 (10) : 138-155.

TOOVEY, F. W. (1953). Field Planting of oil palms. *J. W. Afr. Inst. for Oil Palm Res.* 1 : 68-75.

WEST AFRICAN INSTITUTE FOR OIL PALM RESEARCH (1954). *The West African Institute for Oil Palm Research.* Lagos: Nigerian Information Service. 80 pp.

REPORT ON A VISIT TO COTTON GROWING AREAS OF QUEENSLAND

A. W. CHARLES. *

INTRODUCTION.

COTTON was first grown in Queensland in about 1860 and since 1920 the industry has been assisted by a system of guaranteed prices. In the immediate pre-war decade, relative stability was reached with about 40,000 acres planted each year, producing up to 20,000 bales of seed cotton. The peak area planted was 70,000 acres. The industry was maintained at a fairly high level throughout the war as a matter of national emergency but from 1948-51 planting slipped away to a mere 2,500 acres when competing forms of land use were clearly more profitable than cotton growing. These forms of land use included dairy and beef cattle raising, sheep raising and grain farming, particularly sorghum. Acreages have been low and fluctuating since 1951 but 5,000 acres was planted to cotton in 1958-59, 20,100 acres in 1959-60 and 40,000 acres in 1960-61. On the basis of land preparation for the 1961-62 crop, it is anticipated that 40,000 acres of cotton will be planted this year. The upsurge in interest may be attributed primarily to two factors, namely :—

(*a*) The lesser attraction of the previously mentioned competing forms of land use, particularly grain sorghum growing. The price for coarse grains has fallen considerably in recent years and indications are that it will remain at a low level ; and

(*b*) The wider use of cotton picking machines, the efficiency of which is being constantly improved.

It has always been difficult to find sufficient pickers to cope with cotton crops in years when large acreages have been planted. The mechanical picker eliminates much of the uncertainty of cotton growing and also enables the industry to build up a stable cost structure. Not only does the mechanical picker compete fully with hand picking on a price basis, but it can pick about an acre per hour, replacing anything from 20 to 100 hand pickers, depending on the type of crop. The pickers in operation in Queensland are only single-row pickers and each will do about 1,500 acres in a season but double-row pickers, with a corresponding increase in coverage, are now being operated in the United States. The Board operated 19 pickers in 1960-61.

In spite of the increased interest in cotton growing in Queensland in recent years and the possibility of significant production in other States, especially in the north-west of New South Wales where new irrigation projects will soon be operating, it does not seem likely that home-grown cotton will fill the Australian demand in the near future. In the last quinquennium Australia used about 100,000 bales of cotton per annum, of which 95 per cent. was imported. Cotton fabrics were also imported on a large scale.

Against this background of a market which is not being satisfied by local production, prospects are promising for selling Territory produced cotton in Australia, if in fact there are suitable areas for growing the crop in the Territory and it can be produced economically. It was to investigate cotton growing in Queensland with a view to assessing prospects for the industry in the Territory that the writer visited Queensland.

* Chief, Division of Plant Industry, Department of Agriculture, Stock and Fisheries, Port Moresby.

PRODUCTION.

Varieties.

There are three main varieties being grown in Queensland, namely, "Empire", "New Mexico (or New Mexican) Acala" and "Miller". The varieties "Lankart", "Bobshaw" and "D & PL-15" are also grown as well as a number of others which have persisted in certain areas only. "Miller", which has a short but strong staple and is hardy and adaptable to a range of environments, is the most popular. "Empire" has the longest staple but is weaker than "Miller" and much more sensitive to environmental vagaries. The former is favoured under irrigation and is also grown by dryland farmers with good land preparation aimed at moisture conservation. "New Mexico Acala" is another high quality variety but is also more sensitive than "Miller". As with other crops, certain varieties show particular adaptation to specific areas.

Plate I.—An irrigated crop of the variety "Empire" at Gibbergunyah, Dawson Valley, 10 weeks old and in excellent condition. [Photo I. F. Wood.]

Yields.

Only in occasional very good years does the average State yield reach 500 lb. per acre. However, State-wide yields always include a number of failures and do not necessarily give the whole picture. Under dryland farming conditions yields of at least 600 lb. of seed cotton may be expected in an average season if land preparation and crop maintenance are good. Double this yield may be obtained in very good seasons and irrigated crops should regularly yield upwards of 1,000 lb. per acre. Maximum yields as high as 2,000 lb. have been obtained and an irrigated crop of 108 acres produced 164,000 lb. in 1957-58 at Theodore. Yields in excess of 3,000 lb. of cotton seed per acre have been reached on commercial acreages in the United States. There is little doubt that the availability of moisture is the most important factor limiting yields in Central Queensland.

Climatic Conditions.

Cotton requires a minimum growing season of six months free from frosts, with relatively high day temperatures. In the American cotton belt, the average summer maximum temperature is 77 degrees F. along the northern boundary

Plate II.—An excellent mature crop of the variety "New Mexico Acala" at Thangool, Callide Valley.

(The area on the left has been hand-picked once. The crop yielded 2,000 lb. of seed cotton per acre. It was not irrigated but the season was excellent and the standard of farming very high.)

[Photo I. F. Wood.]

and this is considered to be about the minimum required for growing commercial cotton. The average maximum temperature is as high as 95 degrees F. in the Imperial Valley of California, where excellent cotton is grown.

Average summer temperatures in Central Queensland are not quite as high as this but severe heat waves with temperatures up to 110 degrees F. do occur. These extreme temperatures damage the crop, causing boll shedding and premature opening of nearly mature bolls, giving tight, poor quality locks.

Although cotton is a deep-rooted and fairly drought-hardy plant, it is notable in times of moisture stress that the crop suffers first and the bolls are freely shed before the plants show other signs of distress. The rainfall in the main cotton areas of Queensland is less than 30 inches per annum with under 20 inches falling during the growing period of the crop. In much of the American cotton belt, the annual rainfall is about 40 inches and commonly up to 55 inches or more. Not only is the rainfall relatively low in Queensland, but the distribution is poor and erratic, with a relatively high probability of periods of up to six weeks with little effective rainfall at any time during the growing season. The figures in Table 1 for a good cotton area show that there is a saturation deficit during every month of the growing period in an average season, so that the crop must have conserved moisture or irrigation water to draw on.

Table I.

Precipitation and Evaporation at the Regional Experiment Station, Biloela, during the Cotton Growing Season

	Precipitation (points).	Evaporation (points).
November	289	803
December	355	910
January	409	883
February	493	652
March	280	691
April	106	578
May	157	461
June	167	351

Soils.

Cotton is grown successfully on a wide range of soil types, ranging from sands to fairly heavy clays. It does best on friable loams with a fairly heavy, but not impermeable, clay sub-soil which holds moisture well. The chemical data in Table II are taken from two cotton soils at the Biloela Regional Experiment Station.

Table II.

Chemical Data for Cotton Soils at Biloela.

(1) *Good virgin soils.*—			
pH	6.8	6.3	6.3
Available P_2O_5	400	400	400
Total N per cent	0.12	0.10	0.20
Exchangeable K (m.e. per cent.)	0.93	1.33	3.84 *
Total exchangeable bases (m.e. per cent.)	25.2	29.4	26.6
K per cent. total exchangeable bases	3.69	4.52	14.43 *
SO_4	2	21	12
* Exceptionally high.			
(2) *Rather poor soils.*—			
Avail. P_2O_5	222	284	
Exchangeable K (m.e. per cent.)	1.33	1.29	
Total exchangeable bases (m.e. per cent.)	22.8	23.4	
K per cent. of total exchangeable bases	5.8	5.5	
N per cent.	0.123	0.081	

The main soil types on which cotton is grown in Queensland are :—

(*a*) *Alluvial Soils.*

These are mainly deep soils, varying from dark grey to grey-brown in colour, and are either clay loams or loams. Their basic fertility is high and they prove productive under all crops. The natural cover is usually an open forest, the dominant tree being red gum, sometimes called blue gum (*Eucalyptus tereticornis*).

(*b*) *Sandy Soils.*

There are limited areas of sandy soils, also probably alluvial in origin although quite different from the typical alluvials. They are grey to reddish-grey sands overlying clay and the vegetation is a broad-leaf iron bark association (*E. melanophloia*). Although good crops have been grown on these soils, especially with irrigation, they dry out quickly and are limited both in extent and value for cotton production.

(*c*) *Brigalow and softwood scrub soils.*

This is a large and rather heterogenous group, covering a wide expanse of sediments and basaltic soils, fringing the alluvials. The brigalow soils are typically grey to grey-brown clays to clay loams, with a self-mulching surface horizon, and are fairly well drained. Free lime is usually present at varying depths in the profile and fertility is high. The dominant timber is brigalow (*Acacia harpophylla*). The softwood scrub soils fall into the same land unit as the brigalow soils but occur usually at higher elevations on basalt residuals. They are red to brown and grey-brown clays and clay loams, self-mulching and with good physical structure. The fertility is high but the moisture holding capacity is not usually as good as that of the better class of Brigalow soils. The dominant species on these soils are *Flindersia colliva, Bridelia exalta* (scrub ironbark), *Atalaya hemiglauca* (whitewood) and the distinctive bottle tree (*Brachychiton rupestris*).

(*d*) *Black earths.*

These soils occur on plain country and are self-mulching with high fertility and good physical structure. They are probably derived from basaltic alluvium. The black earths are mainly open grassland with little timber.

All the above soil types are used for cotton, especially the alluvials and brigalow and softwood scrub soils.

Soil Preparation.

Cotton requires good land preparation and for dryland culture in Queensland early ploughing to conserve moisture is essential, especially in virgin country. Only conventional cultivating equipment is required. Over the years the tendency has been to move land preparation further back into the preceding season and the fallow frequently commences about nine months before the crop will be sown in order to conserve the moisture from the summer monsoons. In any case, cultivation must start not later than about June for dryland cotton, although where irrigation is available it can be later, especially

on old land. After the initial ploughing, a second cross-ploughing is usually necessary, preferably followed immediately by one or more workings with a spike-toothed harrow to prepare a fine and even seed bed.

Planting.

A good tilth is necessary in the cotton seed bed. If mechanical harvesting is contemplated, it is also important that it be free of sticks and stones as these can cause serious damage to the fingers of the harvester.

The recommended month for planting in Queensland is October, in time to take full advantage of the summer rains and the warmest part of the growing season. About 15 lb. of seed per acre gives a good even stand. The 4-row planter has now largely superseded the old 1- and 2-row horse-drawn machines, and 40 inches between rows, which suits mechanical pickers, is becoming standard. Row spacing used to be 4 feet or 4 feet 6 inches and the older varieties usually have a more dwarfed habit.

Plate III.—A tractor mounted. 4-row planter.

(The split wheel behind each dropper firms the soil on either side of the seed but leaves it loose directly above, thus creating good conditions for germination.)

[Photo I. F. Wood.]

It is very important that the rows be as straight and the planting as perfect as possible to increase the efficiency of inter-row cultivation. In really well planted cotton, cultivating machinery can get to within about 2 inches of the bases of the plants and weed more efficiently than is possible if the rows are crooked.

Thinning.

Thinning is usually carried out by cross-harrowing the young plants. This must be done early as harrows cease to pull the plants out efficiently when they are about 5 inches high. Light spike-toothed harrows are most satisfactory. For hand picking, the desired final stand is about one plant per foot of row, but for machine picking the density should be twice as great to keep the plants dwarfed, and in America, especially under irrigation, three plants per foot has given extremely high yields. Older style spacings, which may suit the Territory because of the long growing season and the likelihood that hand picking will be used initially, were 4 feet or 4 feet 6 inches between the rows and 1 foot 6 inches between plants. With these spacings, hand hoes were frequently used for thinning, although this practice is rarely used in Queensland today.

Cultivation.

Once the plants are about 6 inches high, cross-harrowing is an effective method of weeding and does little damage, especially on a hot day when the plants are flaccid. Cross-harrowing can be continued until the plants are quite large and it removes many weeds which are missed by inter-row cultivation. However, inter-row cultivation must be resorted to, as required, when the plants develop further. Mid-mounted equipment and good planting lines make for maximum efficiency and minimum damage. Well prepared new land naturally requires less weed control than old land. Rod weeders are being used by some growers and may do a better job than conventional tyned equipment.

Fertilizing.

As moisture is the main limiting factor under dryland farming conditions in Queensland and, furthermore, most cotton is grown on soils which still retain much of their virgin fertility, responses to fertilizers have been rare and insignificant except on irrigated cotton. Irrigated cotton at the Regional Experiment Station, Biloela, has responded fairly consistently to nitrogen, phosphorus and potash. It is important that the mixture contain not too much nitrogen or excessive vegetative growth may reduce the crop and make mechanical harvesting difficult or impossible. As only about 5 per cent. of the cotton crop is at present irrigated in Queensland, there are not many data on the use of fertilizers on the different soil types.

In the United States, where rainfall in the cotton belt is higher and many of the soils have been worked for a long period, cotton is con-

sidered fairly sensitive to mineral deficiencies and regular and heavy fertilizing is common. The mixtures recommended in most areas are higher in phosphorus than nitrogen or potassium. Cotton lint takes practically nothing from the soil, being essentially a carbohydrate, but cotton seed does remove appreciable nutrients.

Pests and Diseases.

Cotton diseases are of minor significance in Queensland, which is entirely free from several major diseases occurring in America and other countries. The only diseases seen at the time of the visit were angular leaf spot and black arm, both of which are caused by the bacterium *Xanthomonas malvacearum*. Neither was causing serious damage but it is understood that in some seasons black arm can be serious. It attacks the laterals which carry the bolls, causing them to die beyond the point of attack.

The pest situation is more complex. There are insects which attack cotton at all stages of growth. Some, such as cutworms, thrips and the cotton tip worm, may injure the seedlings; *Heliothis* larvae destroy squares and bolls; rough and pink boll worms and yellow peach moth larvae attack mainly the older bolls; the harlequin and stainer bugs puncture bolls, allowing entry of moisture and fungi; and loopers, leaf perforators, web spinners, aphids and jassids injure foliage.

Many of the serious insects attacking cotton in overseas countries, particularly the destructive cotton boll weevil, are not found in Australia.

Until fairly recently, efforts were directed at the control of insects at an early stage. However, there is currently a revolution in practice, following experiments carried out by the Queensland Department of Agriculture. These experiments have demonstrated that control of the early insect pests results in holding a larger percentage of the early-formed squares and bolls. Later, however, boll fall from sprayed plants is heavy and sudden, whilst that from unsprayed plants is gradual, so that the number of bolls ultimately matured is rarely significantly increased by early spraying. Spraying has resulted in appreciably increased yields on the first picking but not in greater total crop yields. These findings apply to well-grown crops in average seasons. Poorly developed crops which have insufficient vigour to replace the squares and bolls lost by insect attack, and late-sown crops where the onset of cool conditions prevents replacements, are benefited by early spraying.

D.D.T. gives good control of most pests and Endrin is the insecticide of choice for loopers. The current recommendation of the Queensland Department is to give no spraying at any stage in a good crop unless the infestation of a particular insect becomes unusually heavy. In 1960-61 loopers were severe in many maturing crops and aerial spraying with Endrin was used effectively.

HARVESTING.

Time of Picking.

It is a matter of judgment when picking should commence. The bolls open gradually and the lint loses bloom and quality if exposed to the weather for too long. This loss of quality has to be balanced against the number of bolls open, which determines whether picking will be worthwhile. Ideally, a good crop of cotton should be picked up to five or six times and this may be done on small family holdings where few, if any, outside pickers are employed. However, it is more usual to pick only two or three times.

***Plate* IV.—Bolls ready for picking.**
(The boll on the left would soon begin to lose quality if not harvested.)

Machine picking does not prevent several pickings of one crop, although close-planted cotton, which is most suitable for machines, is usually completely stripped after two pickings.

Damp cotton will not gin satisfactorily and there is also a real danger of heating and even spontaneous combustion if the lint is baled wet

Plate V.—**Children often assist their parents at picking time.**

or too much green leafy material is included. There is no objection to picking while there is still dew on the bolls, provided the cotton is dried in the sun before baling.

Picking Rates.

The award rate for picking in an average crop in Queensland is currently 4d. per lb. of seed cotton but, in fact, few growers are able to obtain pickers below about 6d. per lb. This is too much to pay when the gross value of the crop is only 14d. per lb. and mechanical harvesting is advancing rapidly.

Mechanical pickers.

Two pickers of similar type are being used in Queensland, namely the International Harvester Company model and the John Deere. Both are single row drum types which pick the locks of cotton by means of slowly revolving spindles which move horizontally through the bushes as the machine advances. The loose, fluffed-out locks from mature bolls are wound around the spindles but immature bolls and branches pass between them with little or no damage. An occasional immature boll is broken off but the bushes are hardly damaged by the passage of the machine.

The machine picks 85-95 per cent. of the crop, depending on its condition. It does not operate satisfactorily in weedy and uneven crops. In the past, hand picked cotton has been preferred to machine picked. The machine is naturally less selective and the suction mechanism which carries the locks away from the spindles also carries up a certain amount of leaf trash which is very difficult to remove from the lint. However, recent developments in cleaning machinery in America have removed much of the objection to machine picking. Machine picked cotton has one definite quality advantage ; only mature locks are harvested. The hand picker takes more of the diseased and slightly immature locks as he is paid by weight and they all help to keep up the tally. Thus, machine picked cotton is of more even staple and strength than hand picked.

Machines hired from the Cotton Marketing Board pick for 4d. per lb. of seed cotton. This figure covers transport and other costs around the district as well as actual picking costs. It is estimated that an owner-operated machine on a large enough acreage to keep it occupied can operate at 2d. per lb. In the past, much of Queensland's cotton has been grown in small areas but the current development is towards large individual areas grown by farmers who specialize in cotton as their major cash crop. It is economic for them to purchase their own mechanical pickers.

The pickers are expensive but are so mounted on a light tractor that they may be removed during the off-season and the tractor used for normal farming operations, which helps to make them more economical. The two essentials for their satisfactory use are that the crop must be

Plate VI.—**A cotton picking machine at work.**

clean, i.e., the ground well prepared and free of sticks and stones, which are likely to break the spindles, and the crop reasonably free of weeds, and that the cotton be handled by a modern ginnery with adequate cleaning equipment.

TRANSPORT.

Transport in the Field.

The hand picker puts his cotton in a sack which is carried to the headland. Machine picked cotton goes straight into a large box mounted on top of the machine and is likewise usually dumped at the headland in a large pile on the ground or on a tarpaulin. There it may either be baled or handled in bulk.

Transport from Farm to Ginnery.

The seed cotton is transported by road or rail to the ginnery. The approximate dimensions of an average bale are 5 feet 9 inches x 2 feet 9 inches x 2 feet 9 inches, i.e., nearly 25 cubic feet. The average weight is 450 lbs. Seed cotton cannot be compressed much more than this or some oil will be expressed, staining the lint.

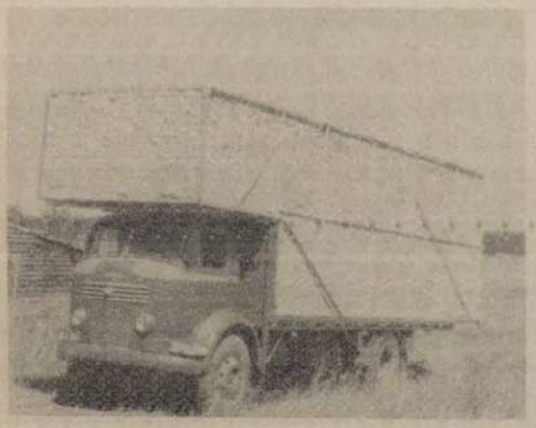

Plate VII.—**A fully loaded truck, of seed cotton.** (The truck carries 10,000 lb. of seed cotton.)

Bulk handling on semi-trailers carrying up to 20,000 lb. of seed coton is increasing. Three methods of loading are employed. The cotton may be tipped direct from the picker into the trailer but this is unsatisfactory, except where a farmer owns his own vehicle, as it may take days to pick sufficient cotton to fill it. Blowers are sometimes used to carry the cotton from the ground to the trailer but the locks are fluffed-out in the process and several men are required to tramp it down again. This makes the process expensive. A blower which is not operated at the right speed may damage the seed and it is hard to clean cotton which has been through a blower. This method is therefore not very efficient. A third method which appears cumbersome at first sight is considered to be the best yet evolved because it keeps the cotton compressed, minimizing labour, and damages neither seed nor lint. In this method the cotton is dragged by a tractor onto the trailer in a mesh net, taking a load of 1,000 lb. at the time.

Processing.

At the official opening of the new ginnery at Glenmore, there was an opportunity to see a fully equipped modern ginnery as up-to-date as any in the world. The old ginnery at Whinstanes was also seen.

At Glenmore, Lummus machinery has been installed throughout. The three principal makers of cotton processing machinery in America are the Murray Company, the Hardwicke-Etter Company and the Lummus Company. Examination of the specifications of the machines produced by each suggested that there was little to choose between them. The Cotton Marketing Board sent their Chairman to America to see the machinery produced by these and other firms and they eventually decided on Lummus machinery, partly because it is now manufactured under licence in Britain and thus available from the sterling area, but, more particularly, because he considered it to have one or two superior features when compared with the machinery produced by competing firms.

All the major manufacturers produce 90-saw gins but the Lummus Company has recently turned out their "Super 88" with a slight modification which doubles the output compared with the old type 90-saw gin. The modification was produced as a result of examining high-speed photographs of the gins in operation. They found that the rapidly turning saws were not operating at the fullest efficiency because the seed cotton tended to collect between the saws. The modification feeds the cotton continuously directly onto the saws.

Plate VIII.—Unloading directly from the harvester to a farm truck.

(The harvester bin holds 700-800 lb. Bales of cotton in right foreground.)

[Photo I. F. Wood.]

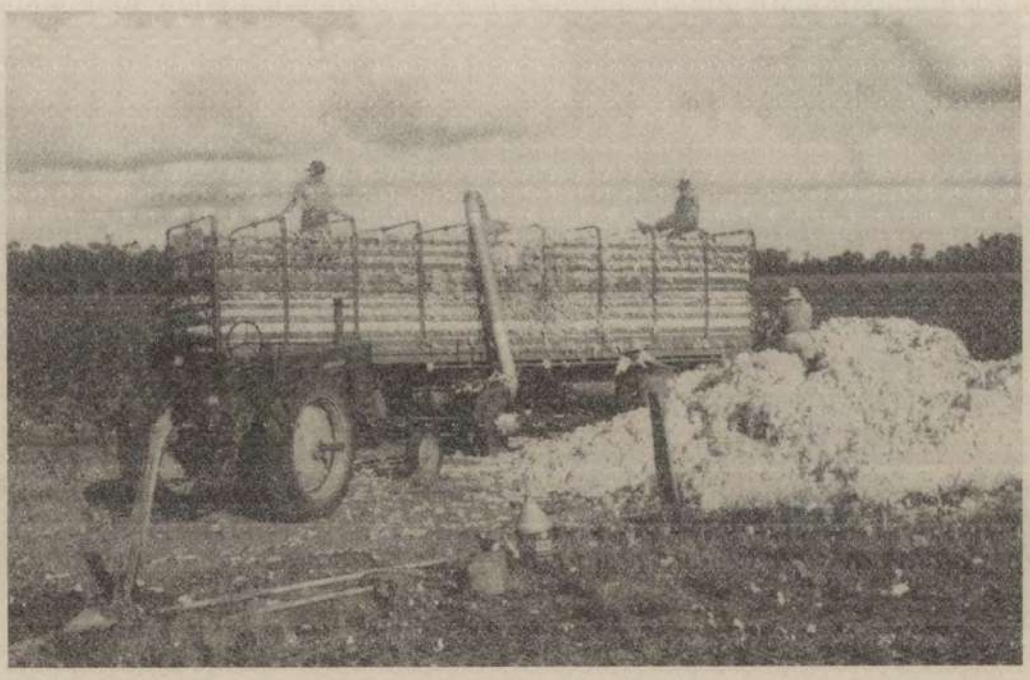

Plate IX.—Cotton being loaded onto a semi-trailer by a portable blower.

[Photo I. F. Wood.]

Plate X.—**Using a net to load a truck.**
(This method of loading with a net is preferred because it does not damage the seed and uses a minimum of labour for trampling.) [Photo I. F. Wood.]

Perhaps the most important variation in the Lummus machinery, however, is the process of cleaning the lint after it is ginned. The competing manufacturers use a mechanical process, whereas Lummus with their "Superjet" cleaning use an air blast. It is claimed that this method of cleaning damages the fibres less than mechanical methods.

The complete new installation at Glenmore cost £90,000. The old machinery was considered to be fit only for scrap after dismantling. The new installation is as modern as anything in the world, with the very best of cleaning equipment. Apart from greater output and efficiency it can clean machine picked cotton to a level at least approaching that of the best hand picked cotton, which was impossible in the old gin, and the new baling press produces denser bales, which minimizes freight. At present the ginnery can handle 32,000 lb. of seed cotton per day and its output can be doubled, if required, with relatively little modification.

The main stages in processing are as follows :—

1. The seed cotton is weighed.
2. It is then carried by conveyor tubes to a hot-air tower dryer, which removes any remaining moisture.

(These are manufactured under licence by Platt and Co. in England and will be converted to "Super-88's" with twice the output.)

Plate XII.—**The automatic hydraulic baling press.**

3. It passes through a series of cleaners which remove the grosser impurities, such as stones, stalks, metal fragments, etc., using mainly gravity and magnets.
4. It is fed to the saw gins, which remove the lint from the seed.
5. The seed falls by gravity onto a belt, whence it is carried to another part of the factory.
6. The fibres, now separated from the seed, are further cleaned by the "Superjet" cleaner.
7. The fibres are combed to put them in line and then delivered to a condenser, where they are made into a loose sheet.
8. The lint thus condensed goes to the press, where it is automatically tamped and compressed to a pre-determined weight. The press compresses to a density of 88 lb. per cubic foot and the size and weight of bales is automatically determined.

MARKETING.

All Australian cotton is sold through the Cotton Marketing Board.

The marketing of Papua and New Guinea cotton was discussed at the Cotton Marketing Board in Brisbane. The Board Chairman was most co-operative and is prepared to arrange the ginning of Territory cotton, if desired, either on an experimental or commercial basis, and is also prepared to handle the marketing of ginned fibre. Arrangements can be made to have Territory seed cotton fumigated and to have the seed processed after ginning to eliminate any danger of introducing pests and diseases to Australia.

POTENTIAL IN PAPUA AND NEW GUINEA.

Both ecological and economic factors have to be considered in assessing the potential of the Territory for cotton production. Most of the Territory is too wet for commercial cotton production. However, the Papuan dry belt and the central Markham Valley may have suitable annual rainfall with satisfactory distribution. The alluvial soils of Papua, particularly at the Kemp Welch River, the Brown River and the Mekeo region, would appear to be suitable for cotton production. Of these three areas, the Brown River is the least fertile but, because of its ready accessibility, fertilizer could probably be used economically there. The better alluvial soils of the Markham Valley should also be suitable for cotton. The soils in none of the areas mentioned have much in common with typical cotton growing soils in Queensland from the viewpoint of derivation or physical characteristics. However, the analysis of the better Markham soils is not unlike that of the good cotton soil at Biloela, given earlier in this report. Perhaps the most important point with regard to the Markham Valley is the ability of cotton to tolerate rather high alkalinity, even to the extent of tolerating free lime at relatively shallow depth. Lime is often found at a depth of no more than 2 feet on brigalow soils which grow good cotton. Cotton is not, however, restricted to such soils and should do well on the less alkaline alluvials of such areas as the Mekeo.

Agricultural Problems.

Before commercial cotton growing is likely to be agronomically successful in Papua and New Guinea, certain investigations are necessary. There are data going back forty years or more from small trials and the results have been promising but further trials are necessary if a major industry is contemplated. The main trials which need to be carried out are as follows :—

(*a*) *Variety Trials.*

There is no information available on the relative adaptation of modern cotton varieties to the environments of the Territory. It is important in this regard that quality tests be associated with variety trials. Environment can affect the length of the staple and, even more markedly, the strength of the fibre. Staple length can be estimated adequately in the Territory but test lots would have to be sent to Australia for ginning to fully assess quality. The Territory environments have sufficient in common with those parts of Queensland and the United States to suggest that adapted varieties could be found.

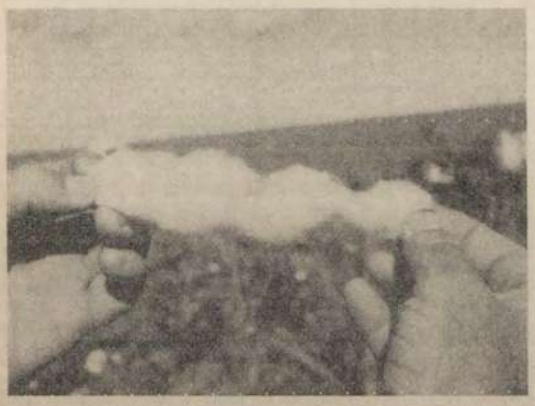

Plate XIII.—A lock pulled out to show the staple length.

(*b*) *Spacing Trials.*

It is not unlikely that, for cotton to be hand picked, fairly wide spacings would be desirable in the Territory with the constant high temperatures and adequate rainfall during the growing season, although closer spacings would be necessary as the industry developed and machine picking was introduced.

(*c*) *Time of Sowing Trials.*

Trials are under way in the Markham Valley with duplicate sowings in the Mekeo, covering the leading Australian varieties planted at different times and with different spacings.

(*d*) *Disease and Pest Control Trials.*

In the initial trials in the Territory, full insecticide coverage is being given to prevent pest damage obscuring the results. However, later experiments to determine what is the minimum necessary control in commercial crops will be essential.

It is not envisaged that insuperable agronomic difficulties will be encountered. Some variations from Australian practice are likely. The rainfall in potential cotton growing areas of the Territory is higher than in Queensland so that less effort need be made to conserve moisture. As it is also recognized here as an undesirable practice to leave the soil bare for a prolonged period, cultivation operations, although basically similar, would be compressed in time. One or two dry season ploughings would destroy weeds and grasses and this would be followed by fine working with harrows or a similar implement to prepare the seed bed.

As has already been mentioned, it is unlikely that the small amount of pest control practised in Queensland would be sufficient in the Territory where no marked cool season is experienced to reduce insect populations drastically. As cotton plants could become perennial in the Territory and could, under irrigation, be grown at any time of the year, it might be necessary to have a period of the year when all cotton had to be destroyed to minimize the build-up of pests. Unfortunately, there are alternative hosts for the majority of them. After harvesting, bushes may be cut and burned or destroyed in various ways. Plate XIV demonstrates the use of a forage harvester for bush disposal. Slashers have also been used with variable success.

The Territory planter would have a definite advantage in picking as native labour should be able to pick for not more than 2d. per lb. Mechanization would probably become necessary if the industry developed rapidly.

In Queensland it has not been found necessary to defoliate cotton crops for mechanical harvesting. However, defoliation by means of chemicals is often necessary in America and it is likely that it would be necessary here where there is no oncoming winter to check vegetative growth. Chemicals are now available which are said to defoliate quickly, thoroughly and cheaply.

Plate XIV.—**A forage harvester used for bush disposal in a well-grown crop.**
(The strip just in front of the tractor had already been treated with a chain slasher, which was less satisfactory.) [Photo I. F. Wood.]

Economic Problems.

The economics of cotton growing in the Territory are obscure and difficult to predict without basic information on yields and costs of pest control. One of the major problems to be faced would be that of freight, both by land to seaport and then by sea to Australia.

As already stated, a bale of seed cotton has a volume of nearly 25 cubic feet or more than half a shipping ton. At 14d. per lb., cotton is worth only around £25 a bale so that shipping freight on Territory seed cotton would be economically crippling. Seed cotton cannot be compressed appreciably more than it is in a wool bale. It would thus seem impossible for Territory-grown seed cotton to be transported to Australia for ginning unless special freight assistance were forthcoming. It is understood that cotton growers in States other than Queensland do receive Commonwealth assistance in freighting their seed cotton to Queensland ginneries.

The other problem in sea transport of seed cotton is that it can be hazardous to handle with the possibility of heating and even spontaneous combustion if it is not thoroughly dried or if much green leaf is included.

It seems clear that a local ginnery would have to be established to minimize shipping freights. The capitalization for this ginnery is a problem. There would be very little to commend the establishment of anything other than a modern ginnery capable of turning out the best quality cotton. Even if this installation were made in stages i.e., only the minimum cleaning equipment were installed initially on the basis that all cotton would be hand picked in the early stages, capitalization would be at least £20,000 to £25,000. An adequate baling press alone costs nearly £10,000. When the factory was expanded to cope fully with machine picked cotton, the smallest practical installation would cost at least £40,000 to £50,000.

Given a central ginnery, however, there is no reason why individuals should not grow small areas of cotton for processing at the

ginnery and it could have a future as a native crop provided the pest control problems are not too great. Cotton would not be a crop only for the large-scale specialist. Production from small properties would no doubt be baled for transport to the central ginnery while bulk handling could be looked for on the larger properties if the industry developed. A point in favour of cotton growing, even on the small scale, is the fact that no specialized equipment is required by the individual farmer. Conventional land preparation and conventional row crop maintenance only are required.

ACKNOWLEDGEMENTS.

I wish to acknowledge with thanks the help so readily given by officers of the Queensland Department of Agriculture who arranged the tour of the cotton growing areas, especially Messrs. K. Henderson, W. Steel, I. Wood and I. Swann. These officers, particularly Mr. Wood, gave their time freely to conduct Mr. J. O. Smith of the Department of Territories, and myself over cotton growing properties and contributed much from their wide fund of knowledge of the industry. Mr. Johnson of the Cotton Marketing Board and officers at the Glenmore ginnery also did everything in their power to make the visit pleasant and informative. My thanks are also due to Mr. J. Stevens, Manager of the Regional Experiment Station at Biloela, and to his staff, for an instructive day at the Station.

RURAL EXTENSION IN EASTERN PAPUA*

By W. Cottrell-Dormer †

SUMMARY.

An account is given of the development of a Village Committee Organization, for the purposes of Agricultural Extension in the first instance, and of how the extension programme inevitably becomes broadened into what might more aptly be termed "Rural Extension" (Penders 1956); of how the programme is at first channelled through the men but how inevitably it spreads to the women too. The organization gradually develops through the village level to the area level and finally to the Administrative District level. Meanwhile the Native Local Government Council movement is also progressing and the paper discusses how the non-statutory Committee organization becomes linked with the statutory Council organization and how its activities become co-ordinated and to some extent integrated with those of the Councils. Finally the writer concludes that urgent needs in extension activities of all kinds in the Territory are: The greater and greater emphasis on participation by the village people in the planning and execution of programmes; the stepping up of opportunities for the emergence and training of native leaders, both men and women, at all levels and for their acceptance of real responsibility; and the greater insistance on the fostering of the team spirit between Departments at the District and Subdistrict levels. To assist the reader to visualize the environment in which the work discussed is being done he is taken, during the first half of the paper, on a reconnaissance patrol with the Agricultural Officer.

Introduction.

"To organize the villages for a happier, fuller and more prosperous life in which the villager will have an opportunity to develop both as an individual and as a member of a well integrated society"..... "by using local initiative and local resources to the utmost extent possible in the economic, political and social fields of reconstruction on cooperative lines"..... "to produce a self-reliant, self-dependent and properly organized life." (Dube 1959.) These were the objectives laid down by the Madras Government for its Rural Welfare Scheme, inspired by Ghandi and later adopted with outstanding results for the whole of India. The Scheme is referred to here because it is based on sound extension philosophy and could well form the model for much of the work which requires to be done in this Territory. It emphasizes self-help, the use of local resources of all kinds, the co-ordination of endeavour in the economic, political and social fields, and the participation of the people in programme planning and implementation. These have been the principles followed in the work here described and discussed.

Reconnaissance.

The writer was posted to the enchanting little island of Samarai on the China Straits in August, 1953. Samarai, on its crowded 57 acres, is the administrative and commercial centre of the region in which the work described is being pursued. As soon as practicable he proceeded to carry out reconnaissance patrols to find out about the people and their resources. This early work was very necessary as no previous Agricultural Officer had worked in the region, which extends from Cloudy Bay and Collingwood Bay to Rossel Island. Now there are seven of us.

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* This paper was read at the Brisbane, Queensland, meeting of the Australian and New Zealand Association for the Advancement of Science, May, 1961.

† Formerly Principal Agricultural Officer, Samarai, Papua.

District administration

To put the reader more in the picture he is invited to join the writer in portion of one of these early patrols. We first call on the District Commissioner and the District Officer to discuss our plans and receive many useful suggestions. We also send a telegram to the Assistant District Officer of the Subdistrict which we are to visit so that he will know we are working in the area. We take this action in the interest of co-ordinating inter-Departmental activities because "the Head of the Administration in the widest sense in each District is the District Commissioner. He is the representative of the Administrator in his District . . . . Departmental Officers must realize that upon the District Commissioner rests the responsibility for the progress and welfare of the peoples in his District, for the maintenance of law and order and for the general working of the machinery of the Administration in conformity with the policy laid down by the Commonwealth Government." (Cleland 1957 *a.*) and "Because of the need to facilitate Administration by the establishment of Subdistricts, it is also desirable that there should be the closest possible co-ordination and co-operation within Subdistricts. As the District Commissioner is not in a position personally to achieve detailed co-ordination and co-operation at Subdistrict level, the Assistant District Officer in charge of the Subdistrict is to be regarded for that purpose as the agent of and responsible to the District Commissioner.". (Cleland 1957*b*.) The District Officer is the senior officer of the Department of Native Affairs within the District. The Assistant District Officer with the help of his Patrol Officers is responsible to him in matters relating to that Department which, as its name implies, is largely responsible for the maintenance of law and order and for the general welfare of the native people.

Departure on reconnaissance patrol.

Having received the official blessings we pack our camping gear and provisions into patrol boxes and together with a little band of youthful trainees we board the small ship which will take us from Samarai to a suitable landing place for our patrol—we must not miss this boat because if we do we might be waiting a long time for another opportunity, and we can go nowhere from Samarai without water transport. We travel first to East Cape where we spend the night on the ship at anchor and also go ashore and call on Reverend R. and Mrs. Grant the Methodist Missionaries there. We will be going into what is largely a Methodist area and they are most helpful in telling us about various customs of that area and giving us the names of some prominent people there.

General observations on terrain.

Early next morning our native skipper rings the engines to start and we leave our sheltered anchorage to thread our way through the brightly coloured coral reefs into open waters. Already one or two canoes are out fishing just inside the reef. It is fairly rough outside as there is a freshening south-west wind but not so bad that we cannot read or look about. We set our course eastward for Normanby Island and after approaching it we skirt the south coast and travel some little distance north up the east coast. As we are only a mile or so out we have a good opportunity of observing the area we are about to visit. The island is a large one—it runs mainly north-west to south-east and is about forty miles in length and about twenty-six at its greatest width, and has a central range of mountains rising from some 3,000 to nearly 4,000 feet. It has a native population of about 8,000 and European of about 30. Along much of the coastline the mountains or their foothills "sweep down to the sea" and there is only a vestige of a coastal plain at most points. In many places we see pale limestone outcrops 100 or 200 feet above sea level; as the limestone is derived from geologically recent coral formations these are indications that severe earth movements must have taken place at some time in the not so distant past. The coast is mostly fringed by coral reef with pretty little golden beaches here and there which are not infrequently backed by hamlets or villages of small lightly built thatched dwellings. The hillsides are mostly covered in rain forest, with here and there a patch of *Imperata* or other grass where maybe the soil is highly laterised. *Imperata*, or "bladey grass" or "lalang" as it is variously known can be used for the manufacture of high class paper pulp and is also very good for roof thatching if available in quantity. However it is generally looked upon by tropical agriculturists as an insidious curse which can gradually take over land which is not properly

managed and render it subject to fires and erosion. Much of the local rain forest is secondary to an elevation of about 1,000 feet as can clearly be seen by its paler colour. The upper edge of this old garden pattern is rather like that of an old lace-work table cover with its many projections into darker primary forest. As it is the month of November the gardening season is at its peak and many newly cleared gardens are to be seen ; perhaps as much as five per cent. of the secondary forest has been cleared in these patches in some areas. The people over the centuries have worked out a system of shifting cultivation on these steep slopes which has enabled them to maintain themselves under conditions which would be extremely difficult for anyone not brought up to the system. We are careful not to interfere with the system as we have nothing better within existing resources to replace it ; likewise the people themselves will not readily depart from it since they have learnt to rely upon it as it stands for their very existence. Each year in these parts they work something of the order of 0.25 acre per person.

Now we are approaching our immediate destination and the skipper takes the ship close inshore to Kasiguleu village where we drop anchor. We remove our gear from the hold and proceed to take it ashore in the dinghy. From the beach we carry it into the "rest house", which is maintained by the people principally for the use of Government patrols such as ours, at the same time frightening away half a dozen nondescript village pigs which are resting below it. Meanwhile the skipper ups anchor and with a cheerful wave of the hand goes on his way while we set up camp. During the next three or four weeks we will slowly work our way to the Subdistrict Headquarters at Esa'ala some fifty miles away where we will discuss our findings with the Assistant District Officer prior to deciding on a definite working plan for the area.

A typical Papuan village.

Kasiguleu is a typical village in this part of the region. About twenty huts or dwellings huddled amongst tall swaying coconut palms and *Casuarinas* and great *Calophyllum* and *Barringtonia* trees with their promise of dark cooling shade and one or two *Terminalia* nut trees ; sleepily they watch the days go by on the coral shore of a small protected bay where is found some respite from the roaring south-east winds during the "winter" months. The dwellings are small—mostly of one room measuring perhaps ten by fifteen feet—because the sago thatch which is used for roofing is difficult to find in this particular area and is mostly imported from a long distance. Most of the dwellings are made entirely of bush materials without nails and without windows or chimneys and with one door only. One or two of these are open and inside we can see the central hearth for a cooking fire. This serves not only for cooking (actually much of the cooking is done outside) but also provides warmth when the cold night air comes down the mountainside ; occasionally a child will be known to roll into the fire while asleep and will carry scars for the rest of its life. The smoke from the fire also has its use in keeping away mosquitoes and, so it is said, in helping to preserve the valuable thatch roof.

As weather and shipping movements are rather unpredictable we had not notified the village that we were coming and there is hardly anyone about. There are three old women in their old grass skirts and one old man dressed in a somewhat inadequate strip of green leaf ; a younger woman sits peeling some sweet potatoes while her baby hangs sleeping under her house in a string bag made of local fibre. Inside one house we see wrapped in a rather thin and dirty "trade" blanket a young man who asks for quinine, which we give him later. There are some naked carefree children laughing and playing by the beach, their wet brown bodies glistening in the sun ; they have cleverly contrived miniature toy boats from sticks and coconut midribs each with a leaf for a sail and are having most lively fun. In the deep shade of an over-hanging Kokoila tree (*Calophyllum inophyllum*) are three young men wearing brightly coloured new calicos, sitting chatting and chewing betel nut on the sand ; they have recently returned from working in the "Gulf" country with the Australasian Petroleum Company and are obviously curious about us. Everyone else is out in the food gardens or fishing as it is such a fine day. We will have to wait until dusk to meet most of them.

The beach strand.

Immediately behind the village, which is built on the raised part of the beach strand, is a slight depression which is wet in rainy weather and

on which is growing a fascinating plant association. There we find the yellow flowered rosewood tree (*Pterocarpus indica*) whose valuable timber can be used for making pestles and mortars for hulling rice paddy and for building and other purposes; there are great broad leaved and white flowered *Crinum asiaticum* lillies whose pseudostems provide the native's favourite fish-trolling lure; there are giant eerie-looking *Pandanus* palms with their extraordinary root systems which provide a vascular fibre of great strength and utility, and the Hibiscus tree (*H. tiliaceus*) which provides an equally valuable bast fibre; there are long *Flagellaria* canes which are extensively used in house-building for lashing timbers together and in fencing, and a climbing fern which can be used for binding outriggers on to canoes; there also we find the *Derris* vine, whose crushed roots will stupefy fish in quiet waters, climbing over a monstrous and useless strangling fig (*Ficus sp.*) whose intricate and spooky root crannies must surely house the local gremlins!

The village coconut grove.

Behind this belt is a small gently up-sloping area of a few acres carrying coconut trees. Their bearing is poor because of the presence of the Nutfall Bug, *Amblypelta lutescens papuensis*, whose very close relative sometimes makes big trouble for the coastal papaw-growers of Central Queensland. These coconuts were planted some thirty or forty years ago under the direct supervision of the local Patrol Officer of the day and the copra produced from them now makes a welcome contribution to the village income. It seems to have been quite some time since the grove was cleaned and the undergrowth brought under control. As the grove belongs to everybody, it evidently belongs to nobody—and so it is nobody's business to look after it. Maybe this is not such a bad thing anyway because undergrowth encourages the predatory red tree ant (*Oecophylla*) to establish itself in the area and to build its paper-like tissue nests in the palm tops where it farms relatively harmless scale insects: no Nutfall Bug will dare to linger on an *Oecophylla*-infested palm and that palm will bear well, other conditions being satisfactory. There is also, amongst some of the people, a subconscious suspicion that as the area was planted under Government supervision, maybe it really belongs to the Government! A similar situation arose many years ago when the Government first tried to get the people to plant rice. It distributed seed in many places and encouraged communities to plant it. But when harvesting time came—if there was any paddy to harvest—no one knew what to do with it or to whom it belonged. The Government Officer of the area soon found great heaps of paddy deposited at his office door because the people figured that it must belong to the Government. Even to this day there persists in some areas the idea that rice is a Government crop!

A family food garden.

Immediately behind the coconut grove are the timbered and stony foothills which lead to the main ranges of the area. As we follow the rough path bordered here and there by bright *Hibiscus* or *Croton* and an occasional breadfruit or *Citrus* tree we notice at first some limestone outcrops and then a prevalence of flat slabs of schistose rock followed by basaltic boulders in a ravine; these augur well for soil fertility. The secondary growth is vigorous and the plant population is very mixed—both conditions being indicative of fertile soils. We continue up the path through dense secondary rain forest and come to the first food garden. These are nearly always some distance away partly because of the bush rotation which is going on; partly also to keep them away from the destructive village pigs, the control of which appears to be an insoluble problem in many communities because of their great prestige value—and this Territory is by no means alone in this respect. This garden which belongs to an "extended family" has an area of about two acres. It has been carved from the jungle and a start has been made in building a rough but solid bush pig fence around it. Some men are working on the fence, others are sitting in a shady spot chatting and chewing betel nut in what seems to be a blissful state of underemployment. The several women are all busy weeding while some children walk about chewing pieces of sugar cane. The native's fondness for his children is proverbial and they generally have a very easy time. A baby hangs in its string bag inside a rough shelter which has been built in the middle of the garden under a shady tree. Half a dozen or so underfed and rather mangy dogs bark piercingly at us. Everyone stops in his tracks and looks at us. Someone calls out "Kagutoki" (a greeting) and a young man dressed in an old pair of khaki shorts

comes across to us from the working group. His name is Lenadi. He can speak a few words of English and knows Police Motu which he learned while away working on plantations. He also speaks fluently in Dobu, the local lingua franca used by the Missions, and, of course his own dialect. He also knows the Tavara language of East Cape where his people engage in barter trade from time to time. He makes himself known and seems pleased to meet us. He has never before met an Agricultural Officer and is interested in what he can understand of our talk. He is bright and intelligent and takes us around the garden explaining as well as the language difficulty will allow, what is going on. In the garden is a mixed culture of taros (*Colocasia,*) yams (*Dioscorea*), sweet potatoes, pumpkins, native greens (*Abelmoschus*), a few long beans and tomatoes, papaws and pine-apples. The garden is coming on very nicely and already other perennials—sugar cane, bananas and tapioca (*Manihot*) are being planted in preparation for the second year of the cycle at the conclusion of which the garden will be allowed to revert to forest. The women are weeding and tilling with sharpened and fire-hardened sticks in such a way as to keep each plant on a miniature terrace or depression in the interests of soil conservation. The garden is subdivided into small sections by poles and logs laid on the ground, each section being someone's weeding task. The bigger timbers are placed along the contours as a further measure against soil erosion—but this new bush ground is so rich in humus that rain penetrates immediately and there is little run-off other than during exceptionally heavy rainfall. The only steel tools we have seen so far have been machetes and light axes.

We then meet the whole "extended family" group including Lenadi's wife, a neat young woman looking very attractive and dignified in her grass skirt. As we get to know them we are increasingly impressed with Lenadi and his wife. Later we will be training them and they will become Leaders of their Village Committees and again later they will become Chairman and Women's Leader of their Local Agricultural Association; but we are anticipating as all this will not be for some time to come. As the afternoon is drawing on Lenadi decides to call it a day and we all return along another track which goes past a clear running stream. We sit on the banks and talk of what we have seen while the group divides into men who go down stream a little way and women and children who go up stream. Each has a secluded spot where we hear them noisily and merrily bathing for a few minutes after which we re-assemble and continue back to the village. The women settle down to preparing the evening meal while the men walk around the village with us.

More observations within the village.

Most of the dwellings are on stumps a few feet off the ground; there are also one or two which are built right on to the ground which, Lenadi explains, are temporary while the owner or the newly wed couple are building a good new one. He takes us inside some of the dwellings. The floors of those on stumps are of split palm lashed to bearers with split *Flagellaria* canes. To prevent the wind blowing up through the floor there are laid mats made of *Pandanus* leaves which have been dried and ribboned and woven the way Tongan and Samoan missionaries have taught the people, or simply sewn whole one to the other with fibre and a needle made from the wing bone of a flying-fox, in accordance with local custom. Some of the dwellings have shelves made of neatly lashed sticks hanging from the mangrove pole rafters for storing various possessions. Some also have a shelf outside and near the door for the accessible storage of ready cut fire-wood. There also is storage above the rafters under the roof. There, when our eyes have become accustomed to the dim light, we will find many curious things of which a few examples can be given:—A souvenir collection of the jawbones of pigs which have prominently figured in past feasts given by the owner to mark various occasions; a beautifully carved but wicked-looking ebony fighting stick which used to belong to the owner's great-great-grandfther; some large gourds with twisted leaf plugs for carrying drinking and cooking water—there are no tanks or catchment areas in the village; small delicately ornamented gourds for storing the shell lime burnt by the women for use with betel nut; one or two intricately carved lime spatulas used for transferring a little of the lime from the lime pot to the mouth; a couple of bamboo or palm-wood combs whose long prongs, firmly held together at their base to a handle by plaited

Pandanus root fibre, are necessary to penetrate the owner's abundant fuzzy hair ; some fish traps made from the mid ribs of coconut leaflets ; a pig-hunting net made from the strong wild *Hibiscus* fibre ; also, maybe, a very good fishing net made from cord teased out from old motor truck tyres obtained from some distant war-time army dump—for weights the shells of a local bivalve mollusc with holes neatly drilled by means of a home-made Archimedian drill serve admirably, and for floats smoothly cut lozenge-shaped pieces of dry *Hibiscus tiliaceus* wood cost nothing and are long-lasting ; a couple of gracefully shaped canoe paddles and a digging stick might complete the collection.

Hanging to the smoke-grimed walls are some workaday grass skirts made from finely split coconut leaves, and one or two pieces of bright calico. If the home belongs to a person of consequence there will almost certainly also be a simple frock hanging amongst other brightly-coloured grass skirts set aside for use on Sundays and on special occasions. Sometimes we see an old green mosquito net hanging dispiritedly from the base of the wall where it was used last night, or bundled in a corner or folded neatly away—depending maybe on whether the wife has had any domestic training from the Mission. Some dwellings have a hurricane lamp and one even has a pressure lamp. There are half a dozen or so clay cooking pots, bought probably by barter or food, from Ware Island or from East Cape where the potter's clay is excellent and the women have great skill in the age-old craft. In one or two dwellings we also see a big aluminium or iron boiler and all have one or two enamel basins and some mugs and plates and knives and spoons and maybe one or two saucepans. Bush knives, or machetes, appear to be standard equipment, also one or two spears for fish or for bush pigs ; maybe sometimes also a hammer and a saw.

Apart from an occasional metal folding chair obtained at the end of the war from the army or from the Coastwatchers, or one or two home-made from rattan (*Calamus*), the dwellings are singularly lacking in furniture of any kind, even in cupboards and tables which seem so essential to us. One or two might boast of a home-made bed with woven rattan cane top, but mostly the bed consists of a mat on the floor. In a corner will most likely be found a "trade box" or a suitcase in which special treasures are kept away from vermin and moisture—treasures such as the beautiful Bird of Paradise head-dress carefully wrapped in special leaves which has been handed down from father to son for use at special dances ; but the Mission is apt to frown on this old traditional entertainment and the head-dress now, alas, is seldom worn. In most dwellings there is suspended from the rafters above the central hearth a platform of tightly lashed sticks on which to dry and smoke fish and other foods, or even to make a shilling or two worth of copra. Hanging to the rafters also above the fire are usually a few corn cobs being preserved for seed or to be eaten some day. They will become weevil infested if stored in a container ; they will be eaten by the owner's gaily coloured rooster if stored too low. If any rats succeed in dodging the guard of hungry dogs they will find it extremely awkward to eat those cobs the way they are hung.

In front of one dwelling, slung on a tree is a long cage made of lashed sticks in which is kept a very beautiful ginger-coloured opposum ; a valued pet which could maybe provide a meal at a pinch ! Running up from the ground into a hole in the wall of some dwellings is a light log with steps notched into the upper side for the owner's dogs to run in and out at will without having to negotiate the more difficult ladder arrangement which constitutes the front entrance. We ask Lenadi why do they not have more windows and back doors and he replies that they cannot afford blankets to keep themselves warm at night. Then why not try to make more copra ?—because the trader is not paying what they think is a fair price, or because they do not have adequate means of transporting the copra safely to Samarai where it could be sold for a better price to the Copra Marketing Board, or because the individual only has rights to a few trees and has not yet felt the urge to plant more or does not have suitable land for the purpose, or because the Old Man says "we have been getting along very well as we are so why get involved in these new-fangled notions", or because someone might work sorcery on one if one seems to be progressing beyond the common level, or we suspect, simply because it will require sustained effort on anyone's part to get out of the normal village rut. At the same time it is perhaps as well to remember that the division of labour does not

go far in the village—a man and his family are practically entirely self-sufficient ; the husband is his own farmer, carpenter, canoe builder, transport agent, fish supplier, etc. while his wife is her own dress-maker, cook, gardener, carrier, baby-sitter, kindergarten teacher, carpet maker, etc., etc. The people, and more especially the clans, team together for many jobs—but each member, or at least each family unit, still has to be proficient in all of the skills needed for survival at the village level—and these do not yet include the need to be also an expert cash cropper. Also do not let us forget that a large proportion of these people have suffered sporadically from malaria, and often also from unbalanced nutrition, since babyhood.

The Rest House is built according to a recognized plan which has been in use for a long time ; it is to be found on a back page of the Village Book given to the Village Constable by the Department of Native Affairs for the recording of instructions and observations by visiting officers. It is partitioned into rooms and has plenty of windows and a roomy verandah and a separate kitchen. We ask Lenadi why other houses in the village have not been built like it. Lenadi says that Papuans are not so tall as Europeans and so do not require so much room ; and in any case they cannot afford all that goes with such a big house ; and just think of the difficulty of maintaining it, and who is going to obtain or pay for the sago leaf for such a big roof ? And all those doors and windows will not only let in cold air but goodness knows what thieves and evil spirits as well !

Now we see the main body of the people coming back in small groups to the village. The women are mostly walking in front and the men in the rear. The women are carrying great string bags, full of foodstuffs from the gardens, slung across their foreheads. They take great pride in being able to carry what seem to us in some cases to be incredible loads. Many of the well laden bags also have on top one or two bundles of the leaves of the " New Guinea Cabbage " (*Gnetum* sp.) picked from trees growing in the older secondary forest. Some of the children also have bundles of *Canarium* nuts wrapped in bush *Caladium* leaves. The people have quite a number of forest sources of additional accessory foods to build up the vitamin and protein content of their diet, though it is often a time-consuming business to harvest them and sometimes also to prepare them for eating. We may think that this is a matter of inefficiency and that the same food values could be obtained with less effort in other ways. (Gourou 1959.) But we have not yet taught them any such ways, and in any case it is very good fun for a party to go into the bush and pick fruit or leaves from those trees which yielded so well last year ! The men are carrying pieces of timber for house repairs or other purposes, or maybe a bunch of bananas slung from a stick, or a couple of spears or an axe, or maybe a small child sits on one shoulder clinging to father's crinkly hair. The small babies are carried by the women in string bags above the vegetables. They all go to their dwellings and put down their loads and chat and call out to each other and sort things out prior to settling down to cooking the evening meal. Some put a proportion of their tubers in neat little yam-storage houses behind the village. Later we will see cooking pots each held up by three stones anchored in the ground and each filled with root vegetables and with greens and coconut cream and covered over with banana leaves boiling merrily. The women make a pretty picture as they sit in their grass skirts on the sand chatting and tending their cooking fires. Now some small out-rigger canoes are returning from the day's fishing and there is great excitement as everybody calls out inquiries about the fishermen's luck. Soon we will see an example of native ingenuity when one or two women stand really big fish on their snouts, in the cooking pots, amongst the vegetables and wrap them with big leaves in such a way that the steam from the cooking vegetables will pass up through the leaves and steam the fish ! This also yields a *Bouillabaisse Kasiguleu* of incomparable flavour !

Constituted authority at the village level.

Presently an individual comes forward dressed in a dark navy-blue " rami " and shirt with red trim and wearing a leather belt and carrying his village book in a waterproof jacket and also wearing a big brass medallion inscribed " V.C. ". He is Nidoi, the newly-appointed Village Constable, who is responsible to the Assistant District Officer for the maintenance of law and order in his community and for seeing that Government orders as written in the book by Patrol Officers, Medical Officers, etc., are carried out. Now three other older and rather more

primitive looking individuals join Nidoi before us. They are Manisi and Lolobala and Pulitala and each wears a small aluminium disc inscribed "Councillor". These men are voluntary workers appointed by the Government to assist and support the Village Constable. They are usually clan leaders or their deputies. Their reward is prestige and an occasional gift of tobacco from a passing patrol. Their main function seems to be to see that the village is kept reasonably clean and to supervise the supply of carriers to visiting Government patrols and the keeping clear of the so-called "Government Roads", which actually are the main trade and patrol routes and consist of fairly good walking tracks through the jungle or along the coast. These men and their predecessors between them have not been unsuccessful in maintaining the status quo for many years but they hardly seem fitted to deal with modern pressures. We give them a stick of tobacco each and tell them we would like to talk with them and some of the elders and interested persons after all have had their evening meal. They go off with mutual exchanges of compliments and leave us to take it in turns to have our baths from a bucket in a corner of the Rest House partitioned off for the purpose. Meanwhile one or two people shyly approach with vegetables and pineapples to exchange with us for some tobacco. We buy a little and proceed with our evening meal.

A quiet talk with the elders.

That night about 10 or 12 men besides Lenadi come along for a pow-wow. We talk about the local totem clan organization of the community, the inheritance of land, the amount of copra made each month and by whom, relationships with the Mission in the next village and with the trader a couple of bays further on. We talk about land and sea communications and find that there are no roads whatsoever other than tracks like the one we followed to-day, that there are no regular boats calling and that no one knows of any suitable locality in the area where an airstrip could be laid down. To overcome this problem of communications to some extent the village has bought with native "currency" a very fine and beautifully ornamented canoe from distant Woodlark Island which can carry four or five bags of copra or other produce—but the wind and weather must be right and it takes as many men as it can carry bags to handle the craft safely. None of our visitors can speak more than a few words of English and our conversation is carried on with great difficulty with the help of Lenadi and of our own trainees, one of whom speaks English and has a good knowledge of the local lingua franca. We therefore record our findings with reservations. We gather that the people would like to engage in some form of economic development but have very little idea as to where or how to start. So we tell our visitors that during the night we want them to consider giving us someone to take away with us for training in agriculture and also that we want to look at some of their lands and meet some more of their people the following day. They leave us and make for a clan leader's house from which the low murmur of their continued discussion can be heard. We then retire and go off to sleep to the sound of waves lapping on the beach accompanied by the distant roar of breakers on the reef.

A soil reconnaissance.

Early the next morning two young men present themselves as potential trainees before the Rest House. They are Lenadi, whom we met yesterday, and Mowedi from a neighbouring village to which the talk of our visit had already spread. They have discussed the proposal with their wives and their people and all are agreed so we accept them and they join forces with us at once and we all settle down for some breakfast. We are not yet ready to take Lenadi's wife, too, for training. Soon the Village Constable and a couple of Councillors and three or four younger men join us and we set out with our soil auger and indicator papers and altimeter and other paraphernalia for the rapid reconnaissance we propose making. We follow jungle paths to the principal arable lands of the clans and make borings. We decide that the area seems suitable for coffee and for dry paddy—coffee to bring in more income and rice likewise (since rice imports to the Territory are considerable) but more particularly in this case to provide a storable food to tide over periods of shortage. The only storable garden produce of consequence at present is the yam (*Dioscorea*) which in most places keeps only for about nine months although with care it can be stored for over one year. Always there is the risk of crop failure because of unfavourable weather or of attack by disease or pest

regardless of how provident or painstaking the people may be. Apart from maize which is very subject to attack from weevils and vermin the people have no storable cereal. Rice is of special value in regard to storage as every grain is encased in its own little storage compartment made up of its two tough glumes. An extremely important food reserve for many communities is found in the naturally occurring (and sometimes artificially extended) groves of sago palm (*Metroxylon*). When the palm reaches maturity and flowers it contains within its trunk an astonishing quantity of stored-up starch whose grains can ingeniously be recovered for food by the native people through the use of their own age-old processes and equipment. The "working" of sago is usually an extended family or clan activity which not only helps fill the larder and yields a barterable produce, but also is a pleasant social occasion which affords splendid opportunities for displaying skill and prowess. Rice-growing is of little interest to communities which have a reasonably reliable source of sago. The planting of cassava is another indirect form of food storage. We also see some scope for increased coconut plantings. Other crops could also be tried, including especially such as could improve the protein content of the diet. That night we go to bed early as it has been a long and a tiring day.

The Missionary and the Trader.

The third day we call on the native Missionary in the next village. He is busy teaching in his thatched classroom—in the Dobu language—and has a couple of youthful assistants looking after the very young children. He is keen and seems genuinely anxious to do all he can for the children in his care. He speaks quite good English and is most interested in our visit and gives us a lot of useful information about the people and the local leaders. We then give the senior class a simple talk about economic development and listen to them sing very nicely a parts song and then move on to the little trade store at the next village. Our first impression is of the prominent place occupied on the rather bare shelves by imported canned mackerel! This seems curious in a fishing village but could well be a taste acquired by the men while away on indenture. The store, which belongs to a European living elsewhere, is in the charge of a young Papuan from Taupota in Goodenough Bay. He is taller and fairer skinned and better educated than the local people and judging by the rude abruptness with which he deals with them makes it quite clear that he considers himself as belonging to a superior race. We question him about the price of copra. He explains that he cannot pay a good price because so much of what the people bring is very bad or requires reconditioning before it can be sent to Samarai. We suggest he should be stricter in insisting on good quality when he buys. He replies that when he adopts that attitude the people become disheartened and neither he nor they get anything from copra whereas the existing system brings everyone a little. We can see his point, especially when we look as some of the copra, but it seems awfully defeatist and wasteful.

Absence of men from community.

We spend the rest of the day going about amongst the people in their gardens and again through the village, finding out all we can about their social and political and economic state. One important thing that we find is that a significant proportion of the adult male population is absent at work on plantations or elsewhere and that they frequently stay away because they feel that the village has nothing worthwhile to offer them. Not infrequently a man will set up his wife and family with a good dwelling and a good garden and then go off to work but will not return for two or more years. Consequently the wife and family become short of food and depend largely on help from relatives, with a consequent general lowering of the living standard of the community. There are some villages where this is a very real and serious problem. The cause of all this, of course, is that employers prefer single men and do not want, or cannot afford, to accept dependants to be housed and provided for. The married village men accept employment with conditions originally designed for single men. Sometimes the families follow their men to the larger towns and there create further problems owing to their inadequate food and housing.

Some people fear land confiscation.

That night we ask the Village Constable to call the people together and we hold a general meeting. We see that the Missionary is amongst the people so we ask him to help us speak to them. We tell them what we have been doing and that we believe they could better their living standard if they had more money with which

to purchase many things they could use to good advantage in and about the village. They could get more money by improving the output and quality of their copra and also by planting up coffee gardens. All this seems rather to go over the heads of many of the people as they find it difficult to visualize a life other than the only one they know. However one of the elders gets up and says that the village would like to try our new ways and will be ready to start when Lenadi and Mowedi return from their training. The Missionary then turns to us and says in a stage whisper that the people are not as keen as they might be because a couple of characters, recently returned from Port Moresby, have been spreading the rumour that our only interest is to try out their lands with new crops and that if these are successful the Government will confiscate both the land and the crops. We ask the Missionary to assure the people that that is all nonsense and also to tell those who are making that kind of talk (and who, it so happens, are not at the meeting) that they are doing a bad thing for their village by holding back their people. We will later come across the same talk in other parts of the region. However the main body of the people seem pleased with our visit. The writer returned some four years later and received a tremendous welcome and found that much had been done in the interim.

Think twice when a farmer says "Come, it is quite close!".

The following morning Lenadi begs us to look at his own land before we leave. We point out that it will take us about two hours to walk to the next Rest House and that we have much to do there. Lenadi throws his hand out towards the heavens in a general westerly direction and most persuasively insists that his land is really quite close. We weaken and agree to go. This was a mistake which newcomers must be careful to avoid, it turns out to be one hour's walk away! However we make a quick inspection of the land and reassure him as to its quality and return to the Rest House where our senior boy, or Patrol Leader, with the help of the Village Constable and Councillors, has got the carriers lined up and ready, with poles tied to the patrol boxes, to swing them on to their shoulders and move on to our next base. Equally important, our cook boy has a billy of tea ready. So after drinking our tea and giving out a few presents of tobacco to the Constable and others who have helped, and also, as a special courtesy, to the oldest man and woman we can find in the village, our carriers go off in Indian file along the jungle trail singing and gossiping and we follow to a chorus of "Kaione!" (Farewell).

The above account of our visit to an average village is factual but has necessarily been telescoped to some extent with others to bring in many factors without occupying too many pages. Some communities are of course much more sophisticated and others more primitive. Some patrols were in wet and stormy weather or in difficult mountainous country where leeches or bush mites or both can be troublesome, or in low-lying areas where mud and mosquitoes and sand-flies can make life a misery. Patrols of the type described were continued as frequently as was practicable throughout the greater part of the region both along the cost, and inland where some of the communities are really very primitive and are dependant for money entirely on the sale of their labour to recruiters and of Bird of Paradise feathers to coastal natives. It was not long before some conclusions could be drawn on which to base some kind of plan for our extension activities.

Action.

Findings of the Reconnaissance Patrols.

In almost all the localities visited there was a conscious desire amongst the people to engage in some form of economic development—even if only as a matter of prestige, or because it appeared to be the accepted thing to do these days! Also in many places, at least along the coast, there were village people who had a reasonable knowledge of English learnt at Mission schools and who could help to some extent as intermediaries in an extension programme. It would be necessary of course to interest them and help them understand the aims of such a programme.

The region is geologically young and is one of great and recent upheavals. Consequently its topography is in general sharply accidented and its soils are immature and patchy. Also it is virtually a "maritime province" and communications are difficult. It offers little opportunity for European development since the cost of the services necessary to make possible the maintenance of a European standard of living, for

the few people likely to benefit from them would be prohibitive. However, the native people are already adapted to their difficult environment ; practically every native family has at least usufructuary rights to some good land —even if it be in patches. In this respect land tenure and inheritance pose some difficult problems owing to variations in native customs from place to place ; problems which are dealt with little by little by a Native Lands Commission. Economic development would have to be on the basis of small holdings scattered throughout the inhabited portions of the region and not through the development of any specially favoured area, which in any case occur only in the Abau Subdistrict and would mainly be the responsibility of the re-settlement authorities.

The most important source of native income was derived from a coastal fringe of coconuts. Many of these were old and bearing was generally poor. Some income was also derived from the failing and fluctuating trochus shell and natural gum markets. A good proportion of the people had little means of obtaining money other than by leaving their families and offering themselves to recruiters as plantation or other labour. The evil lay not in going out to work but in the hardships which resulted for the families left behind. Local sources of cash income must if possible be created.

With few exceptions coconuts in the region do not thrive away from the proximity of the sea border. Many of the native people had little or no land suitable for this crop, which belongs essentially to the waterfront, because of altitude or soils or other reasons, nor did they have any alternative crop which they could plant in its place. Apart from those limited areas where Co-operative Societies administered by the Department of Native Affairs, were in existence, the marketing services provided to the people for the disposal of their copra were in many instances inadequate and in some cases also very unsatisfactory. The desirability of setting up a simple form of co-operative society known as the Rural Progress Society, which is administered by the Department of Agriculture, might need to be considered in these areas in which because of lack of staff or for other reasons the Co-operative Registry was unable to operate.

The only extensive commercial crop other than coconuts was rubber on some European plantations. A start had also been made with cocoa planting on some of these. Efforts made by the Administration early in the century to introduce and test other likely crops had been abandoned before useful results were obtained—probably because of lack of funds. It would be necessary again to take up this work and to determine as rapidly as possible the most suitable crops for the various communities throughout the region.

The 100,000 or so native people of the region, apart from their undoubted expertise in the traditional subsistence farming, were extremely backward in agricultural education. This had so far been restricted to limited opportunities of learning some very elementary and generally foreign nature study in primary schools or of working in the teacher's kitchen garden. As no suitable institution existed in the Territory a regional Training Centre would need to be set up where boys and young men from the villages could be taught the necessary new techniques for cash cropping at the village level. Where also they could be given a new outlook on life which would help them to break down the barriers of ignorance, superstition and apathy which were so firmly established back in their villages. Such an institution was also necessary to provide a cadre of better informed people on whose sympathy and co-operation we would be able to rely—and with whom we would be able to speak at least a common technical language. We now have over three hundred voluntary helpers scattered throughout the region who have received some training from us at the Extension Centre we set up at Kuiaro, near Samarai.

A Training Centre is started.

So almost the first thing which was done in our extension programme was to find a suitable spot close to Samarai with a permanent stream and sufficient land on which to set up a plant introduction garden. At the same time boys and young men like Lenadi and Mowedi were brought in from patrols and became our first trainees. Space does not allow a detailed account of the findings of the reconnaissance patrols but it seemed evident that the principal commercial crops in which we should interest ourselves would be coconuts, coffee, rice, peanuts and cocoa; we would also be interested in reafforestation in certain areas and also in those condiment and flavouring and nut-bearing plants which can be treated more or less as forest

species since many island communities would always remain difficult as regards supervision. Hence, apart from encouraging in them a new philosophy, it is principally in the culture and processing of these crops that our boys have been trained. We have also considered the sponsoring of rubber planting by the native people but decided that, apart from establishing high quality clonal groves for the later local supply of seed, this would be better postponed owing to the scattered nature of most of the populations—and also because of the need for those engaged in that industry to develop reasonably regular working habits before rubber tapping and processing could be successful.

Village Agricultural Committees are started.

However, agricultural training alone could not meet our extension needs. Not only was the "know how" important, but equally vital was the "know why". A medium of communication between us and the people must be created to carry not only a new technology but also a new philosophy. There were tens of thousands of people who had no cash crop whatever and practically no means, other than by deserting their families and going to work in distant places, of obtaining cash. At the same time these very people and their families simply could not imagine what would constitute progress for their jungle communities and consequently felt no real need for it. Changed attitudes were just as essential to advancement as the availability of cash. Their interest had been aroused by the patrols and quick action was needed while this interest lasted, not only to encourage economic development but also to ensure on the part of the people some appreciation or understanding of aims as well as of methods. Some "grass roots" organization was required through which we could have intimate contact with the village communities. Their representatives could then participate in the formulation and implementation of plans—and at the same time help us to avoid making social or political blunders. Experience on the patrols had indicated that the old Village Constable cum Village Councillor organization had outlived its usefulness and was not geared to modern needs. Something younger and more alive was required. This had already been recognized by the Department of Native Affairs when it introduced the Native Local Government Councils. The latter would not be the answer however because the limited representation on them is on a population rather than a village or community basis and because they are rigidly controlled by Ordinances which must be closely administered by officers specially trained for the purpose. In any case there were only two small Councils in the region at the time. We needed something flexible and informal which could be put into operation and maintained by the village people themselves with a minimum of supervision. Especially was this so as it was necessary rapidly to get out many pilot plots of rice and of coffee throughout the region before interest waned. There was still only one agricultural officer at the time. Those were the circumstances that originally led to the setting up of our Village Agricultural Committees. One or two Committees were tentatively started by the writer in the Cape Vogel area in January, 1954, for the purpose of establishing rice-growing in that area where food shortages are an annual occurrence and no local sago is available. The idea obviously appealed to the people and so all trainees were thenceforth given instruction in this very simple form of rural organization. On their return to their villages they talked about the new idea and it was not very long before gradually, and usually with the helpful collaboration of the Assistant District Officers and Patrol Officers, the movement went right through the region excepting in those remote island areas where it was not encouraged because of supervision difficulties, and in the Trobriand Islands where a powerful clan organization with hereditary chiefs already existed. It should perhaps be explained that in most areas the old chieftainships have lost their importance and hereditary leaders no longer exist excepting to some extent in the determination of local custom. However the old totem clan framework still forms the basis of the gardening and working organization within village communities to a large degree. Consequently the new Committees are made up of representatives of the several totemic clans in each village (thereby, at least to some small degree, attempting the blending of the new culture with the old so wisely advocated pre-war by Williams, 1935) or of hamlets where population is scattered. Each Committee chooses its own Leader and its meetings, which it is seldom possible for a Government Officer to attend, are very informal, being held, as a rule weekly, under a shady tree or in any convenient place. In fact each Committee might more accurately

be termed a " representative group ". To-day there are something of the order of 400 villages with Agricultural Committees. Their zeal depends to a large degree on local leadership and on the frequency of patrols and on the interest of the Assistant District Officer. Their activities range from lip service to the detailed organization and management of economic endeavour.

Councils and Missions support the new Committees.

In those areas where there already existed Native Local Government Councils the latter, and also the Assistant District Officers in charge of Local Government activities, welcomed the Committee movement as providing a useful adjunct and ally in community organization and a further medium for the promotion of their own programmes at the village level. Not a few Local Government Councillors are also members of the Village Committee Organization. In other areas where Local Government Councils do not exist the Committee Organization has contributed to the preparation of the people for the introduction of Councils. In some areas the Co-operative Society movement has also helped in this regard. All of the Missions have expressed support of the new Village Committee movement because it is based on Christian principles and has for its aim the betterment of the people and of their lives. Most of the native Missionaries and some of the Europeans also take an active part in helping the Committees to understand their duties and to carry them out.

Interest in cash cropping is rapidly stimulated.

As trainees returned to their villages and Committees were set up the extension work gathered momentum. Within six years, starting from nothing with a crop completely new to the people and to the region, there were about 3,000 individually-owned coffee gardens of about 50 trees each established with few technical errors throughout the region, including both *Robusta* on the lowlands and *Arabica* in the underprivileged and primitive inland areas at altitudes of 2,000 feet and over. Many gardens are being expanded and coffee exports have begun ; in fact through the co-operation of the Anglican Mission a bank agency has been started at Dogura and a number of the primitive inland Arabica growers now have savings bank accounts which will make it easier for them to save shares for setting up a Rural Progress Society to handle their coffee marketing and other needs in the future. Some of their boys are now also receiving special training in preparation for business activities. There were also many trial rice gardens planted and some communities in areas subject to long dry seasons and occasional near-famine conditions have adopted the new cereal in their traditional food garden pattern. Also many thousands of coconuts were planted, with some help from the Department of Native Affairs, and over 150 hot-air copra driers built—though some of these later fell into disuse because of the low price differentiation between hot-air and smoke-dried copra. A small cocoa project has been started and recently chilli-growing has been promoted in some of the most poverty-stricken and least fertile areas. It should perhaps be added that while we do encourage " community development " in the sense of mass or community education, we at the same time encourage individual enterprise and discourage the communal planting of permanent crops because of the ownership problems which would later ensue.

Village Women's Committees are started.

When a Government patrol is expected at a village it is usual for the Village Constable to stand in line with his Village Councillors to greet and receive the Patrol Officer (and, who knows, maybe also to receive a small gift of tobacco if he is a kind man who is happy to be amongst us !). Soon the Village Agricultural Committees were joining the line and being recognized as persons of some little consequence in the village as they proudly displayed their Committee Membership Cards. In a few cases in the more primitive areas where the new agricultural extension work was the biggest thing that had happened within living memory, they became so filled with their own importance that they cheerfully attempted to take over the authority of the Government-appointed Constables and Councillors. However such incidents were merely growing pains and were soon corrected by a few words from the Patrol Officer or the Agricultural Officer or, in some cases by a brief period of re-orientation at our Kuiaro Centre. Of course where Local Government Councils are set up in an area the old Village Constable and Village Councillor organization is disbanded and all of

its authority is passed on to the new Council. At no time has there been any such friction in war by Williams) or of hamlets where population Local Government Council areas.

But, to continue with our story, it was noticed first in one village in southern Normanby and then in others that the wives of the Committeemen too were starting to " line up " with the Constable and his Councillors and the Committeemen. In one place they even told the Patrol Officer that they were the " Women's Committee " ! This was reported to the writer by the Patrol Officer (Mr. Hastings).

The writer had been deeply concerned at the time that so much Administration extension work (and particularly agricultural extension) was carried on through and for the men while so comparatively little was being done through or for the women. Our approach to native advancement on the whole seemed singularly one-sided and futile if we were to deal only with the men and overlook the women who are, in point of fact, the principal workers not only in the home but also in the gardens. It seemed essential that our extension plans be reconsidered and action taken to reach not only the men but the whole community. Every effort should be made to ensure that economic development be always accompanied by parallel social and political development in a constant endeavour to broaden the whole lives of the families and of the communities. We should do all we can also for the children to ensure that the next generation will be prepared to take proper advantage of the greater opportunities that to-day's economic development will bring. To achieve these aims it was essential for us to have close contact with the women at the village level. The matter was discussed with the District Commissioner and a radio-telephone call put through to Headquarters at Port Moresby. Both saw the wisdom of this approach and it was not long before an outstanding Papuan woman, Miss Alice Wedega of the Kwato Mission, was loaned to us by the Mission and appointed to our staff to assist with our work in women's interests. And so in July, 1957, the first Village Women's Committees were started in Milne Bay and on the basis of that experience soon spread through the region. Now there are at least 300 villages with Women's Committees, and, in addition a Welfare Officer has recently been appointed to Samarai by the Department of Native Affairs and will be helping a great deal with the Women's Committee work. Miss Wedega, it should be added, has continued with her fine Committee work and made many patrols with the writer and his team or alone with picked girls, and is now also a member of the Legislative Council for the Territory.

Integration of community effort.

The formation of the Women's Committees (by the Papuan people themselves to a very large degree be it noted) helped to unify each village in its efforts towards a common, if somewhat nebulous goal, namely " Progress ". For example, the organization of the weeding of coffee gardens has become in many places a responsibility of the Women's Committees, as also the organization of harvesting and processing of coffee, rice and peanuts. But their activities do not stop at agricultural pursuits. They include much in the way of civic and social or welfare activities—including child welfare, village hygiene, handcrafts, getting the children to school each day, etc. In some places they even attempt to operate a pre-school centre for the care of small children while the mothers are busy. One advanced Committee has also taken Committee Women from primitive areas for training ; on the other hand there are some who get little further beyond mat-making. The Committees are encouraged to co-operate closely with the Mission Sisters and to participate in Mission organizations for women's welfare where these exist. The Agricultural Committees for their part are encouraged to work closely together with the Women's Committees, and vice versa, so that little by little the movement is becoming a Community Development force rather than one designed purely for agricultural extension as was the case at the beginning. Nevertheless the two Committees are kept as separate entities because although the men and the women have many common interests there are also many which are diverse. A good example of how the Committees co-operate and yet remain separate is to be found in the way they have helped the anti-malarial teams on Fergusson Island and elsewhere. The Agricultural Committees combined with the Village Constables and Councillors to ensure that carriers were available and other men to assist with spraying and in other ways. Women's Commitees organized a canteen service so that the

spraying teams had resting points along their route where they and their carriers could have a spell in the shade and where they were given some food and drink.

Agricultural Associations are started.

This integration within the communities was so evident that it led logically to the grouping of Committees into Associations within geographic and linguistic areas. There was no problem in determining which communities should belong to various Associations as this was already pre-determined by natural and traditional affinities. In our Committee work, whilst adhering to a common pattern and policy, we endeavour to leave much flexibility in the organization and so representatives of any village are welcome at meetings regardless of whether or not they belong strictly to the given Association. The latter are called "Agricultural Associations" in recognition of the importance of Agriculture in the lives of the communities. Each Association consists of all the Agricultural Committees and all the Women's Committees of a given linguistic or political (Local Government Council) area. Meetings of each Association are held in a different host village within its area about every six months. There are now fifteen Associations covering about 46,000 people belonging to about 280 communities. New Associations are being formed as the people indicate their desire for this action. The meetings, which generally take up two days, are also valued by the people as social functions apart from the opportunity it gives representatives of the communities to discuss and obtain advice regarding their various technical and other village problems. They are normally attended not only by representatives of the Committees (both men and women) but also by most of the Village Constables and Councillors who are encouraged to take part in the discussions. The opportunity is also taken wherever practicable of including demonstration classes in specific agricultural and homecraft subjects of special local interest. It is also intended to encourage handcraft displays at these meetngs. Naturally the Assistant District Officer endeavours to attend as well as the Agricultural Officer. It is an excellent opportunity for the Assistant District Officer to have contact with people from many villages in a capacity divorced from his customary association with law and order. The meetings will now have added value since our Welfare Officer will also endeavour to attend. The meetings, of course, have as their principal purposes the unification of the people and the encouragement of their participation in programme planning for their area. Each Association has its elected Chairman and Vice-Chairman and Women's Leaders and Secretary and so gives further opportunities for the emergence and training of native leaders at the village level. Fortunately Agricultural Officers are being appointed to Subdistricts otherwise it would not be possible for us always to arrange Departmental representation at meetings. As opportunities arise the office bearers of Associations are being given tours of other Districts together with Local Government Councillors to broaden their outlook and experience.

Native Local Government Policy.

It will be well now to digress for a moment to discuss briefly the Local Government Council movement in the context of our outline of the new Committee Organization. These Councils originated with an Ordinance passed in 1949 known as the "Native Village Councils Ordinance" whose title was changed in 1954 to the "Native Local Government Councils Ordinance". The first Councils were established in 1950. At the time our extension work started in Eastern Papua there were two Councils—the Baleba Council and the Tavara Council, one on each side of Milne Bay. These have since amalgamated. It was perhaps natural that our first two Agricultural Associations should have been formed of the Committees of these two Council areas since it was there that existed the best likelihood of finding people capable of accepting the responsibilities of office bearers in the new organization. The basic aims of Native Local Government policy have been formulated and are given in a recent Administration Circular on the subject. We quote :—

> "(*a*) To provide a medium for teaching natives to assume a measure of responsibility for their local affairs in accordance with democratic procedures ;
>
> (*b*) To provide area machinery and local funds for extending and co-ordinating social and public services at village level and hence to enlist native support in endeavours to raise native living standards ;

(*c*) To face the native population squarely with the fact that progress is inseparable from good order and industrious habits and that social services have to be paid for ; and

(*d*) To prepare the way for ultimately fitting the native people in a way they can understand into the Territory's political system.".

Each Village Agricultural Committee and each Village Women's Committee, as has already been mentioned, is made up in each case of representatives of each of the totemic clans of each village. This ensures broad representation and prevents the taking over of too much authority by any one family group, and also serves to link the new organization with the old traditional organization of the villages. Hence the Village Committee Organization is essentially democratic and was welcomed by both the officer in charge at the time of Native Local Government and by the two Councils as dove-tailing with Council policy. Since then two more Councils have been formed at Misima and in the Cloudy Bay area and both are working very closely with the Agricultural Associations in those areas. In all these cases prominent Councillors are also office bearers in the Associations.

Village Committee principles codified.

In 1956 when the Committee Organization was already well advanced a start was made with the publication of a newsletter every month or few weeks. This has been continued and is called the " V.A.C. ". It deals with the many letters and personal reports which we receive from the native people about Committee work and is our official organ for the dissemination of policy decisions, agricultural and women's news, etc. It also gives accounts of the activities of various Committees and advice on what they should be doing. In 1959 much of this material was worked over and a booklet was brought out, with a foreword by the Administrator, called " The Village Committee Book " (Cottrell-Dormer, 1959*b*) which gave guidance in simple English regarding the formation and functions of Committees and Associations and on the duties, etc., of Committee members and Association office bearers. The duties and functions as laid down in the booklet are the result of observing the activities of the Committees over the years since their inception. All of the functions and duties prescribed are such as have in fact been practised of their own volition by the Committees in the villages in varying degrees according to the state of advancement of their communities. However, there was still a good deal of uncertainty amongst some of the people on the true nature of their duties and, whilst retaining flexibility and informality to a large degree the movement was developing to such magnitude in the region that it became important to codify its principles to some extent and to give all of the Committees not only a common purpose but also a common modus operandi. Their purpose is indicated in their slogan: " Our work is for our people and our villages and our country.". The booklet has been widely distributed amongst such Committee members and others who can read and understand sufficient English. It has been printed also in the Dobu language and widely distributed in the D'Entrecasteaux Group, and in the Suau language for distribution in areas using that talk for a lingua franca. Translations are also being prepared in Wedau, Misima and Mailu for later printing and distribution. The effect has been striking particularly in the Dobu language areas where so many people are now able to read it. The booklet has recently been slightly revised to make it of more general usefulness.

The functions of the Village Committees.

In 1959, functions were summarized in the *Agricultural Journal* (Cottrell-Dormer, 1959*a*). Put briefly—

> " The functions of the Agricultural Committees are to provide a liaison between the Agricultural Officers and the people, to give leadership to the people in ensuring that sufficient food is grown and that the people participate in an approved manner in programmes for the economic development of the area, to co-operate with constituted authority and with the Women's Committees in improving village life and generally to give an example of good citizenship.
>
> " The functions of the Village Women's Committees are to provide a liaison between the Agricultural Officers and the Welfare Officers and the village women, to give leadership to the women in improving home life and in providing a better environment for the rearing of the village children, to assist in the organization of garden work (both subsistence and economic), to co-operate with

constituted authority and with the Village Agricultural Committees in improving village life and generally to give an example of good citizenship.".

Co-ordination of activities of Council and Committee Organizations.

It will have been seen that in some respects there is a close similarity in the ultimate aims of the Councils and of the Committee Organization. This was strongly emphasized at an Extension Conference at Wewak in 1959 by officers of the Department of Native Affairs which administers the Local Government Councils Ordinance. As a result it was decided that there should be some definite co-ordination of the activities of the two organizations and it was proposed that a Council Agricultural Committee should be set up which would be made up of men and women representatives of the Council and of the Agricultural Associations. This Committee was to meet periodically and advise the Council of action or assistance which it considers should be given by the Council in the furtherance of various developmental projects. The first of these Committees has been appointed in Milne Bay and is being observed prior to others being set up. Reports from the Assistant District Officer in charge of the area have so far been very encouraging.

Formation of District Development Committee.

In 1959 there was also an inspection tour of the region by the Administrator and later by a panel of senior Headquarters officers sent by him to study and report to him on the Committee Organization. There followed a directive supporting the movement and setting up, in 1960, an inter-Departmental Committee at Samarai which came to be known as the District Development Committee. It meets about every month under the Chairmanship of the District Commissioner and determines policy and plans at District level on matters concerning the advancement of the native people—both men and women—and does much towards fostering the team spirit amongst Departmental officers.

Educational Conference supports Committee system.

The Village Committee Organization was discussed in detail with special reference to the education of women and girls at the "Second Camilla Wedgwood Seminar" held in Port Moresby in December, 1960, under the auspices of the Department of Education, and the following recommendation was adopted :—

"The Group recommends that the Committee System operating in the Samarai areas should be extended on a Territory-wide basis. It is the view of this group that it fits the natural mode of village life and is demonstrably successful in revealing and giving training by experience to the natural leaders within the village. Its value is that it is not dependent on an expensive external administrative organization but infiltrates from village to village and can be supervised by ordinary patrolling. It provides a link between all villages in a given area and, eventually, of the whole Territory. It co-ordinates all other clubs or groups such as Parents and Citizens Associations, Guides and Scouts for the teenagers, Church Clubs and Women's Clubs. It links these groups with the men in their gardening and general village improvement. It brings the views of the people in the village eventually to the Local Government Council.". (Anon., 1960.)

A Rural Women's Training Centre.

As a result of pressure from the Milne Bay Women's Committees, encouraged by Miss Wedega and supported by their Agricultural Associations and the Local Government Council, the first Rural Training Centre for women in the Territory is now being set up near Ahioma, in Milne Bay, by the Department of Native Affairs. This will make possible the training of women's leaders for Committee and other work and will soon change the whole complexion of our work amongst the village women. It will also provide a "Kuiaro Centre" for girls which is so badly needed.

The District Development Conference.

The figures given earlier for the number of Committees within the region under discussion are only approximate because the movement is still spreading in far inland areas where our coffee work is being carried forward. It is also spreading to other regions. The latest step forward has as its aim the further unification of the people of the region and their encouragement to participate more fully in extension and development programme planning; that is the holding of an annual District Development Conference. It was originally proposed that a

" Council of Agriculture " should in due course be set up. (Cottrell-Dormer, 1959*a*.) After full discussion by the District Development Committee it was decided to broaden its function and at the same time bring together all the principal native developmental agencies. It was decided also not to use the name " Council " for fear of confusion with Native Local Government Councils, but rather to call together an annual " Conference ". It is proposed to hold the first Conference this year at our Kuiaro Centre and that it should be attended by the members of the District Development Committee and all Assistant District Officers, and by the senior office bearers or representatives of the Local Government Councils, the Agricultural Associations and the Co-operative Societies Associations. Such other persons as the Development Committee may consider it desirable should attend will also be invited including representatives from Headquarters. The Conference will be under the overall Chairmanship of the District Commissioner and will be addressed on important matters related to District Development planning and implementation by the senior officers of the Departments concerned. The purpose of the conference, as already indicated, will be not only to inform the people of the Government's views on development but more especially to obtain the people's views and suggestions regarding the development of the various areas they represent and regarding the District as a unified whole. It will be natural to expect that it might be a few years before the people fully realize that they have a vital part to play in planning—but if they are never given the opportunity to participate they never will obtain the realization. It does not require much imagination to visualize District Development Conferences some day sending representatives to Territorial Conferences.

The functions of the Agricultural Associations

To conclude this section of this paper we will quote from the *Village Committee Book*, as recently brought up to date, the work of the Agricultural Associations. This will serve to bring out the cohesion which is being encouraged between different groups and authorities through the medium of the Village Committee Organization:—

" 1. To bring together all the Men's Committees and Women's Committees of the Association area about twice in every year. This is so that all the Committees will know that they belong to one big Committee family and so that they can help each other.

2. To hear and understand the messages or talks of the Agricultural Officer and the Welfare Officer and of other Government Officers and advisers.

3. To hear the reports of each Committee Leader and to talk about these reports and help each Committee to fix up its troubles.

4. To hear about each Committee's target of work for the year or for the next six months and to advise each Committee on how to reach its target.

5. To tell the Agricultural Officer and the Welfare Officer about things that are worrying the Committees.

6. To prepare messages to send to the District Commissioner or to the Assistant District Officer or to the Local Government Council about any big trouble that is worrying the Committees.

7. Each year to elect representatives to the Local Government Council Agricultural Committee.

8. To advise the Local Government Council about how the development work is going on in the area.

9. To make recommendations to the Local Government Council about new works or new laws to help development.

10. To back up the Local Government Council, the Co-operative Societies, the Rural Progress Societies.

11. To make sure that all villages in the area have plenty of good food gardens.

12. To help the Agricultural Officer and the Committees to make good plans for cash cropping.

13. To help the Welfare Officer and the Committees to make good plans for Women's Committee work.

14. To help the Agricultural Officer and the Committees to make good plans for the selling of cash crops.

15. To help with Agricultural Carnivals or Shows when they are held in the District.

16. To make a good feast and dance when an Association meeting is finished.".

Among the duties of the Chairmen and Women's Leaders is included the following:—

"To attend all meetings of the District Development Conference.".

Discussion and Conclusions

In some respects the villager's life, though apt to be relatively short, is, at least superficially, Utopian. Idle observers sometimes ask why do we not leave the people in peace instead of all the time wanting to "develop" them or "advance" them or lead them to "progress". The answer is, of course, that change is going on and will continue to do so regardless of what we may or may not do. Our job is to guide that change along mutually beneficial lines. As the writer once told a conference of young extension officers ...."There are some communities which are poverty-stricken, or have low standards of health, or suffer from malnutrition and which obviously need at least technical assistance. But the matter goes deeper than that. Our native people are, like ourselves, living in a changing world. But change for them is not only a matter of progressive scientific and technical advance or of political alternations but in most affected communities change of the whole tenor of their lives—their customs, their social organization, their way of life. This sometimes rapid change is resulting from contact with our own race and is inevitable. Many, if not most, of the communities affected do not have the cultural resources to enable them, without guidance, to adapt themselves to the new influences without harm to themselves. It is our task and our duty to supply that guidance and to prepare them also for those further changes which will occur as a result of our own activities.".(Cottrell-Dormer, 1956.)

Our guidance and other forms of help cannot be effective unless a need is felt for them by the people and unless we have their co-operation. Real co-operation is generally difficult to obtain because the people we are dealing with seldom have any real desire for improvement. Apart from the retarding influence of their superstitions, and their secret fear of the jealous sorcerer, their life experience is so limited and circumscribed that it is impossible for them to visualize the ideal modern native society towards which they might strive through the medium of greater effort in the economic field. Native effort in the village is therefore largely directed to meeting immediate needs rather than to following out some planned programme of development. Similarly it is not possible for a European to form a clear picture in his mind of precisely what should be the nature of the economic, social and political "advancement" we are endeavouring to promote, or precisely what should constitute the "self-reliant, self-dependent and properly organized life" we desire to foster in the villages. It is impossible for the people because they do not have an adequate background on which to build up such thoughts or plans. It is impossible for us because we can never put ourselves in their place to appreciate their sense of values, or duplicate their thought processes or feel the full impact ourselves of the predicament of being obliged to rely upon the meagre resources which are available to them. To a certain degree then, the village man is, relative to ourselves, like Ouspensky's "plane-being", incommunicado.

Our greatest need is perhaps to find increasingly effective means of exchanging with the villager progressive ideas through which to determine desirable and practicable plans of community development which will be enthusiastically followed by the people and supported by the Administration. It is largely as a step towards meeting this need that the Village Committee system is being evolved—to provide a two-way medium of communication from villager to Government authority in rural extension matters. Quite apart from considerations of availability of staff we are unable effectively to deal directly with the ordinary village people; we simply cannot understand each other sufficiently. Our dealings must be through the intermedium of the more progressive and the more influential members of the community. Our organization encourages the emergence at all levels of natural and accepted leaders both men and women. They will have at least some appreciation of the problems and difficulties, of the needs and (where they exist) the aspirations of the communities. However, their ability to assist in the formulation of a programme is limited by their inadequate earlier training and experience. At present there are very few who can give real help in programme-planning. The provision of greatly increased facilities for broad training and preparation for progressive community leadership would seem to the writer to be a vital matter of the greatest urgency on a Territory-wide scale.

The finding and training of leaders is an urgent matter not only to provide help in various extension schemes but also that they may be given and be able to accept real responsibility as early as possible in all walks of their new life. In this way only can initiative be encouraged Without this initiative native leaders can hardly be expected usefully to participate in formulating plans for the overall advancement of the people of the Territory. Plans formulated entirely in European minds are almost certain eventually to prove unacceptable to the people. At the risk of making some mistakes the handing over of real responsibility to native men and women leaders should be speeded up so that they may make their own plans to suit their own needs. In our own small sphere we have already adopted this policy in our rural extension work with very promising results.

An interesting aspect of our organization is the support it provides for young trainees when they return to their villages after their time spent at our Kuiaro Centre. Many of these boys are quite young and would normally be thrust aside by their elders until they married or at least until they became a good deal more mature. However, with our system, the trainee is welcomed back to the village by the Committees and at once with their help and support can commence practising his new skills and declaiming his new philosophy. A further step is thus taken in encouraging proper participation of the community in the extension programme by this forging of a link between the Committees and the Kuiaro Centre. Our limited experience has shown that these remarks apply also to girl trainees.

To borrow an axiom from the educationists, in any teaching programme one must proceed from the known to the unknown. Similiary in the extension field we must start from what is and advance towards what should be. The use of trained village youths for this communication of new ideas and techniques to the Committees and the people has the advantage of ensuring that by the time they reach the village people they will have been reduced and simplified to terms and propositions which the trainees themselves can understand. This brings them within the comprehension of the village people who consequently are able without great mental effort to take the next step forward. The point the writer wishes to bring forward is that the village Trainee and Committee system is giving tremendous help in overcoming the communication difficulties which lie between us and the village people. With the advance of scholastic education in the villages the system should become increasingly effective. At the same time it should perhaps be made clear that the greater part of the people we are dealing with have been under Mission influence for many years and that some vernacular primary Mission schooling even if usually of a low standard has been available to many of them in the past. This means to say that they are sufficiently advanced to adopt the system for orthodox rural extension purposes rather than for the furtherance of primitive politico-magical cults.

An outstanding feature of our Village Committee work has been the response of the women. The movement seemed to give them an opportunity of playing a fuller part in village affairs which they have seized upon with some enthusiasm, sometimes after first overcoming reluctance on the part of some men. It has also helped to stimulate the men to greater endeavour in the economic and social aspects of village life. These observations have served to confirm the writer's view that an extension programme should be as full as may be practicable and be aimed at all sections of the community. It should not consist, for example, of economic agricultural extension for men on the one hand and so-called "welfare" activities for women on the other. The two should be welded together as part of a single programme. All Administration extension activities—agricultural, economic, welfare, educational, health, political—should, to the greatest extent possible, be welded into a concerted team effort at the District level (and even more essentially at the Subdistrict level) and preferably under the overall direction of a single executive and co-ordinating body at the Headquarters level. A close liaison should also be maintained with related Mission activities at all levels.

Much has happened since we went on our patrol to Kasiguleu seven years ago. Hundreds of thousands of coffee trees have been planted and tens of thousands of coconut palms, and native primary production is expanding. But of equal importance, or perhaps even of greater importance, a cohesion of the hundreds of isolated village communities is taking place and a feeling of common purpose developing amongst

them. Not only is there satisfying evidence of economic and social advancement, but also of a growing political awareness. Not least amongst the factors which are bringing all this about is the Village Committee Organization which, the writer believes, owes its success very largely to its democratic structure, to its totemic clan representation of the common village people. Whether it will continue to gather strength and play a valuable role will depend upon the support and guidance it receives. After all it is but a broad extension or mass education tool. Like any other tool, it will lose its edge if neglected or abused.

REFERENCES.

ANON (1960). *The Second Camilla Wedgwood Memorial Lecture and Seminar,* Port Moresby. Government Printer. 37 pp.

CLELAND, D. M. (1957*a*). The Position of the District Commissioner in his District. *Administrator's Circular* HH 1/57.

CLELAND, D. M. (1957*b*). The Position of the Assistant District Officer in his Subdistrict. *Administrator's Circular* HH 2/57.

COTTRELL-DORMER, W. (1956). Paper presented to District Agricultural Officers' Conference, Goroka. (Unpublished.)

COTTRELL-DORMER, W. (1959*a*). Rural Organization in South-East Papua. *Papua and New Guinea agric. J.* 12 : 37 - 40.

COTTRELL-DORMER, W. (1959*b*). *The Village Committee Book.* Rabaul: Methodist Mission Press. 20 pp.

DUBE, S. C. (1959). *India's changing villages.* London: Routledge and Kegan Paul. 248 pp.

GOUROU, P. (1953). *The Tropical World.* London: Longmans. 156 pp.

PENDERS, J. M. A. (1956). *Methods and Programme Planning in Rural Extension.* Wageningen : Veenman. 324 pp.

WILLIAMS, F. E. (1935). The Blending of Culture. *Territory of Papua Anthropology Report* 16. 41 pp.

A PROJECT IN THE DEVELOPMENT OF CATTLE ADAPTED TO A TROPICAL ENVIRONMENT

By J. L. Anderson.*

INTRODUCTION.

THE Administration of the Territory of Papua and New Guinea is aiming at a Cattle Industry which will enable the Territory to be self-sufficient in beef. The following paper outlines one aspect of the Administration's functions in approaching this aim.

The cattle industry in the Territory of Papua and New Guinea commenced well before World War II and was, at that time, chiefly associated with coconut plantations around the coasts of the islands. The cattle were, in general, of a nondescript type and many of them had a smattering of Zebu blood. The majority of these animals were killed off during the war although pockets of them are still found in many parts of the Territory.

Postwar the cattle industry has developed along slightly different lines, although the use of cattle as grass cutters in coconut plantations is important in some areas. Large areas of land have been made available as grazing leases and have been taken up for the grazing of beef cattle. However, most of these areas are in the hot lowland environment of the Territory where European breeds of cattle show poor productivity. Although much can be done in the development of improved pastures to provide a better nutritional level, the immediate answer seems to lie in the development of types of cattle which are fitted to economic performance in the environment.

In other parts of the world strains of adapted cattle have been developed. The American Brahman (Jacobs 1949, Kelley 1959) and the Santa Gertrudis (Rhoad 1949) are types developed for the environment of southern United States. In South Africa, where the environment is marginal for European breeds of cattle, the Afrikaner type has been used both as the purebred and for cross-breeding with European breeds (Bonsma, van Marle and Hofmeyr 1953, Joubert, 1957). The recent development of the "Droughtmaster" type in Northern Australia is a step towards this adapted type.

The development of adapted types in the Territory of Papua and New Guinea is based upon the use of two of the breeds mentioned above, namely American Brahman and Afrikaner. Brahman cross-breeding is carried out at the Papuan Lowlands Livestock Station, Moitaka, Port Moresby, and the Afrikaner cross-breeding at the New Guinea Lowlands Livestock Station, Erap, via Lae. The Brahman cross-breeding project is described below.

Environment.

The Papuan Lowlands Livestock Station, Moitaka, is typical of the dry coastal belt of Papua but is not representative of the whole of the hot lowland environment of the Territory since humidity and rainfall registrations elsewhere are generally higher. The station occupies an area of 40,000 acres about eight miles north-east of Port Moresby but only 10,000 acres are used. Port Moresby is at a latitude of 9 degrees 30 minutes south and longitude 147 degrees 10 minutes east. The monthly means of rainfall, humidity and maximum and minimum dry-bulb temperatures are shown in Table I. Figure 1 gives the climographs of Messina (South Africa), Port of Spain (Trinidad), Rockhampton (Queensland) and Port Moresby. A discussion of the use of climographs is included later.

* Chief, Division of Animal Industry, Department of Agriculture, Stock and Fisheries, Port Moresby.

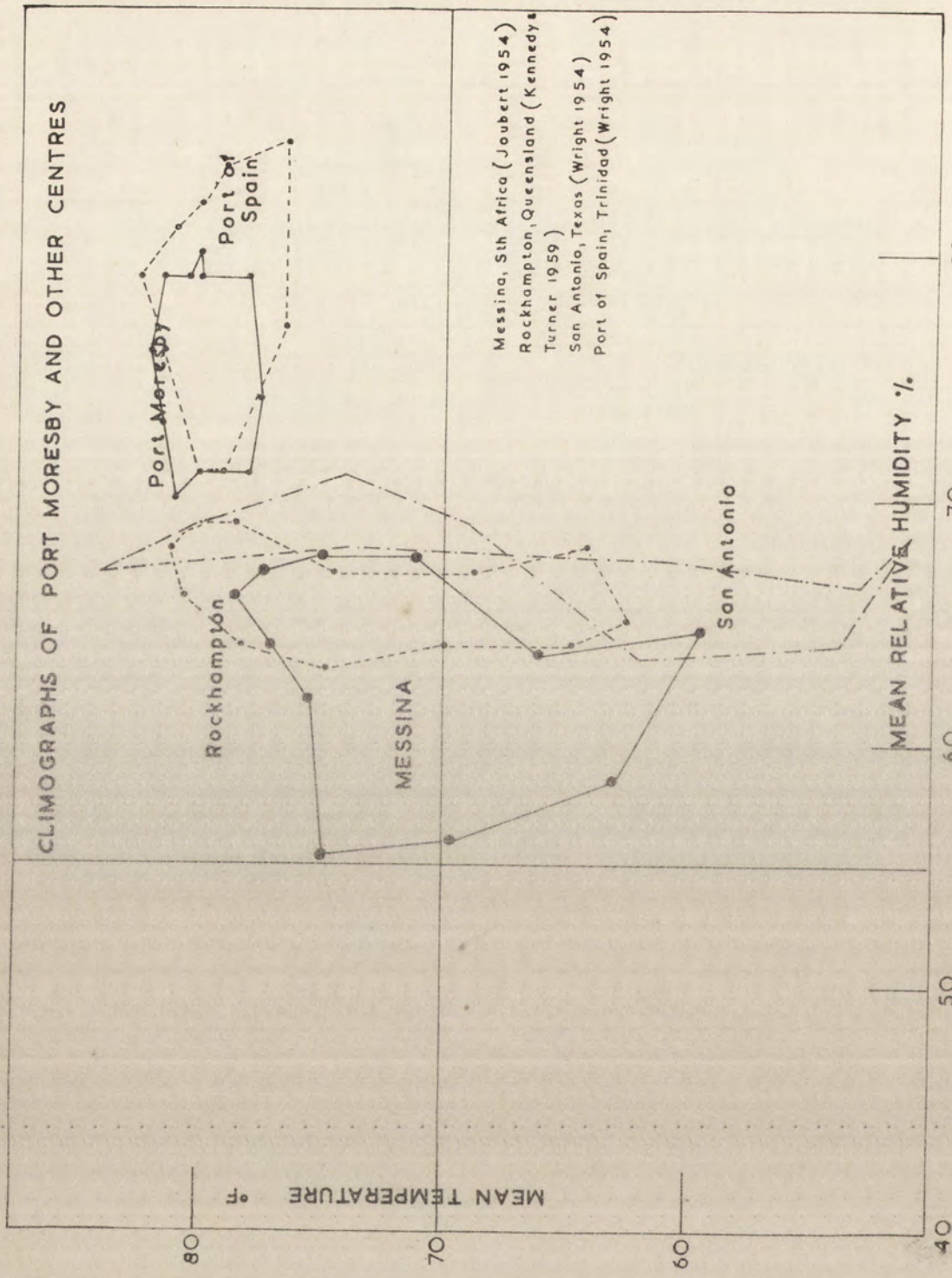

CLIMOGRAPHS OF PORT MORESBY AND OTHER CENTRES
Port Moresby
Port of Spain
Rockhampton
MESSINA
San Antonio
Messina, Sth Africa (Joubert 1954)
Rockhampton, Queensland (Kennedy & Turner 1959)
San Antonio, Texas (Wright 1954)
Port of Spain, Trinidad (Wright 1954)
MEAN RELATIVE HUMIDITY %
MEAN TEMPERATURE °F
80
70
60
50
40
60
70
80

Figure 1.

Table I.

Climatic Averages—Jackson's Airport, Port Moresby 1946-1960.

Month.	Average Daily Maximum Temperature.	Average Daily Minimum Temperature.	Average Daily Relative Humidity.	Average Monthly Rainfall.	Average Number of Rain Days.
January	90	74	76	529	15
February	89	74	79	839	19
March	88	73	79	674	18
April	87	73	80	801	16
May	87	73	79	201	8
June	86	72	79	175	7
July	86	71	74	71	5
August	86	72	71	132	7
September	87	73	71	159	6
October	89	73	70	147	7
November	89	73	70	321	9
December	89	74	73	637	14

Highest Maximum Temperature recorded—97.0—February, 1947.
Lowest Minimum Temperature recorded—57.3—July, 1946.

"Moitaka" is bounded on one side by the Laloki River and on the other by a range of hills up to 1,500 feet in height separating it from the sea. It extends from an altitude of about 200 feet to parts which are permanent swamps caused by the Laloki and Brown Rivers. The low country is susceptible to flooding during the "wet" season and much is covered by heavy rain forest. When the rain forest has been cleared improved pastures of Elephant grass (*Pennisetum purpureum*), Para grass (*Brachiaria mutica*) and Molasses grass (*Melinus minutiflora*) have been established. The higher country is covered mainly by Kangaroo grass (*Themeda* spp.) on the poorer soils, and Kunai (*Imperata* spp.) on the better soils. This country provides grazing during the wet season and for a short period following the rain. The Kan-

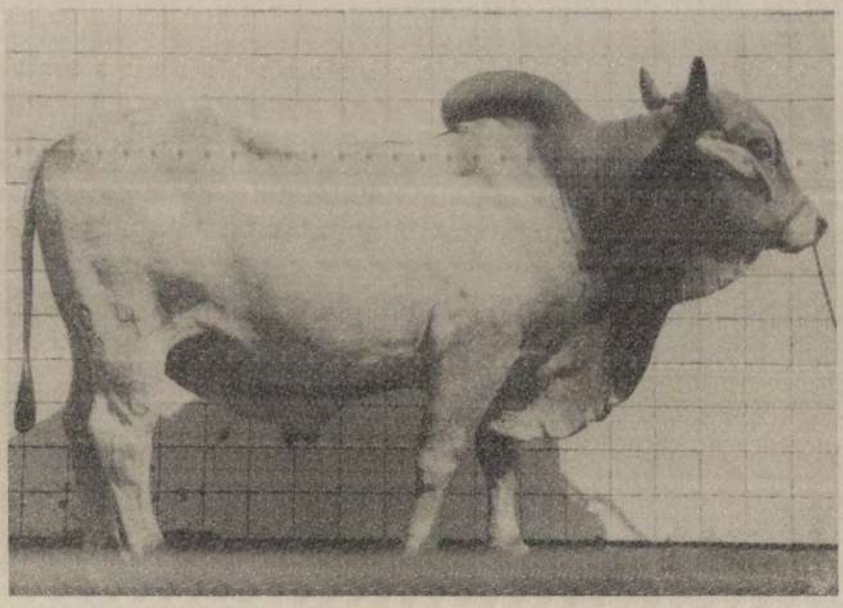


Plate I.—Imported Brahman Bull "Vela de Manso".
(The Pedigree of this Bull is shown at Figure 2.)

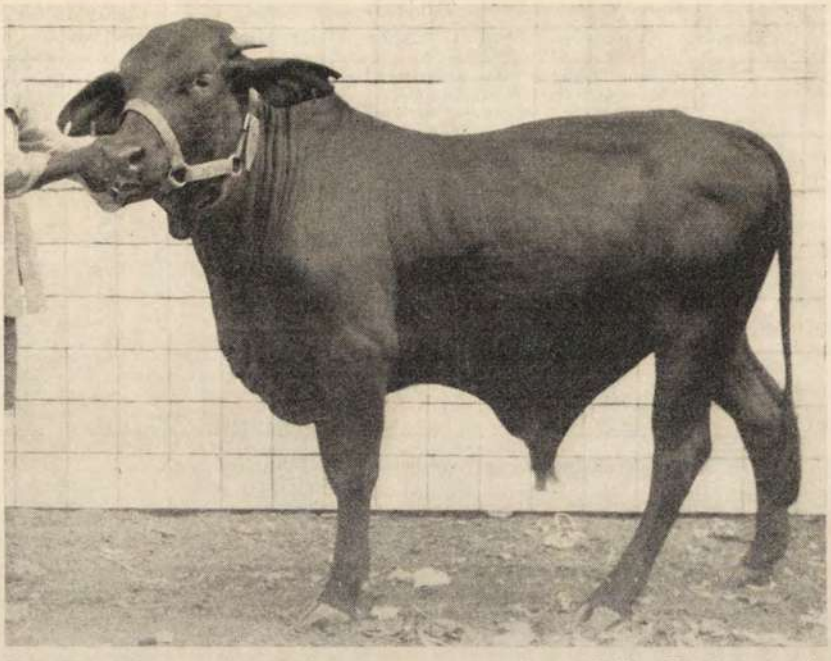


Plate II.—Three quarter Brahman one quarter Angus Bull. Twelve months of age.

garoo grass dries off extremely quickly in the high environmental temperatures and provides little more than poor quality roughage. Both areas have been liberally sown with the tropical vine type legumes Centro (*Centrosema pubescens*), Puero (*Pueraria phaseoloides*), Calopo (*Calopogonium mucunoides*) and Clitoria (*Clitoria ternatea*), which have helped to provide a longer grazing period on the higher ground. Townsville lucerne (*Stylosanthes sundaica*) has also proved of considerable benefit.

Because of the uneven distribution of the rainfall during the year it has been found necessary to conserve fodder in the form of silage for use during the dry season. It has been made in the past from crops of maize and sorghum planted for this purpose. During 1960 part of the standing crop of Elephant grass was cut and ensiled. Approximately 900 tons of Elephant grass silage is available for feeding out should is be necessary.

Diseases.

Screw Worm Fly (Chrysomyia bezziana).

This fly is endemic to the area. It necessitates prophylactic insecticide treatments every four to six weeks and inspection of all animals at least every two days. Station procedures such as branding and castration must be carried out when the incidence of the fly is low or has been reduced by spraying. The treated animals must be kept under close supervision until the wounds have healed to the stage where they are no longer attractive to the fly. It is important also that each calf, as it is dropped, be treated to prevent navel strike. This procedure becomes part of the experimental management described later.

Cattle Tick (Boophilus microplus).

This parasite is also present. Eradication programmes have been attempted but re-infection has occurred due primarily to the presence of deer and wild horses which are proving difficult to eliminate and which act as hosts for the cattle tick. The tick is controlled by treatment of all stock in the area every three weeks.

Bovine Tuberculosis.

The herd is regularly tested and no reactors have been found.

Bovine Brucellosis.

The breeding herd is regularly tested and the beef herd has shown clean tests.

Internal Parasites.

Parasites are not a severe problem but all calves are treated with "Neguvon" at weaning.

Plant Poisonings.

Cycas circinalis, the common fern tree, causes a condition of incoordination in the hind quarters of cattle. This incoordination limits the grazing habits of the animals, but cows can calve normally provided they are maintained on reasonable pasture. The plant is being eradicated from all grazing areas.

Animals.

The breeds of cattle in this project are the European breeds, Angus and Polled Shorthorn and the Zebu breed, Brahman. The major breeding programme is based upon the Brahman/Angus cross while the small number of polled Shorthorn breeders have been used as a basis upon which to develop a line of grade Brahman animals by continual back crossing to Brahman bulls.

The Brahman animals available are animals imported from J. D. Hudgins, Texas, U.S.A., and their progeny. All carry a high proportion of "Manso" blood as is shown by the pedigree of one of the imported bulls "Vela de Manso" shown in Figure 2.

The Department imported three bulls and three heifers from U.S.A. in 1954. One of the imported bulls has since died and an unfortunate distribution of sexes among the progeny resulted in only two bulls out of ten calves up to the 1959 calving. This has severely limited the use of the Brahman bulls in the cross-breeding programme.

The Angus breeders have been imported from herds in Queensland and New South Wales. They number 460 but many are approaching the time when they are beyond economical breeding age. Previous experience in the breeding of the purebred Angus has shown the difficulty of producing European breeds in the environment. Locally bred animals have failed to thrive and have shown a considerable reduction in size compared with their imported mothers. Heifers in particular fail to approach the size and conformation of the imported cows. The greatest setback seems to be at weaning when the animal is thrust onto its own resources. Weaner unthrift is a considerable problem with the weaners' growth remaining static for up to 12 months. In the limited cross-breeding undertaken to date, this unthrift does not occur with the F_1 crossbred and in several cases these animals have weaned themselves when the mother's milk

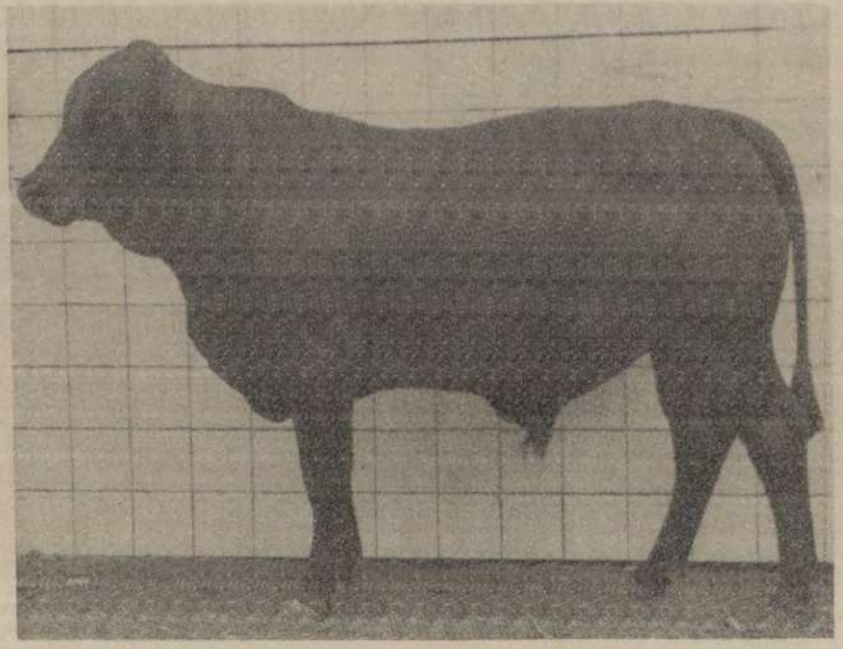
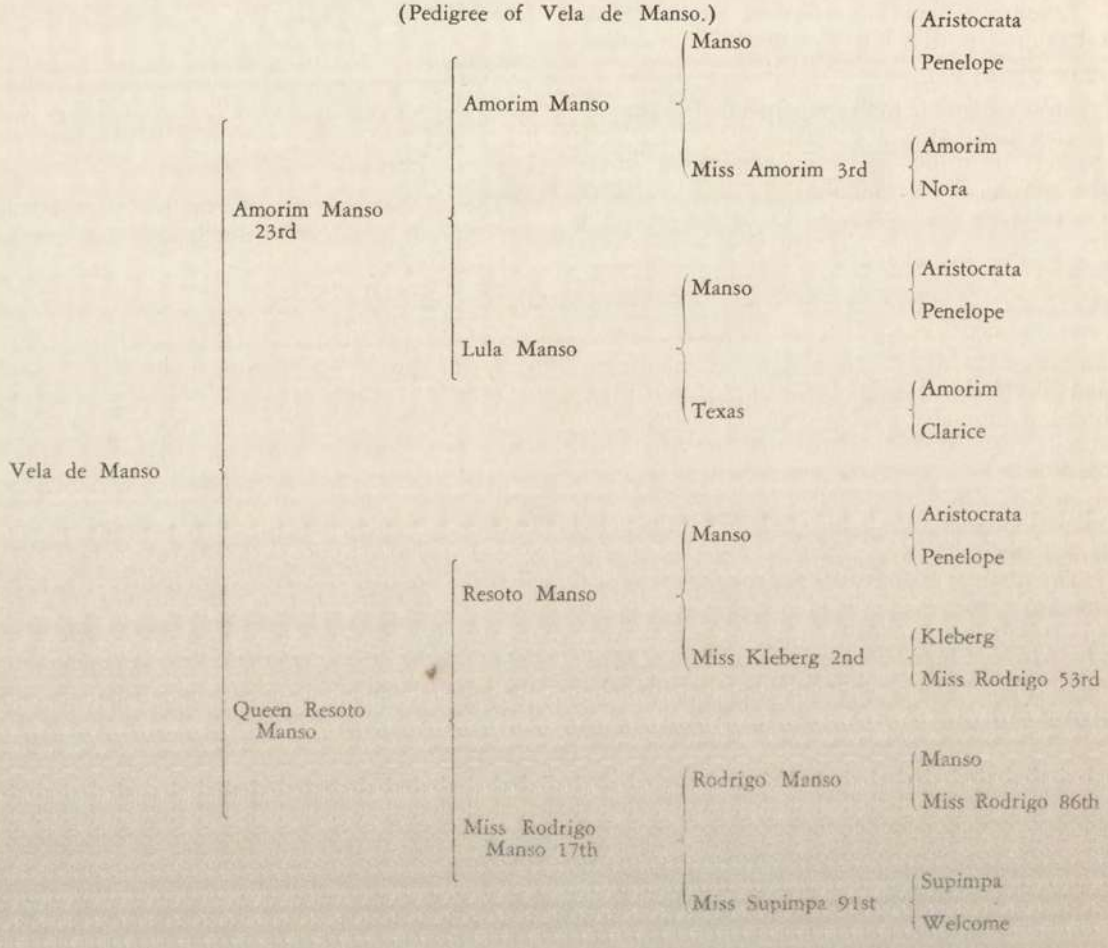


Plate III.—Half Brahman half Angus Bull. Twelve months of age.

Figure 2.

(Pedigree of Vela de Manso.)



production has decreased. Even under such early weaning they have shown no setback corresponding to that suffered by the purebreds.

As a result of these preliminary observations the present breeding programme was formulated to introduce Brahman blood into the whole herd as soon as possible. The programme is handicapped by the present shortage of Brahman and Brahman cross bulls. The present sires are three Brahman bulls and four F_1 Brahman/Angus bulls. The latter are only two years old.

In the first few years of the project the aim will not be to attempt breeding towards a type of animal with a fixed percentage of Brahman blood but rather to produce a herd of varying percentages which can be compared under existing environmental conditions. It will also be essential, at least in the early years, to continue to produce some purebred Angus animals. There will, therefore, be opportunities to compare critically the performance of these against the crossbreds.

Future policy in determining the final aim of the project will be based upon the observations made upon the performance of the animals within the various percentage groups. It will then be possible to select towards the type which shows optimum performance under the local environment.

In conjunction with this major programme a subsidiary breeding programme based upon the 30 head of polled Shorthorn cows is being carried out. These animals are mated to Brahman bulls and their progeny are continually

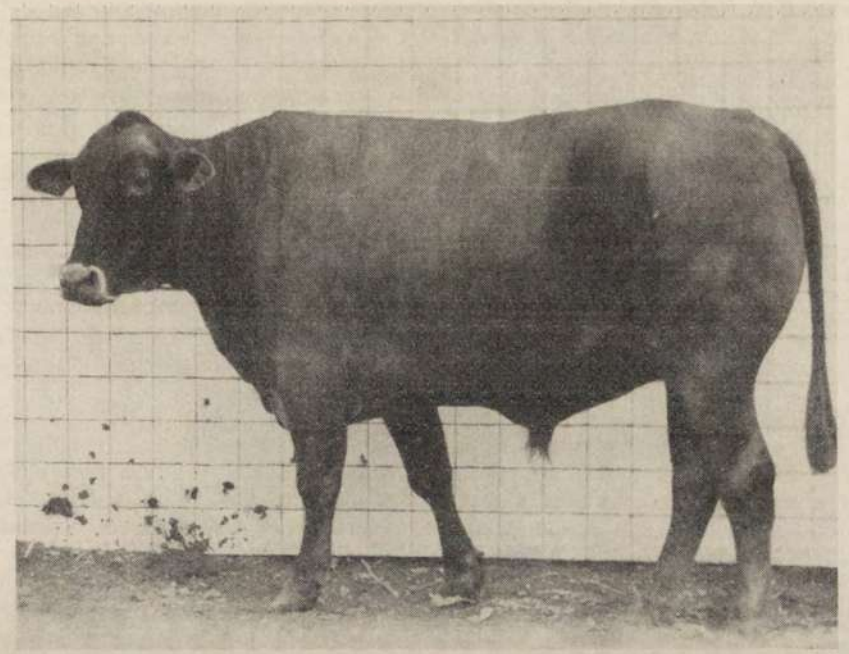


Plate IV.—Half Brahman half Shorthorn Bullock. Four and one half years of age, live weight 1,700 lb.

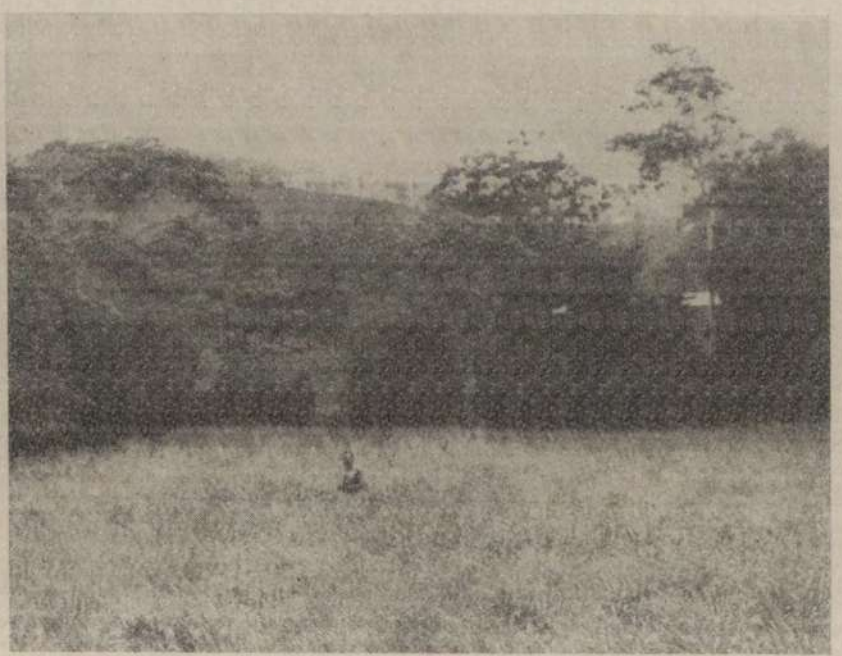


Plate V.—A mixed Guinea Grass—Centrosema Pasture.

back crossed to Brahmans. The grading up process is being carried out to produce a herd of high-grade Brahmans which will be available for distribution. Bulls from this herd will be sold as they become available and their percentage of Brahman blood will be indicated at the time of sale. All females born into the herd will be retained until the herd is of sufficient size to allow for some distribution.

Management.

Mating.

Prior to the establishment of the present breeding programme, cows had been mated throughout the year resulting in an extensively distributed calving. One of the reasons for this type of mating was the failure of the Angus bulls to cover the cows in a restricted mating period even when used at a density of five per cent. With the introduction of the more active Brahman and Brahman/Angus bulls an attempt is being made to close the mating period down. In 1960 the mating was carried out in two parts:—

1. The primary mating commenced on 1st April and was carried through for three months until 30th June. The bulls were then removed and rested for one month. During that month they were maintained on special pasture in an attempt to improve their condition.
2. The secondary mating commenced on 1st August following a pregnancy diagnosis on the herd. This mating was carried through until 30th September at which stage the bulls were removed and the cows which had not conceived at either of these matings will be carried through until the 1961 season or culled from the herd.

As a result of this programme the calving will extend over a period of six months in two definite groups. In 1961 the period will be closed down to five months and it is hoped that by 1964 the mating and calving will be further restricted.

In both the primary and secondary matings the cows were divided into two families:—

Family 1:—Those mated to Brahman bulls. In the primary mating 165 Angus breeders were included in this family as well as a small number of Brahman-Angus, Brahman-Shorthorn and Shorthorn cows. In the secondary mating 140 Angus were in this family with some Brahman-Angus, Brahman-Shorthorn and Shorthorn cows.

Family 2:—Those mated to F_1 Braham-Angus bulls. In the primary mating 97 Angus breeders were mated to four F_1 Brahman-Angus bulls. In the secondary mating there were 85 Angus breeders.

Both families were mated on an extensive system with the cows as one group. There was no attempt to arrange individual sire mating groups.

This system has some advantages under the existing circumstances of a shortage of Brahman and Brahman cross bulls. It has allowed the extended use of the present bulls over a greater number of cows and so brings closer the aim of the introduction of Brahman blood into the whole herd. By the time the mating has been closed down to four months there will be four more Brahman bulls and several more F_1 Brahman/Angus bulls available.

Calving.

A pregnancy diagnosis will be made on the secondary mating group at about six months gestation so that the pregnant cows can be given special treatment. As calving approaches the pregnant cows will be moved to calving paddocks which will enable the close supervision of calving. Stockmen will patrol the calving paddocks and each calf will be ear-tagged and recorded as soon after birth as possible. This duty merges well with the prophylactic treatment of the navel of each calf to prevent screw fly strike.

The cows will be broken up into the families mentioned above so that the parentage of the calves is known. This fact, as well as the sex of the calf, will be recorded at birth against the ear tag number. As cows calve they and their calves will be moved out of the calving paddocks into a "wet" cow paddock. The calving will begin in January and the bulls will be returned to this "wet" cow mob in separate families in April.

Branding and Marking.

Under the present mating programme this must necessarily be carried out in two stages. Calves are branded and marked at an average age of three months. Cross-bred calves, as well as being branded with a registered and age

Plate VI.—**Purebred European breeds and crossbred Brahman cattle on heavily grazed Elephant Grass pasture.**
(The crossbred cattle are grazing while others rest under shade.)

brand are given a distinctive brand on the near thigh of a numeral between 1 and 8 representing eighths of Brahman blood. This figure will provide a ready field identification of percentage of Brahman blood in the animal.

Pastures.

The basic pastures were mentioned above and the distinct wet and dry seasons dictate the pasture management of "Moitaka". During the wet season the herd is maintained on the natural pasture. This is the period of active growth of these pastures and they are utilized as fully as possible before the change in season dries them off. Although it is not the policy to burn these pastures, fires occur almost annually as a result of the hunting methods of the local people. This does provide a fresh growth following the first rains but the burning is, on the whole, badly timed and is a considerable problem. Every effort is made to graze heavily this pasture so that there is insufficient bulk to feed a severe fire.

During the dry season the cattle are shifted on to areas of cleared rain forest which are planted down to improve pasture. Management of these pastures to keep them in a condition suitable for the cattle is important. The excessive growth must be removed about six to eight weeks before grazing. In some instances this excessive growth is utilized in the preparation of silage and as a green feed supplement for dairy cows and horses. This management, therefore, must include the subdivision of these areas into small paddocks that can be intensively grazed for a short time and then rested. Under such conditions the Elephant grass-legume mixture will carry better than one beast to the acre.

Discussion.

In our attempt to produce cattle adapted to the hot lowland environment of the Territory of Papua and New Guinea we have been guided by experience in this field in other tropical and sub-tropical countries. In the United States of America most of the cross-breeding for adapted types was carried out by commercial breeders. The three most advanced groups of crossbreds in America are Santa Gertrudis (Rhoad 1949), Beefmaster (Joyce 1955) and Brangus. These types are stable crossbreds of Zebu and European breeds.

Controlled crossbreeding has been commenced in the Union of South Africa on experiment stations operated by the Government. The aim on these stations is to establish a type of cattle well adapted for production within the Union. The major breeding experiments consist of the breeding of Afrikaners, Shorthorns and Herefords as such, and the crossbreeding of Afrikaners on Shorthorns and Herefords with backcrossing to produce animals of varying percentage of Afrikaner blood. After 20 years, these experiments resulted in the development of the Bonsmara breed which is five-eighths Afrikaner and three-sixteenths Shorthorn and three-sixteenths Hereford and shows outstanding adaption to the local conditions (Joubert 1957).

Crossbreeding with dairy type cattle has been carried out with success in several different tropical countries. In Jamaica a new breed called the Jamaica Hope, a relatively fixed crossbred of Jersey and Sahiwal breeds with 75 per cent. Jersey, has been developed (Lecky 1949; Department of Agriculture, Jamaica, 1952). Extensive work has been carried out on military farms in India but much is not recorded. Littlewood (1933), provides details of Ayrshire-Sindhi cross-breeding in Madras State, and Stonaker, Agarwala and Sundaresan (1952) record the production characteristics of Sindhi crossbreds. Work is under way at Beltsville in the United States (Fohrman, McDowell, Sykes and Lee, 1951) with Sindhi cattle, and in Australia (Rendel, 1959) with Sindhi and Sahiwal cattle.

The first large consignment of Zebu cattle imported into Australia for crossbreeding with European breeds was brought in under the direction of the Council for Scientific and Industrial Research in 1933 (Kelley 1932). These animals were used in a co-operative experiment on Stations in North Queensland which were owned by private interests (Kelley 1943). The success of the crossbreeding from this importation prompted private importations of Brahmans after World War II as well as the importation for C.S.I.R.O. in which were included the animals at present in Papua and New Guinea. In this shipment were the Brahmans and Afrikaners in use on the National Cattle Breeding Station "Belmont", where the C.S.I.R.O. is carrying out research to investigate, from a genetic point of view, the physiology of adaption of cattle to a tropical environment (Kennedy and Turner 1959).

The environments of some of the areas in which these experiments have been carried out are compared with that of Port Moresby in the climographs in Figure 1.

Climographs were originally devised by Ball (1910) and have been applied to cattle breeding and development by Wright (1946). They are a convenient method of diagrammatically indicating the climate of an area to be studied and are constructed by plotting as a single graph the mean monthly temperature against the mean monthly relative humidity. The shape and position of the climograph gives a composite picture of the environment. Climographs can be used in predicting the adaptability of breeds of cattle to new environments. Where they show, by their close agreement, homoclimatic environments, the cattle from these environments are equivalent types. Similarly it may be assumed that the introduction of cattle into a new environment will show most success where the climograph of this new environment and of the original home of the cattle coincide.

The areas chosen for the climographs in Figure 1 are areas where crossbreeding for adapted cattle has been carried out.

The fairly close correlation of the climographs of Rockhampton (Queensland) and San Antonio (Texas) and of Port Moresby (Papua) and Port of Spain (Trinidad) indicate that the same type of cattle would be suitable to each corresponding environment. It is interesting to note that the climographs for Port Moresby (Papua) and Port of Spain (Trinidad) coincide closely with those of the home environments of the dwarf breeds of Indian and African Zebus. These "dwarfing" areas show the characteristics of high levels of temperature and humidity with a complete lack of any marked seasonal variation in climate. This type of climate provides a severe challenge to the production of high producing cattle.

The home environment of the Brahman animals used in this experiment shows a climograph that overlaps that of Port Moresby but for three months of the year the temperature is below the critical 70 degrees F. and for one month the relative humidity drops below 55 per cent.

The measurement of performance within the environment being used is body weight gain. Preliminary observations on purebred and F_1 crossbred types are under way. Critical

observations on the weight gain of various percentage groups will depend upon the establishment of significant numbers of these animals. Although critical observations are essential the present obvious advantage of the crossbred animal is appreciated by most of the cattle producers of the lowlands of the Territory. The demand for part Brahman animals at present exceeds the supply but the breeding programme that is now in operation should provide an adequate source of Brahman blood for the cattle herds of Papua and New Guinea.

ACKNOWLEDGEMENTS.

Thanks are due to Dr. J. M. Rendel, Chief, Division of Animal Genetics, C.S.I.R.O., Mr. H. G. Turner and Mr. J. F. Kennedy of this Division at the National Cattle Breeding Station, "Belmont", Rockhampton, for their advice and assistance in the establishment of the breeding programme, and to Mr. F. C. Henderson, Director, Department of Agriculture, Stock and Fisheries, for his encouragement and permission to publish this paper.

REFERENCES.

BALL, J. (1910). *Cairo sci. J.* 4 : 280 cited by Wright (1954).

BONSMA, J. C., VAN MARLE, J., and HOFMEYR, J. H. (1953). Climatological research on Animal Husbandry and its significance in the development of beef cattle production in Colonial Territories. *Emp. J. exp. Agric.* 21 : 154 - 175.

Department of Agriculture, Jamaica (1952). *The Jamaica Hope—a new breed of Dairy Cattle.* Kingston : Government Printer. 22 pp.

FOHRMAN, M. H., MCDOWELL, R. E., SYKES, J. F., and LEE, D. H. K. (1951). Progress report of the Red Sindhi cross-breeding experiment at Beltsville, Md. *U.S. Bureau Dairy Ind. Bull. No.* 128. 6 pp.

JACOBS, W. S. (1949). The American Brahman. *Amer. Brahman J.* 3 (11): 15, 17, 38.

JOUBERT, D. M. (1954). Breeding for Beef in Tropical and Sub-Tropical Climates—with special reference to the continent of Africa. *Colon. Pl. Anim. Prod.* 4 : 1 - 13.

JOUBERT, D. M. (1957). The Bonsmara breed of Cattle in South Africa. *Agric. Rev. (Lond.)* 2 (12): 15 - 17.

JOYCE, E. B. (1955). Tom Lasseter and has Beefmasters. *Pastoral Rev.* 65 : 720 - 722.

KELLEY, R. B. (1932). Zebu (Brahman) cross cattle and their possibilities in North Australia *C.S.I.R.* Pamp. 27.

KELLEY, R. B. (1943). Zebu cross cattle in Northern Australia : an Ecological Experiment. *C.S.I.R.* Pamp. 172.

KELLEY, R. B. (1959). *Native and Adapted Cattle.* Sydney : Angus and Robertson. 275 pp.

KENNEDY, J. F., TURNER, H. G. (1959). A Project on Genetics of Adaptation in Cattle—Aims and Methods. *C.S.I.R.O. Div. Anim. Health & Prod.,* Rep. No. 8 (Series SW3): 26 pp.

LECKY, T. P. (1949). The Hope Jerseys. A Study of the breeding of Jersey Cattle at Hope Agricultural Station, Jamaica. *Dep. Agric. Jamaica Bull.* No. 42: 66 pp.

LITTLEWOOD, R. W. (1933). Cross-breeding for milk. *Indian J. vet. Sci.* 3: 325 - 337.

RENDEL, J. M. (1959). Division of Animal Genetics. C. S. I. R. O. Sydney. *Personal communication.* December, 1959.

RHOAD, A. O. (1949). The Santa Gertrudis Breed. The genesis and genetics of a new breed of beef cattle. *J. Hered.* 40: 115 - 126.

STONAKER, H. H., AGARWALA, O. P. and SUNDARESAN, D. (1953). Production characteristics of crossbred, backcross and purebred Red Sindhi cattle in the Gangetic plains region. *J. dairy Sci.* 36 : 678 - 687.

WRIGHT, N. C. (1946). Report on the development of cattle breeding and milk production in Ceylon. *Ceylon State Council, Sessional Paper* XX. 76 pp.

WRIGHT, N. C. (1954). *Progress in Physiology of Farm Animals.* ed. J. Hammond. London: Butterworth. Vol. 1, pp. 191 - 249.

CASSIA MOSAIC, A PLANT VIRUS OF CASSIA SPP. IN NEW GUINEA

By R. J. van Velsen *

SUMMARY.

Experimental data on the host range and physical properties are recorded of cassia mosaic, a previously undescribed virus disease of Cassia occidentalis *L. in New Guinea. The virus is readily transmissible to* Cassia occidentalis, C. tora *L. and* Crotalaria anagyroides *H.B. et K. The dilution end point lies between* 1:1,000 *and* 1:2,000, *thermal inactivation point between* 60 *and* 62 *degrees C. for an exposure of ten minutes and longevity* in vitro *less than* 168 *hours.*

To date no insect vector has been located and the virus is not seed transmitted in Cassia occidentalis *nor* C. tora.

SHAW (unpublished) first recorded mosaic symptons on *Cassia* spp. in Papua and New Guinea in 1956. In 1959, a mosaic disease was located on *Cassia tora* and *C. occidentalis* growing wild at Ulaveo Plantation at Kokopo on New Britain. Diseased cassia plants have since been located widespread on the Gazelle Peninsula and on ornamental cassias growing at Lae and Aiyura on the New Guinea mainland. *Cassia tora* and *C. occidentalis* have been found growing as weeds in coconut plantations and along the roadside throughout the Gazelle Peninsula and, due to the extensive use of leguminous crops in this area both as food source and shade plants for plantation crops, the disease was investigated to determine its identity and host range. The following investigations were carried out at the Lowlands Agricultural Experiment Station at Keravat, New Britain.

INVESTIGATIONS.

Throughout the host range and physical property tests, the sap source was *Cassia occidentalis* growing at Keravat, and the indicator plant used in all tests was *C. occidentalis.*

Host Range Studies.

The test plants were inoculated with sap expressed from ground diseased leaves of *Cassia occidentalis.* The plants were then grown in sterilized forest soil and kept under observation for 28 days. They were then ground up and indicator plants of *C. occidentalis* were inoculated with the sap. The indicator plants were kept under observation for a further 28 days.

The results (Table 1) indicate that cassia mosaic virus has a very limited host range, and does not infect any important leguminous food, shade or cover plants. Although *Crotalaria anagyroides* is used as a temporary shade plant, the disease does not affect the agronomic features of this plant as a shade plant.

Symptoms on Susceptible Plants.

Cassia occidentalis *and* C. tora.

Pronounced mosaic symptoms appeared on leaves seven to ten days after the inoculation of the cotyledons of the test plants (see Plate). The leaves were slightly twisted compared with healthy leaves and as they matured the mosaic symptoms became less pronounced. The mosaic symptoms were systemic.

* Plant Pathologist, Lowlands Agricultural Experiment Station, Keravat.

(Manuscript received 17th April, 1961.)

Table I.—Host range of Cassia mosaic virus.

Test Plant.	Reaction.	Proportion of Plants Infected.
Cassia tora L. (a)	Mosaic	20/20
Cassia occidentalis L. (a)	Mosaic	20/20
Crotalaria anagyroides H. B. & K. (a)	Mosaic	3/20
Centrosema pubescens Benth. (c)	Nil	0/20
Calopogonium mucunoides Desv. (c)	Nil	0/20
Desmodium distortum (Aubl) Macbride (c)	Nil	0/20
Arachis hypogaeo L. (b)	Nil	0/20
Canavalis ensiformis DC. (a)	Nil	0/20
Phaseolus vulgaris L. "Brown Beauty" (a)	Nil	0/20
P. lunatus L. (a)	Nil	0/20
P. mungo L.	Nil	0/20
Vigna sinensis Savi. var. "Xape" (b)	Nil	0/20
V. sinensis var. "Poona Pea" (c)	Nil	0/20
V. sinensis var. "Black Eye" (c)	Nil	0/20
V. sesquepadalis Fruwirth (c)	Nil	0/20
Dolichos lablab L. (c)	Nil	0/20
Stizolobium deeringianum Bort. (c)	Nil	0/20
Vicia faba L. (c)	Nil	0/20
Pisum sativum L. var. "Earlicrop" (b)	Nil	0/20
Crotalaria spectibilis Roth (c)	Nil	0/20
C. mucronata Desv. (c)	Nil	0/20
Trifolium hybridum L. (b)	Nil	0/20
T. repens L. (b)	Nil	0/20
T. subterraneau L. (b)	Nil	0/20
T. pratense L. (b)	Nil	0/20
Medicago sativa L. (b)	Nil	0/20
Nicotiana tabacum L. var. "White Burley" (b)	Nil	0/20
N. glutinosa L. (b)	Nil	0/20
N. rustica L. (b)	Nil	0/20
N. sylvestris Speggazzini and Comes (b)	Nil	0/20
Solanum nigrum L. (b)	Nil	0/20
S. dulcamara L. (b)	Nil	0/20
Lycopersicon esculentum Mill var. "Grosse Lisse"	Nil	0/20
Petunia hybrida Vilm. var. "Rosy Morn" (b)	Nil	0/20
Datura stramonium L. (b)	Nil	0/20
Capsicum annuum L. (c)	Nil	0/20
Physalis floridana Rydt. (b)	Nil	0/20
Cucumis sativus L. (c)	Nil	0/20
Chenopodium amaranticolor Coste et Reyn (b)	Nil	0/20

(a) inoculated when cotyledons present.

(b) inoculated when 6 leaves present.

(c) inoculated when first true leaf present.

Crotalaria anagyroides.

Mosaic symptons appeared 14 to 21 days after inoculation of the cotyledons with infective sap. The leaves were reduced in size compared with healthy leaves and symptoms were persistent and systemic.

Physical Properties.

Dilution end point.

Sap was expressed from mosaic infected leaves of *C. occidentalis* and serially diluted with distilled water. Indicator plants of *C. occidentalis* were then inoculated with sap on a muslin pad with 500 grit carborundum powder. After 28 days observations were recorded (Table II). Results show that the dilution end point lies between 1:1,000 and 1:2,000.

Table II.

Dilution end point of Cassia mosaic virus, using *Cassia occidentalis* as the test plant.

Dilution.	Proportion of Plants Infected.
Undiluted	20/20
1:10	17/20
1:100	9/20
1:1000	2/20
1:2000	0/20
1:3000	0/20
1:4000	0/20
1:5000	0/20

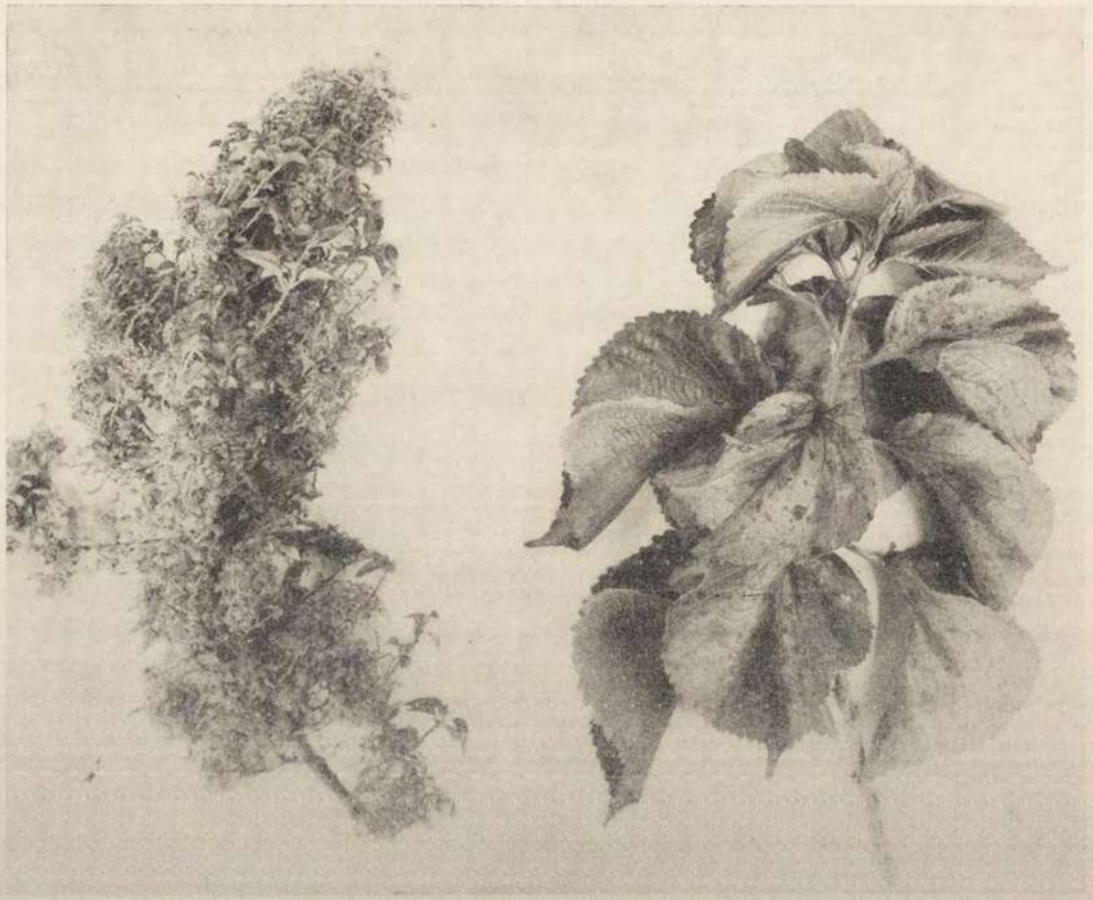


Plate.—Left—"Witches Brooming" on diseased shoot. Right—healthy shoot.
[Photo by A. E. Charles]

Longevity in vitro.

Bulk solution of sap was obtained from mosaic infected leaves of *C. occidentalis* and stored at 1 degree C. Every 24 hours an aliquot of 10 ml. was removed and warmed to room temperature (28 degrees C.) and indicator plants inoculated.

Results (Table III) indicate that the virus is inactivated at 168 hours when stored at 1 degree C.

Thermal Inactivation Point.

Sap was extracted from *C. occidentalis* and 5 ml. was placed in each of 10 thin-walled glass tubes. Each tube was then maintained at a selected temperature for ten minutes. At the end of each period the tube was removed and cooled rapidly by plunging into cold water. Results (Table IV) show that the thermal inactivation point lies between 60 and 62 degrees C. for an exposure of ten minutes.

Table III.

Longevity *in vitro*, of Cassia mosaic virus, using *Cassia occidentalis* as the test plant.

Exposure in Hours.	Proportion of Plants Infected.
0	20/20
24	17/20
48	12/20
72	6/20
96	3/20
120	2/20
144	1/20
168	0/20
196	0/20

Table IV.

Thermal inactivation point of Cassia mosiac virus at an exposure of 10 minutes, using *Cassia occidentalis* as the test plant.

Temperature in degrees Centigrade.	Proportion of Plants Infected.
28	20/20
30	14/20
40	8/20
50	6/20
60	2/20
62	0/20
64	0/20
66	0/20
68	0/20

Attempted Seed Transmission.

One thousand seeds were collected from diseased *C. occidentalis* and *C. tora* plants which had been mechanically inoculated. Of the 948 *C. occidentalis* and 957 *C. tora* seeds which germinated none showed evidence of seed transmission.

Insect Transmission.

No evidence has yet been obtained of the virus being insect transmitted, although widespread incidence and rapid dissemination of the disease in the field suggests that it is.

DISCUSSION.

The following plant viruses have been reported to cause mosaic symptoms on *Cassia* spp : Black eye cowpea mosaic (Anderson, 1958), bean yellow mosaic (Corbett, 1957) and pea mosaic (Norris, 1943).

From a comparison of the above viruses with cassia mosaic virus (Table V), it is evident that the virus investigated has not been recorded previously, nor is it related to any of the legume virus diseases investigated at Keravat. The virus is thus considered to be a new record and the name cassia mosaic virus is suggested.

ACKNOWLEDGEMENTS.

The author acknowledges the identification of *Cassia tora* and *C. occidentalis* by the Division of Botany, Department of Forests, Lae, and that the photograph was taken by Mr. A. E. Charles.

REFERENCES

ANDERSON, C. W. (1958). Report of the Plant Pathologist. *Annu. Rep. agric. expt. Sta. Florida* 1957. pp. 125-131.

CORBETT, M. K. (1957). Local lesions and cross protection studies with bean yellow mosaic virus. *Phytopathology* 47, 573-574.

NORRIS, D. O. (1943). Pea mosaic on *Lupinus varius* L. and other species in Western Australia. *C.S.I.R. Bull.* 170 27 pp.

Table V.

A comparison of Cassia mosaic (van Velsen) Cowpea mosaic (Anderson, 1957), bean yellow mosaic (Corbett, 1957) and pea mosaic (Norris, 1943).

Hosts.	Cassia Mosaic.	Cowpea Mosaic Cucumber Mosaic Str.	Bean Yellow Mosaic.	Pea Mosaic.
Phaseolus vulgaris	—	+	+	—
Pisum sativum	—	+	+	+
Vigna sinensis	—	+	NR	NR
Cassia tora	+	+	+	NR
Cassia occidentalis	+	NR	NR	NR
Cassia sp.	+	NR	NR	+
Nicotiana tabacum	—	+	—	—
N. glutinosa	—	+	—	—
Lycopersicon esculentum	—	NR	—	—
Datura stramonium	—	NR	—	—
Cucumis sativus	—	+	—	—
Physical properties				
Dilution end Point	1:2000	10^{-2}—10^{-3}	1:300—10^{-3}	1:5000
Thermal inactivation Point	60°—62°C.	NR	56°—60°C.	60°—64°C.
Longevity *in vitro*	144—168 hrs.	6—24 hrs.	24—32 hrs.	48—72 hrs.
Insect Vectors—				
Aphis fabae	NR	NR	+	NR
Macrosiphum pisi	NR	NR	+	+
M. gei	NR	NR	+	NR
Myzus persicae	NR	NR	NR	+
Aphis rumicis	NR	NR	NR	+

NR = No results. + = Transmission. — = No transmission.

NOTES

LITTLE LEAF VIRUS ON ACALYPHA WILKESIANA.

IN October, 1960, seven plants *Acalypha wilkesiana* Muell. Arg. were located at the Agricultural Extension Centre, Talliligap, New Britain, showing a marked witches brooming of the branches and severe little leaf condition. Diseased shoots were established in the pathology laboratory at Keravat and graftings made onto disease-free root stocks. Of the ten plants grafted, all developed a severe witches brooming with little leaf symptoms. The symptoms appeared nine weeks after grafting and were persistent. There was no evidence of insect, fungal or bacterial infection and it is considered that a virus is responsible. No transmission was achieved using *Bemesia tabaci* which were found on the diseased plants, nor mealy bugs. The virus could not be transmitted by mechanical inoculation and it is considered that the method of transmission in the field is through the use of diseased cuttings taken inadvertantly from a plant which is infected, but not showing marked symptoms. A plant may not show visible signs of infection for several months and then only in a mild form such as vein clearing with a shortening of the internodes.

The symptoms on the diseased plants are a vein clearing of the secondary veins followed by shortening of the internodes giving the branch a typical witches broom appearance. The leaves on the infected shoots are markedly reduced in size (Plate I).

This disease appears to be of no economic importance, but it is the first record of a virus disease of *Acalypha wilkesiana.*

R. J. VAN VELSEN.

(Manuscript received 11th April, 1961.)

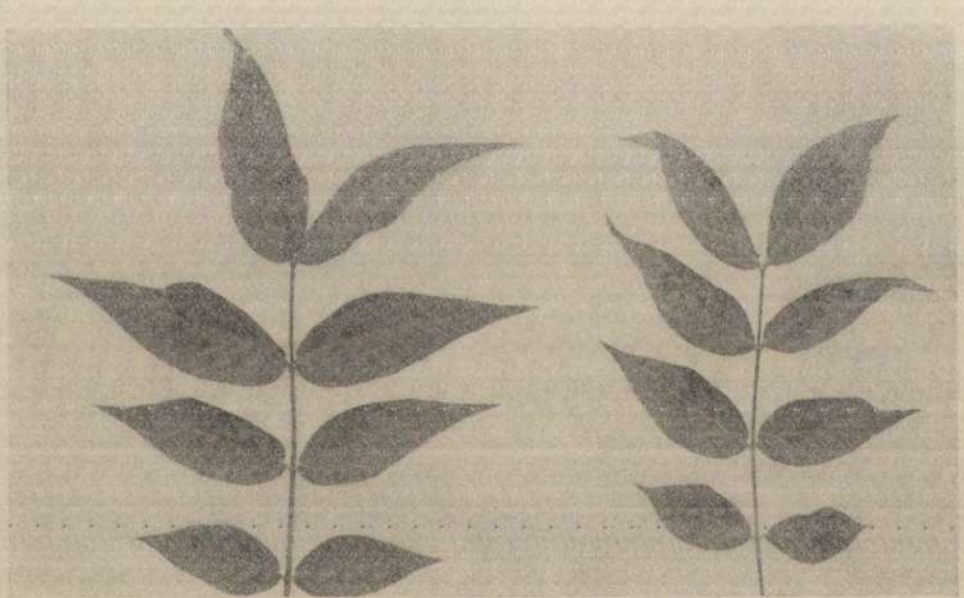


Plate I.—Little leaf virus of *Acalypha wilkesiana.*
(Diseased shoots on right, healthy on left.)

WITCHES BROOM ON PIGEON PEA INDUCED BY MEALY BUG INFESTATIONS.

In January, 1961, 35 out of 56 pigeon pea plants (*Cajanus cajan* Millsp.) in a small plot being grown in the experimental food crop garden at the Lowlands Agricultural Experiment Station, Keravat, New Britain, showed marked witches broom symptoms (Plate II) of the lateral shoots. Each shoot was heavily infested with mealy bugs [*Planococcus citri* (Risso)]† in all stages of development. The plants were thoroughly sprayed with malathion plus wetting agents which eliminated the mealy bugs. Six weeks after spraying, all the plants appeared quite healthy. Buds from abnormal shoots were grafted onto healthy pigeon pea seedlings and of the thirty plants grafted, none developed witches broom shoots.

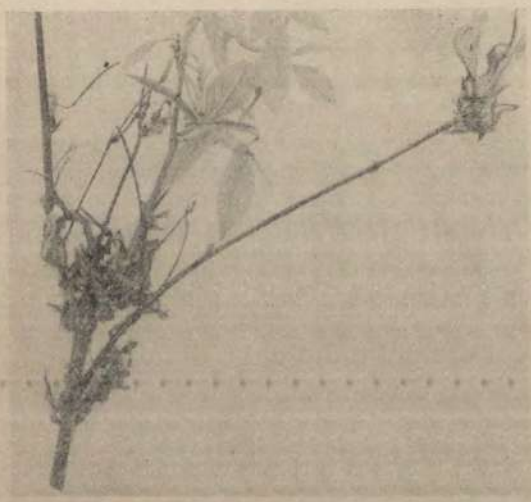


Plate II.—Witches Brooming of lateral shoots on *Cajanus cajan*.
(Induced by infestations of mealy bugs.)

In the glass house, 20 pigeon pea seedlings were raised. Mealy bugs were collected from stock colonies in the glass house and released onto the seedlings when 10 weeks old. The terminal shoots were removed to induce the development of laterals. After 12 weeks, the lateral shoots had developed the typical witches broom symptoms as observed in the field. Spraying was carried out as in the field trial and all the test plants recovered.

Thus it has been concluded that the witches brooming on *Cajanus cajan* observed at Keravat is induced by heavy infestations of mealy bug [*Planococcus citri* (Risso)].

R. J. VAN VELSON.

(Manuscript received 5th September, 1961.)

† The insect identification was made by the Commonwealth Institute of Entomology.

TWO ANIMAL PARASITES PREVIOUSLY UNRECORDED IN NEW GUINEA.

TWO animal parasites, previously unrecorded in New Guinea were recently identified at Lae. They are *Gongylonema ingluvicola* and *Notoedres cati.*

Gongylonema ingluvicola.

A few specimens of this nematode were found in a mature fowl during a routine post-mortem examination.

G. ingluvicola is found in small burrows in the mucous membrane of the crop of fowls, turkeys and quail. The worm is characterized by a zone of shieldlike markings on the anterior end of the body. Mature male worms measure 1.7-2.0 cm long and mature females 3.2-5.5 cm long.

The life cycle is uncertain but it is thought to involve cockroaches and possibly some species of beetles as intermediate hosts.

The only damage these worms cause are local lesions in the form of burrows in the mucosa of the crop.

It is unlikely that infestation with *G. ingluvicola* alone would cause any ill effects in fowls. Their presence, however, indicates that flock hygiene is faulty and that heavy infestations with other parasites likely. The fowl in which this parasite was identified at Lae was also infected with *Amaebotaenia sphenoides* (a tapeworm), *Capillaria* sp. and *Oxyspirura mansoni* (eye worm), despite treatment of the flock with piperazine.

Notoedres cati.

This parasite was responsible for a severe case of mange in a European owned cat.

N. cati is a small mite which closely resembles *Sarcoptes scabei* except for the dorsal position of the anus.

The mite causes a disease known as Notoedric mange, usually seen in cats, but occasionally in pups. In Notoedric mange, thick crusts are seen on the edges of the ears, between the eyes, on the head, neck, paws and tail. There is little irritation, but the animal is very depressed and may even die.

The mites are usually plentiful and easily found when scrapings from affected areas are examined microscopically.

Weekly washing with Tetmosal (Tetra-ethyl-thurium monosuphide) 5 per cent. in soap or application of Gammexane (1 per cent.) in liquid paraffin every four days generally cures the condition.

T. L. W. ROTHWELL.

(Manuscript received 10th May, 1961.)

PEROSIS IN DUCKLINGS.

PEROSIS or slipped tendon is a condition in poultry due to a deficiency of manganese. This element is thought to be required in greater quantities when there is a high calcium and phosphorus intake. A deficiency of choline can also predispose to perosis.

It has been recorded previously in Papua in turkeys but does not appear to be common. There is usually an adequate amount of manganese present in the soil so that if birds are allowed free range they should not suffer from any manganese deficiency.

The outbreak under consideration occurred in a backyard flock of 30 ducklings at Boroko, Port Moresby. The birds were between six and eight weeks old and were locally bred. They were housed in a run with adequate shade and suitable watering facilities. Sawdust, changed once a fortnight, was used on the ground. Free range was not permitted. Diet consisted of green leaf scraps from one of the local freezing companies and imported poultry mash. Six birds had died over a period of four to five days when one was brought in for examination. Its gait showed the typical "spraddle legs" seen in perosis of the tibio-tarsal joint. The affected joint was enlarged and flattened and post-mortem examination revealed that the Achilles tendon had slipped from its groove behind the hock and taken up a position on the medial aspect of the joint, thus completely crippling the leg. The six deaths were probably due to inability to forage. The owner was, therefore, advised to add manganese sulphate to the ration. This, however, proved unobtainable locally so coconut meal, which is rich in manganese, was substituted at the rate of 1 lb. per 3.6 lb of ration.

As expected the affected birds showed an improvement and although further losses occurred in the following week resulting in a total mortality of nearly 50 per cent., no fresh cases developed.

This outbreak was thought to be worth recording because perosis is apparently not common in ducks. This is probably due to the fact that it is usual for ducks to have free range with access to soil.

P. K. ABBOTT.

BOOK REVIEW

Termites Their Recognition and Control.

W. VICTOR HARRIS.

Longmans Green, London. 187 pp., VIII colour plates, 57 black and white plates: 26 figs. and line drawings. 40s. Sterling.

This latest publication in the Tropical Agriculture series maintains the high standards set in earlier volumes and presents a comprehensive coverage of a topic which should interest all those who dwell in tropical and sub-tropical countries.

The book is divided into convenient chapters with plenty of easy-to-find sub-headings. Many aspects of termites are discussed including anatomy, biology, types of damage, methods of control and notes on chemicals used in control. The text is amply backed up with many fine illustrations and a handy bibliography.

The wide scope of the book makes it necessary for the author to deal briefly with some sections and the professional entomologist will find it lacking in many respects. However, it is written mainly for workers interested in pest control and they should find it well suited to their needs.

Termite biology is treated in such a manner as to sustain the reader's interest. Many different species are cited as examples of unusual aspects. Taxonomy of the Isoptera has always been a difficult matter and the author traces the history of the classification without adding anything new to clarify the situation which is outside the scope of this book. He suggests the six family groupings of Mastotermitidae, Kalotermitidae, Termopsidae, Hopotermitidae, Rhinotermitidae, and Termitidae ; the last family containing about four-fifths of the known species as an assembly of divergent forms. Keys to the families are based on characters of the alates, workers and soldiers and hence are easy to follow. A supplementary list of references to be consulted for specific determination is included.

Several theories have been postulated regarding the ecological significance of termites in the soil. Harris attempts to resolve this by collating data from different sources and he dispels the belief that termites contribute greatly to soil fertility. Cases of apparently increased fertility can be attributed to mere redistribution of more fertile subsoil to the less fertile topsoil ; similarly the presence of lime rich termite mounds is, at least, in East Africa a purely local and inconsiderable phenomenon and laterite formation attributed to termites is also probably due to other causes.

In recent years, there has been an increasing awareness of the importance of termites as primary pests of crops. The meagre information available on the topic is discussed under the various crop headings, and reference is made to *Neotermes papua* (Desn.) attacking cacao in New Guinea, but control measures are not given.

Protection of buildings from termites is discussed at considerable length and it should prove to be of great value to those engaged in constructional work. A list of termite resistant timbers and chemicals used in pest control is contained in this section.

The book is well presented in a very readable form and it will be of value to all those interested in protecting their assets from termites which are a real and ever present threat to man's existence in the tropics.

A. CATLEY.

Port Moresby: W. S. Nicholas, Government Printer.—7282/6.62.

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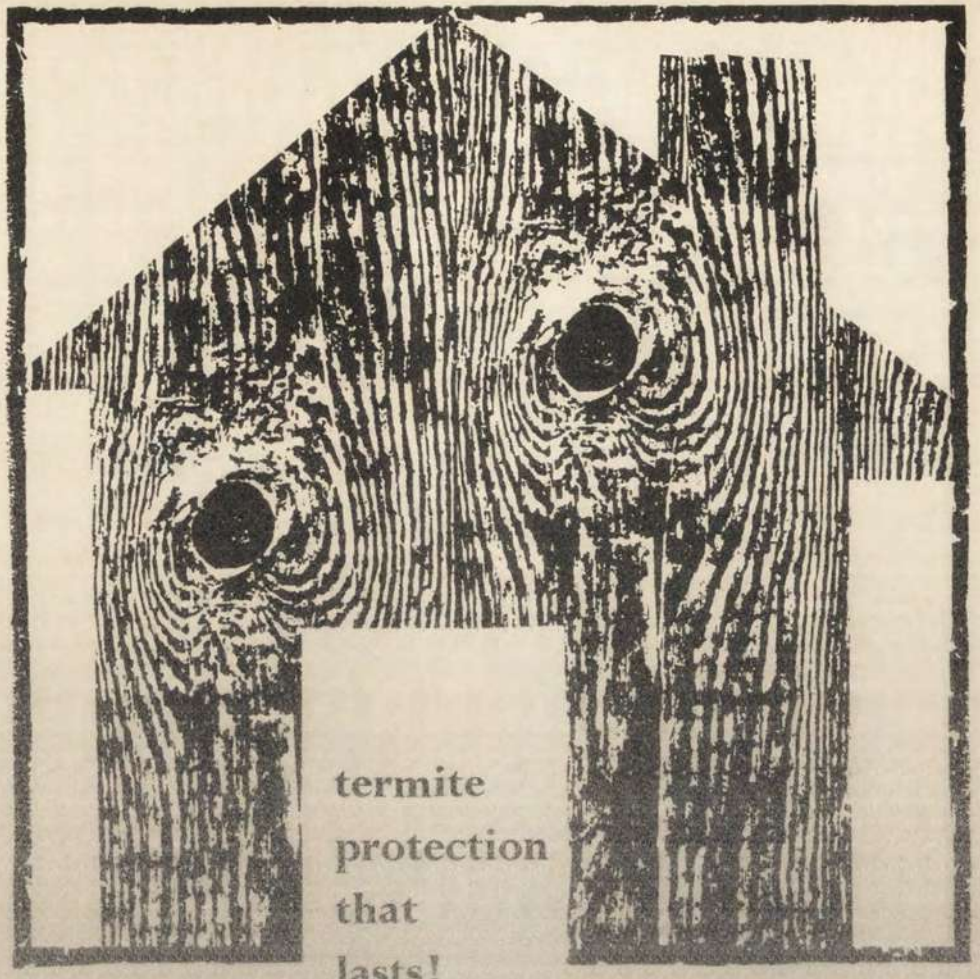

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