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Editorial

This Number

THIS IS THE ELEVENTH INDEPENDENCE DAY NUMBER OF THE "COCONUT Bulletin" and it gives us great pleasure to present before our readers, once again, an outstanding collection of articles by men who can speak authoritatively on the subjects on which they have written.

COCONUT QUARANTINE MAY SEEM A LITTLE REMOTE AND FAR-FETCHED but one has only to read Mr. A. Johnston's article on the subject in this issue to revise one's views. The possibilities of introducing new coconut pests and diseases into areas where they are now unknown through planting material, are so numerous that coconut quarantine measures assume international importance. Not only is there need to prevent existing diseases like cadang-cadang and root-wilt being transmitted to regions which are now free of them but to see that new diseases do not spread to areas already having diseases. This applies to pests also. Hence arises the need for each country concerned to have "an efficient, well-equipped plant quarantine service manned by well trained personnel and backed by suitable legislation"

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EVERYONE KNOWS THAT MANURES AND FERTILIZERS MUST BE APPLIED TO crops to get good harvests and a lot of information is now available regarding the selection of fertilizers, the time and mode of their application and the quantities to be applied. But the availability in recent years of concentrated inorganic and organic fertilizers has led to new investigations regarding their application. Fertilizer placement, as the subject is known, is exhaustively dealt with by Dr. K. M. Pandalai in his article in this issue. Although it may be slightly disappointing to be told that much work has not been done in this field as far as coconut is concerned, one may derive satisfaction from the fact that a start has been made at the Central Coconut Research Station, Kasaragod.

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COCONUT GARDENS, WITH THEIR WIDE INTERSPACES, LEND THEMSELVES admirably to the cultivation of several subsidiary crops. No wise cultivator

(Continued on page 185)

COCONUT QUARANTINE

By
A. JOHNSTON
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IN all parts of the world crop plants are attacked by destructive pests and diseases and the losses caused by them are enormous. To take two examples from India, termites attacking grain crops are estimated to cause a loss of crop worth over $20 million every year; and on coconut the rhinoceros beetle (*Oryctes rhinoceros*) causes so much damage that the amount of crop lost through its depredations represents the produce of nearly 120,000 acres annually.

Many of these pests and diseases are widely distributed so that in almost every area where suitable plants are present for them to attack and where environmental conditions are favourable to their growth and reproduction, there they can be found flourishing, to the detriment of the affected crops. Of the insects feeding on coconut the scale insect *Aspidiotus destructor* comes in this group, being present in almost every country where coconuts are planted. Of the coconut diseases, the grey blight fungus *Pestalotiopsis palmarum* is practically co-extensive with its host plant. There are, on the other hand, many pests and diseases which are more restricted in their geographical distribution. Such organisms may cause serious damage to crops in some areas but they may not yet have spread to other regions where conditions are perfectly suitable for their development and where the crop plants which they attack are to be found. It is against these pests and diseases of limited distribution that action must be taken by governments, by virtue of their plant importation legislation and through the activities of their plant quarantine services, to prevent them from entering so far uninfested countries.

Pests and diseases of restricted distribution

The coconut is similar to other crop plants in that it is subject to attack by many pests and diseases. Some of these, as mentioned above, are known from many countries but others, including most of the more important ones, are still restricted to a limited number of territories. They could, however, given the chance, gain entry to and establish themselves in other coconut-growing areas and cause much loss there. Some of the more important of these coconut pests and diseases of restricted distribution are listed in the accompanying table.

COCONUT PESTS OF LIMITED DISTRIBUTION

PEST	FAMILY	DAMAGE	DISTRIBUTION
Amblypelta cocophaga	Coreidae	Sucking bug causing premature nut fall	British Solomon Islands
Amblypelta lutescens	Coreidae	Sucking bug causing premature nut fall	Papua-New Guinea
Aphelenchoides cocophilus	Aphelenchidae	Nematode causing red ring	Panama, Venezuela, West Indies
Artona catoxantha	Zygaenidae	Leaf-eating caterpillar	Burma, Fiji, Indonesia, Malaya, North Borneo, Philippines, Thailand
Brontispa longissima	Chrysomelidae	Beetles and larvae damage young palms	Indonesia and Pacific Islands to Tahiti
Graeffia crouani	Phasmidae	Stick insect feeding on leaves	Pacific Islands
Nephantis serinopa	Pyralidae	Leaf-eating caterpillar	Burma, Ceylon, India, Pakistan

PEST	FAMILY	DAMAGE	DISTRIBUTION
Oryctes monoceros	Scarabaeidae	Coconut beetle	Africa, Arabia, Madagascar, Seychelles
Oryctes rhinoceros	Scarabaeidae	Rhinoceros beetle	South East Asia and some Pacific Islands
Pachymerus nucleorum	Bruchidae	Nut borer	Brazil, Guiana, Paraguay
Pseudotheraptus wayi	Coreidae	Sucking bug causing premature nut fall	Kenya, Tanganyika, Zanzibar
Rhynchophorus ferrugineus	Curculionidae	Palm weevil, boring in crown and trunk	Indo-Malaysia & Melanesia
Setora nitens	Limacodidae	Nettle caterpillar, eating leaves	Indonesia, Malaya, North Bornea, Vietnam
Tirathaba rufivena	Pyralidae	Spike moth	British Solomon Islands, Indonesia, Malaya, New Caledonia, Papua-New Guinea, Thailand

COCONUT DISEASES OF LIMITED DISTRIBUTION

DISEASE	CAUSE	DISTRIBUTION
Cadang-cadang	? Virus	Philippines
Kaincope	Unknown	Ghana, Togo
Lethal yellowing	? Virus	Bahamas, Cayman Islands, Cuba, Haiti, Jamaica, U.S.A.
Root (wilt)	Virus and possibly other factors	South India
Threadblight	*Corticium penicillatum*	Fiji, New Hebrides, Papua-New Guinea

That it is of considerable economic importance that the pests and diseases included in the table (as well as many other less damaging species) should be prevented from reaching unaffected territories may be illustrated by mentioning a few instances of the devastation which some of them have already caused in affected areas.

Cadang - Cadang havoc

In the Philippines the destructive cadang-cadang disease first began to attract notice about 1931, although it may have been present as early as 1914. By 1931 it had infected 25 per cent of the palms in the first affected areas on the small island of San Miguel. By 1936 the disease had reached the mainland of Luzon but until about 1946 spread was comparatively slow. Thereafter, however, extension of the disease became more rapid and by 1953 it was estimated to have destroyed about five and a half million palms. By 1960, in the southern provinces of Luzon it was estimated that ten to thirteen million palms out of a total of sixteen million had become infected by the disease, which is still spreading.

Damage through Kaincope

Kaincope disease has been known in Togo, in Africa, since about 1932. At first it caused little damage and spread only slowly but since 1954 there have been many outbreaks in several localities. By 1958 about 20 per cent of the coconuts in the country had been killed by the disease. In neighbouring Ghana the same disease is known as Cape St. Paul wilt. It was observed in Ghana at about the same time as disease was first noticed in Togo; since then it has spread and by 1957 it was estimated that about 60 per cent of all the palms in the country had become affected.

Destruction by Red ring

Red ring, caused by the nematode *Aphelenchoides cocophilus*, is widespread in the West Indies but has not been found anywhere outside the Caribbean area. The nematodes invade the stem and cause discoloration and wilting of the leaves; attack is nearly always fatal. In Trinidad, one of the islands in which the trouble is of common occurrence, it is calculated that, if the nematode continues its activity at the present level, within a few years the death of large numbers of palms will cause copra production to fall by up to 20 to 25 per cent.

International action proposed

The importance to coconut growing countries of preventing further spread of pests and diseases, particularly the very destructive ones such as those mentioned above, to new territories was recognised by two international bodies which have met during the past two years. One of of these was the FAO Technical Working Party on Coconut Production, Protection and Processing, which held its first meeting in Trivandrum, India, in November-December 1961. At that time it considered the matter during one of its technical sessions and included in its report a resolution outlining measures which governments were urged to take to prevent introduction into their territories of dangerous pests and diseases of coconut. The second of the international bodies was the Plant

Protection Committee for the South East Asia and Pacific Region, meeting in Manila, Philippines in June 1962 for its fourth session. It also gave attention to the matter of coconut quarantine and, as a result of its deliberations, a recommendation on the subject was presented in its report.

The points brought out by these two international meetings, one a world-wide body of coconut experts and the other a group composed of quarantine specialists from the region in which the majority of world coconut production is centred, were similar in content and cover the points enumerated below.

Prohibition of imports from affected areas

1. No coconut planting material whatsoever should be imported from areas in which diseases of obscure origin are known to occur. The Plant Protection Committee for the South East Asia and Pacific Region enumerated the following diseases in this category:

Lethal yellowing (Caribbean area)
Kaincope disease (Ghana, Togo)
Cadang-Cading (Philippines)
Bronze leaf wilt (Caribbean area)
Root (wilt) disease (South India)
Guam coconut disease (Guam)

This total prohibition is considered necessary because of the enormous losses which can be caused by these diseases. Information on their causes and methods of spread is not yet available and, until it is certain that the diseases cannot be disseminated by means of planting material, a total embargo on imports from affected areas is considered essential.

2. A total prohibition of imports of coconut planting material from countries in which red ring (*Aphelenchoides cocophilus*) is known to occur is also recommended. Spread of this disease is known to take place through the planting of infested seed nuts and any importation from affected areas must therefore be regarded as unsafe.

Importations from other areas is permissible but should be subject to certain restrictions, as follows:

Conditions for importing planting material

3. Coconut planting material should be imported only by official services (such as a Department of Agriculture or a Coconut Research Institute) under permit issued by the plant quarantine authorities of the importing country.

4. The usual phytosanitary certificate issued by the appropriate authorities in the country of origin of the seed nuts should bear or be accompanied by an additional declaration to the effect that the nuts came from palms showing no signs of disease. Provision of such a declaration would mean that the palms from which the nuts were obtained had been inspected and would ensure that no unhealthy condition affected these palms.

5. Seednuts should be fumigated, or treated by any other method considered appropriate by the competent authorities of the importing country, to remove the risk of introducing insects. The Coconut Working Party considered that

treatment might be carried out before despatch from the exporting country, with possible retreatment in the importing country. The regional Plant Protection Committee suggested that treatment should be confined to that given in the importing country.

6. Individual consignments of coconuts should be as small as possible, so that plant quarantine inspectors would be able to carry out thorough and detailed examination. When large numbers of nuts must be imported they should be brought in several small lots to make inspection easier.

7. Only ungerminated nuts should be imported, as the danger of pests and diseases being transported and escaping notice is greater on seedlings than on ungerminated nuts. Perianth scales still adhering to the nuts should be removed, as they provide hiding places for insects and other organisms.

8. The imported seed nuts should be grown in quarantine after import. The Regional Plant Protection Committee specified a period of one year and recommended that the nuts should be planted in individual containers, so that any seedlings which might be found to be diseased, together with the medium in which they were planted and their containers, could be destroyed by burning.

Need for efficient quarantine service

It is the opinion of the two bodies which made the above recommendations that, if the measures suggested are carried out, it should be possible to transfer coconut planting material from one country to another with complete safety. It is, however, essential that, if such movement of planting material is to be undertaken, each country concerned must have an efficient, well-equipped plant quarantine service, manned by well-trained personnel and backed by suitable legislation. The meeting of the FAO Technical Working Party on Coconut Production, Protection and Processing felt this to be of such importance that it introduced into its report a short resolution dealing with the point, worded as follows:—

"THE WORKING PARTY

Recognizing the danger of introducing coconut pests and diseases on planting material;

Considering that in some territories plant quarantine organizations are not yet fully effective;

Recommends that Governments of countries exchanging planting material should take all feasible steps to strengthen such organization."

It is to be hoped that all countries will take any necessary action on this resolution so that further spread of dangerous pests and diseases of coconut and other crops may be prevented.

Fertilizer Placement— A Better Farming Procedure

By
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Introduction

DURING the past few decades much evidence has been obtained to help in fulfilling one of the main aims of agricultural research, namely to tell the farmers, how to put the right manure, in the right place and at the right time. Extensive fertilizer experiments carried out in various parts of the world have given significant information on the manurial requirements of crops in the different soil and climatic regions. These have helped in the more efficient use of the fertilizer materials. Proper selection of the fertilizers, use of adequate and economic amounts of these, for use with particular crops as well as the methods and time of their applications have all now been systematised, and all these have contributed to increased agricultural production. The marketing in recent years of concentrated inorganic and organic fertilizer materials have resulted in exploring new methods of applying them to the soil in order to avoid any possible injurious action to the plant root systems, on account of the salt effects of the fertilizers. Such a procedure is necessary due to the certain inherent and special characteristics of the fertilizer materials particularly their movement within the soil. Of the fertilizers in common use, only nitrates and chlorides are readily mobile in the soil. These get washed down with the percolating water usually accompanied by an equivalent amount of calcium ions. Potassium is also freely mobile in sandy soils low in organic matter as they contain no base exchange material capable of holding it. This, however, is not so in clayey soils where potassium ions may be held up rather tightly. It is well known that phosphorus compounds are very sluggish movers, except in the more sandy soils. In order to get maximum effectiveness it can be seen that phosphorus has to be placed in the soil in the zone of root development. Surface applications, unless worked into the soil, do not help to supply the deeper roots with this nutrient. In a way, this immobility of phosphorus is helpful in that the total quantity of this element necessary for a given season can be applied at one time without any chance of its loss by leachage. Potassium and to an even greater extent, nitrogen tend to move from their ones of placement mostly vertically down depending upon the direction of the water movement in the soil instead of laterally. Nutrients supplied in fertilizers do not move laterally appreciably in level fields as has been shown by an experiment of over ninety years' duration in the grass fields at Rothamstead. It is thus necessary that the plant nutrients be applied in zones within the reach of plant roots, but not so close, as to cause the plant any injury. There should be also adequate amounts of all the necessary nutrients in an available form, but not excessive supplies to avoid loss by fixation or leaching. In the case of nitrogen and potassium it is also possible to apply them in split doses thus avoiding leaching losses, the second application being done as a top-dressing, the water movement helping these to reach the plant roots. This property of nitrogenous and potassic fertilizers necessitates careful consideration in the matter of their placement with respect to the seed.

In general, inorganic nitrogen fertilizers are mobile in soil moisture, and surface dressings are washed into the root zone by rain. Being fairly mobile, the potassium fertilizers in the light soils also move to the roots when dissolved in soil water, while on heavy soils potassium combines with colloids and may not move very far and are therefore better placed near the roots. Soluble phosphorus fertilizers in all soils combine with clay colloids or calcium compounds. In order to be effective, therefore, phosphorus fertilizers should also always be placed in the root zone deep in the soil.

These considerations are again important from the point of view of root systems of plants. Crops with poor root systems are less well equipped than those with good root systems to take up fertilizers distributed through the soil. Crops with well developed lateral roots use nutrients in the soil placed between rows while tap rooted plants take nutrients from deep soil zones.

Moisture and drought aspects in relation to manuring

Plants can obtain their main supply of nutrients only from damp soil. Hence it can be seen that if they are to use nutrients added to the soil as a fertilizer during periods of drought, the mobility of these nutrients in the soil is of great importance. The fertilizers are usually put in seed beds and incorporated with all or part of the top few inches of the soil. This position affects root development of a plant, the root system mostly ramifying in the fertilized soil volume. Thus the fertilizer if put in the sub-soil will bring about a greater development of the roots there than if it is all put in the surface soil.

The practice of putting the fertilizer deep, can affect the drought resistance of plants growing in soils where the sub-soil is very poor in the dry years. From a soil, poorly supplied with a particular nutrient, crops are usually found to be able to take up more of this nutrient from a dressing of fertilizer concentrated in the soil near the plant root system than if the same dressing is applied broadcast over the surface soil. This is because of the availability of the fertilizer at the root feeding zone and earlier in the growing season the plants could get their benefit. Indeed, plants have been found to be able to absorb more potassium from a zone containing a high ratio of available potassium to calcium than a low one under calcareous soil conditions. In the case of phosphatic fertilizers this may be due to the slower reversion of available phosphate when concentrated in a restricted zone of the soil than when distributed uniformly throughout the soil. In soils with strong phosphate fixing power it may even be worthwhile to place pellets of phosphate fertilizer under each plant. Now, this way of putting the fertilizer somewhere in the root zone, near to the seed to enhance easier availability, but far enough to prevent injury is known as "placement of fertilizers", and when adopted helps the plant to the best advantage.

Methods of application of fertilizers

An important factor in the more efficient use of fertilizers is the manner of their application to the soil. These must be applied in the correct place in relation to the seed and this is probably as important as applying the right kind and amount of fertilizers. No single fertilizer placement pattern has so far been found that is superior for all crops and under all conditions although it is now well recognised that localized placement in relation to the seed or plant has been most efficient. In this method the fertilizer is placed at the sides of the seed or plant rather than applied broadcast although obviously with hay, orchard and pasture crops, this method of fertilizer application cannot usually be followed.

The two main general methods of applying fertilizers to soils are broadcasting and localised placement. In the former, the fertilizer is spread over the entire soil area to be fertilized. This is usually done immediately before planting the crop, but is also sometimes done before the land is ploughed or while the crop is growing, that is top dressing. With certain commercial fertilizers it has been shown that a given amount may produce a greater effect in increasing crop yields when placed in the soil in narrow bands near the seed than when broadcast. With some other fertilizers and under other conditions however, the two methods may be equally satisfactory, or broadcasting may be preferable. Quite a number of factors, among them the type of soil, the soil management practices, the crop grown, the method of planting and the kind and amount of fertilizer used, determine the results obtained. In all these matters the cost of labour, the availability of the machinery for applying the fertilizer etc. also orientate the choice of the method.

By broadcasting fertilizers at different stages in the cultivation of arable land, dressings may be incorporated deeply with the soil or may be concentrated in some desired position. Some of these methods have interesting advantages over the common practice of surface broadcasting on a prepared seed bed. These can also be done without any special equipment.

The main objective in broadcasting is to distribute the fertilizer evenly and to mix it with 5–10 cm. of the surface soil by subsequent cultivation. This is usually done by hand or by spreaders and in several countries this is the only method adopted extensively. Broadcasting is a satisfactory method when nitrogenous fertilizers are used and where heavy applications are made to maintain a high fertility level for intensive crop production. Localised placement actually means placing the fertilizer either in bands or local areas along the planted row often in a definite space relationship to the seed or plant. This method was in vogue in China even in the seventeenth century where, farmers placed oilcake meal at the side of each hill of sugarcane and beside each row of cotton and tobacco. Planting seeds mixed with manure in open furrows is said to be a common practice in China. American Indian farmers used to put fish in the hills with seeds of maize. Nitrogenous fertilizer is applied in pinches at the base of each pair of cotton plants in Egypt. French farmers used to inject solutions of fertilizers into the soil in fruit tree orchards at the outer perimeter of the branches. Localised placement has been used to considerable advantage in several countries–Australia, Netherlands, East Indies, New Zeland and in the U. K. Considerable research work has been carried out in the States on localised placement of fertilizers and the National Joint Committee on Fertilizer Application have issued their recommendations covering a great range of crops.

The method of fertilizer application in general may depend on the nature of crops to be fertilized. For this purpose the crops can be divided into row crops, vegetables, small grains, pastures and meadows, and trees. Cultivated crops such as corn, cotton and potatoes are usually fertilized in the hill or the row part, all of the fertilizer being applied at the time of planting. If placed in the hill, the fertilizer may be deposited slightly below and on one side or better on both sides of the seed. When applied to the row fertilizer is usually laid in a narrow band on one or both sides of the row, two or three inches away and a little below the seed level. In general, localised application of fertilizers in narrow bands at moderate rates is most effective for the more widely spaced row crops. Placing the fertilizer directly above the seed or in the furrow or mixing the fertilizer with the soil immediately around the seed is generally hazardous, with large amounts of fertilizer, although crops vary considerably in their susceptibility to damage from fertilizer salts. In fact the idea behind the band or hill application of fertilizers is that the plants may take up a sufficient amount of a nutrient by having only a part of the root system absorbing the nutrient and also that the concentration of the fertilizer element will reduce its fixation or immobilisation. Uneven distribution may result in salt damage to some plants and insufficient fertilization of others. When large doses of fertilizer have to be used, it is wiser to broadcast part of it and work it thoroughly into the soil prior to the planting. The crops may also be side-dressed with an additional amount of fertilizer later in the season. This practice involves placing the fertilizer along the side of the row at a time most satisfactory to the crop; only this is a practice which requires experience and good judgement. This has been reported to give excellent results with vegetables. When the crop is well started, larger total amounts of fertilizers are added and side-dressing is quite common especially with a nitrogenous fertilizer such as nitrate of soda. When the fertilizer is applied around crops such as melons the treatment is called a "spot application".

In the case of small grains and similar crops a drill is used which is equipped with a fertilizer distributor so that the fertilizer enters the soils more or less in contact with the seed. Germination injuries which may be caused by the fertilizer are not serious in concentrations less than 300–400 lb. per acre. Indeed under this condition more seeds than necessary get planted so that the badly coming up seedlings could be sacrificed, without any bad effect on the final yields. It is to be borne in mind that improper placement of a fertilizer can adversely affect the plant stand resulting in plant populations which are too low to adequately utilise the applied fertilizer. In several places, the fertilizer applied to row crops is not properly placed to get the maximum effect. Improperly placed fertilizers may again injure seed or young plants resulting in reduced stands delayed emergence, stunted growth, and delayed maturity. Uniform distribution of the fertilizer is important with both the broadcast and the localised methods of application particularly with the latter. Broadcasting which secures a uniform distribution of the fertilizer in the soil and working it thoroughly into the seed bed is often better particularly when the fertilization is heavy with meadows, pastures and lawns, although usually it is advisable to fertilize the soil well at the time of seeding. Top dressing these crops with suitable fertilizer mixtures in the succeeding years would be necessary but care has to be taken to regulate the amount and time of treatment to avoid injury to the foliage and root crowns of the plants.

Fertilizing orchard trees is usually done individually, the fertilizer being applied around each tree within the spread of the branches, but beginning from several feet away from the trunk. The fertilizer is worked into the soil as much as possible. Ornamental trees are fertilized by the perforation method, that is by sinking numerous small holes around each tree within the outer half of the branch spread zone, and extending well into the upper subsoil. Suitable amounts of the fertilizer is placed in these holes and filled up. This places the nutrient in the root zone, also avoiding undesirable stimulation of grass that may be growing around the ornamental trees. A method used to supply extra fertilizer when large quantities are required than can be safely applied in bands at planting time is that of ploughing the fertilizer under, placing part of the application on the plough-sole before planting. This is known as "plough-sole-fertilization" and is widely used as a supplementary manure, rather than to replace the customary methods although adverse weather conditions may seriously reduce the effectiveness of this procedure.

Water solubility and particle size of the fertilizer

There is some correlation between water solubility and particle size of the fertilizer from point of view of band placement. Experiments conducted with tagged phosphorus (P. 32) on the migration of phosphorus from granules into the soil have shown a strong interaction between degree of phosphorus solubility, particle size and the method of placement. For maximum efficiency band applied fertilizer should contain not less than 40 per cent of its phosphorus in water soluble form and those fertilizers without any water soluble phosphorus should be thoroughly mixed with the soil and should be powdered rather than be granular. In fact granulation and banding avoids extreme fixation of soluble phosphorus in the fertilizers, since both these reduce the area of soil-fertilizer contact. It is also better to band apply solid fertilizers high in degree of water solubility as also liquid fertilizers. The former should better be granular or pelleted if these are to be bulk spread.

Different kinds of fertilizer placement

There are three phases which arise when we take a comprehensive look at the process of fertilizer placement. These are placement under row crops, placement under forage crops, both for establishment and maintenance and the deep placement of fertilizers. It is well known that the rooting zone of all plants must have adequate quantities of plant nutrients in the proper balance to produce maximum yields. Usually in the case of crops seeded annually preplant application of phosphate, potash and lime broadcast in quantities sufficient to bring the entire plough layer of the soil up to a maximum growth level is enough. But leachage losses bring about a deficiency of nitrogen. In many low fertile acidic soils, phosphate fixation chances make it economically unsatisfactory for broadcast application before planting. In such cases planting the fertilizer in bands near the seed is profitable. On soils of high fertility yield differences between broadcast and banded application would be diminished on account of the less tendency of the added phosphate and potash to get fixed, since banding the fertilizer reduces the contact between soil and fertilizer. In low fertility soils band placement would cause greater use of the applied fertilizer resulting in higher yields. Here the root systems of plants also have only reduced contact with the fertilizer elements. The lower the phosphate and potash content of a soil, the less is the likelihood of a given phosphate or potassium, ion being absorbed by the root system. When fertilizer is banded, root proliferation in the zone of banding might increase the total absorptive capacity of the root system in the early stages of growth. When absorption is greater — a fact borne out by studies employing tagged phosphorus—the reduced efficiency of broadcast versus band placement of fertilizer may be traced again to the growth habit of the plant. With row crops considerable time may elapse before the soil between the row is penetrated by the plant root system.

Again, according to the manner in which the fertilizer is applied, the placements are known as hill and row placement, drill placement, plough-sole placement and so on. For maize, tobacco, tomatoes and certain other vegetable crops planted in rows one or more meters apart, hill placement has been practised advantageously. The fertilizer is distributed in bands about 15 to 20 cm in length and 2.5 cm in width on one or both sides of the hill. When the seed is drilled close together or the plants placed rather closely in the row the fertilizer is put in continuous uniform bands on one or both sides of the row in the same relative position to the seed and the method becomes known as row placement, and is widely practised for maize, cotton, tobacco, sugar beets, potatoes and many vegetable crops. Somewhat higher rates of application are possible with row placement than with hill placement. Both these methods although efficient for applying small amounts of fertilizers are less so, for higher rates of application except on many of the red soils of the tropics which possess high phosphate fixing power. When higher rates of fertilizers have to be applied, for example 700–750 kgm. of grade containing a total of 20 to 30 per cent of N, P_2O_5 and K_2O per hectare, the additional quantity should be applied prior to seeding during the preparation of seedbeds and the balance after planting time. Often, the fertilizer is applied together with the seed in narrow rows with a combination seed and fertilizer drill. Such application is known as drill placement, a method which has been proved to be excellent for wheat and other small grains as well as some other close growing crops, the seeds of which could stand contact with the fertilizer. Salt sensitive crops such as peas or beans may have to be given split doses at different times. A method of placing the fertilizer in a continuous band at the bottom of the furrow in the process of ploughing, each band being covered as the next furrow is turned, is called plough-sole-placement. This is advocated in localities where there is a tendency for the surface soil to get dried up during the growing season, soils such as having a heavy clay pan a little below the plough-sole. The possible deeper placement of the fertilizer in most regions helps the roots to gather nutrients in the dry seasons. Here also there are less chances of the phosphate and potash fixation than when the fertilizer is broadcasted. This is also an efficient way to apply quantities of fertilizer too large for safe row or hill applications.

The localized placement of fertilizers is often done at the time of seeding the crop with the use of a combination seeder and fertilizer distributor. This economises labour and also serves to increase fertilizer efficiency. Placement is also done by the hand, using a dibble or hoe or by simple animal drawn machinery like the cultivator shovel. Assured of a good nutrient supply even from the earliest stages of growth the plant performs well under these conditions. A certain amount of weed control, less chances of phosphate fixation etc. are also advantages of this practice.

Possible plant injury due to local salt concentration

A serious hazard of localized application of chemical fertilisers is that germination may sometimes be hindered or the young plant damaged by an excessive concentration of soluble salts, if the materials are put near the seed or the plant. It should be borne in mind that the affinity of most seeds for water is insufficient to secure adequate moisture for germination from solutions of high osmotic pressure. For this reason high concentrations of soluble fertilizers should not be placed close to germinating seeds. The fertilizer should be added to the soil in a way that minimises injury to the seedling and permits maximum N,P,K to be absorbed at the time these are most needed by the plant. When fertilizer comes nearer and nearer to the seed zones some sensitive crops are liable to be injured even during the ridging of surface broadcasted fertilizers. Such injury is greatest in dry sandy soils. The fertilizers also vary considerably in their effect on the soluble salt content of the soil solution. Nitrogen and Potassium fertilizers increase the salt content of the soil solution more than phosphatic fertilizers. In this connection it may be mentioned that experiments have shown that the very small effects of potash either as the chloride or sulphate observed in these tests suggest that injury caused by potash sources, under well drained soil conditions has been rather over emphasised.

The yield and plant stand differences due to various methods of band placement are observed to be greater during drought periods. If there is good rainfall during and after germination little difference in plant stand will probably occur among the various methods of band placement. But if after the rains there is a long period of dry weather the movement of salts with the moving capillary water might cause great plant injury. The accompanying moisture loss due to evaporation tends to concentrate the fertilizer salts in the zone near the seedling. In several years' experiments with tobacco it was seen that during wet years, placement had little or no effect on plant stand, but during dry years considerable injury was caused by placing the fertilizer too near the transplant.

Some results of placement of fertilizers

Depending on the manner of placing the fertilizers, the results of placement can be productive or injurious. If the fertilizer is placed with the seed, the soluble salts in it limit germination by preventing moisture from entering the seed and start the germination process. If, however, it is placed below or to one side, germination of the seed goes unimpaired. The plant uses the food inside the seed and the tiny primary roots bring in water from the soil. Side roots develop and grow out into the zone of placement. The fertilizer placed thus really acts as a "starter" since the plant gets its food without much effort when it is just ready to grow. Until recently little emphasis was put as to where to place the starter fertilizer so long as it got into the soil sometimes with the seed, sometimes above it, sometimes directly below it and was not concentrated enough to hurt the germinating seed or to injure the early root growth. Soluble portions get dissolved and get mobilized laterally and vertically and this can cause seed injury. Today, however, we are using larger quantities of more concentrated fertilizers and this can provide an adverse soil environment for the seed, ultimately resulting in plant injury. The matter of fertilizer placement has thus assumed greater importance and upon the efficient manner in which this is done orientates a full stand, or a poor stand or often no stand of a plant.

The importance of proper placement to high yields has been shown in the case of peanuts, tomatoes and the general conclusion is that for most crops, application in two bands about three inches to each side of and one to two inches below the seed or transplant is adequate. Peas, beans, swedes, and horticultural crops, lettuce, onion and spinach all gave higher yields from artificials placed at the side of the seed than from broadcast fertilizer. In the case of peas and beans a light dressing of placed fertilizer gave much higher yields than twice as much broadcast fertilizer. It was also seen that the heavier dressings of phosphate (5 cwts. per acre) and potash were most profitable.

Crops with long growing seasons and extensive root systems like manglods, kale, and sugar beet gave the same yields with fertilizer placed beside the seed as with broadcast fertilizer. For such crops, dressings are equally profitable howsoever they are applied, but placement saves labour in appplying fertilizer separately.

Conclusion

It may thus be seen that the success or failure of placement methods for individual crops, and for different cultural conditions depends upon a number of factors. Plants can utilize fertilisers only from zones of the soil where their roots are active. The function of placement is to concentrate the fertilizer in the root zone. Roots cannot absorb nutrients from dry soil and placement is the only efficient method of getting nutrients below the surface and into the moist soil. Short duration crops require and use a good supply of plant nutrients throughout their life, and any deficiency that checks growth, reduces yields. Long season crops take up nutrients over a long period, often the highest rate of uptake occurs in the later stages of growth. A rapid start is less important in their case. The nature of the root system of the crop has important influence on the absorption of nutrients from placed sources. Placement near the roots of young seedling helps let to start growing quickly and to grow away from injury by pests or diseases, and to compete with weeds or to withstand early drought effects. The maximum advantage is derived by crops with shallow and restricted root systems, and in the case of crops requiring a rather high nutrient uptake in the earlier stages of their growth. Fertilizer placed near the seed is said often to cause early maturity which is necessary in bad seasons. Thus from several points of view, placement has proved advantageous. For row crops like peas, beans and some horticultural crops it has provided a profit under certain conditions where broadcast manuring would not be justified. For crops like potatoes, smaller quantities of placed than of broadcast fertilizers are needed and give full yields. In the case of sugar beet placed fertilizers give good start but not higher yields than broadcast fertilizer but there would be economy in this case in the application of the fertilizer.

There is now sufficient experimental evidence to prove that coconut palms do respond to manuring under average conditions of soil and climate. Not much work has been carried out on coconuts from point of view of the recent trends in the application of manures although a start has already been made in this direction at the Central Coconut Research Station at Kasaragod. The vast amount of information reported from work on annual plants should certainly help us in our approach to the problem of placement of fertilizers in coconut gardens despite the considerations of the peculiar growth features of the palm particularly its expansive spreading root system, its perennial nature, its capacity for continued yields right during every month for sixty to eighty years etc.

It seems appropriate to conclude this paper by quoting the famous Rothamsted authority on fertilizer matters, G. W. Cooke (to whose results among others, the present article is indebted) and who from extensive work has concluded that "Placement is only one aspect of the wider subject of manuring, which, in turn, is only one of the factors that has to be considered in crop production. Methods of applying fertilizers must always be considered at the same time as manures are being chosen for particular crops; correct placement, whether achieved by a special machine or a particular way of broadcasting is an integral part of crop manuring". Placement is relatively inexpensive since ingeneous mechanical equipments are now available to band place fertilizers properly. There is no reason why Indian farmers should feel embarassed by the rather short supply of fertilizers in this country. They only need a new outlook and work with sound knowledge on the various aspects set forth above when a short supply of fertilizers must have to be used to obtain maximum increase in crop yields.

It's a Profitable Proposition—

Intercropping Sea Island Cotton in Coconut Gardens

By
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NOTWITHSTANDING the vigorous efforts made since the commencement of the First Five-Year Plan for making India self-sufficient in respect of its requirements of raw cotton, there is still a gap between production and consumption. During the last two Five-Year Plan periods, the country attained self-sufficiency in respect of its requirements of cotton stapling below $1\frac{1}{16}''$, and in normal years, some six lakh bales of cotton stapling $1\frac{1}{16}''$ and above valued at Rs. 30 to 50 crores are imported annually to meet the needs of the textile industry. These are of two categories viz., cotton stapling $1\frac{1}{16}''$ and above but below $1\frac{3}{16}''$ imported mainly from U. S. A. and East Africa and cotton stapling $1\frac{3}{16}''$ and above from Egypt, Sudan and Peru.

There are reasonable prospects of saving valuable foreign exchange in so far as the first category is concerned by large scale cultivation of suitable improved varieties already evolved and being propagated in the country. As regards cotton stapling $1\frac{3}{16}''$ and above, the problem of replacing imports of such cotton by indigenous growth is somewhat difficult.

Acclimatisation of Sea Island Strains

A beginning in this direction was, however, made in 1949, when the Indian Central Cotton Committee initiated work for the acclimatisation of some strains belonging to the group of the Sea Island cottons which are one of the longest stapled cottons of the world. As a result of the experiments conducted in Malabar and South Kanara, it was observed that the Sea Island cotton could be successfully established as a rain-grown crop in the heavy rainfall areas of the West Coast provided it was grown with adequate fertilisation and plant protection during the period of growth. Of the various varieties tried during the period from 1949 to 1956, it was observed that the Sea Island "Andrews" variety which possessed a mean fibre length of 1.3″, ginning outturn of 33 per cent and spinning capacity of 70 to 80 counts could be probably grown under the prevailing conditions. In the experimental plots, an acre-yield of 1,600 lb. *kapas* was recorded at Pattambi during the year 1955–56.

Possibilities of Growing "Andrews" Variety

Based upon these results, the Indian Central Cotton Committee launched a self-contained scheme for the development of Andrews cotton in the States of Kerala and Mysore. There is no doubt that as a result of the intensive efforts made under this scheme, the farmers of Kerala and Mysore have realised that the Andrews cotton could be grown under varying conditions of soil and climate, but that the crop demanded meticulous care in its culture including the application of adequate quantities of fertilisers and prevention of damage due to pests and diseases by the adoption of prophylactic plant-protection measures.

In view of the paucity of large tracts particularly in Kerala, available for extending the cultivation of this crop, one of the methods recommended is the practice of intercropping it either in the plantation crops like coconut, rubber, coffee and pineapple, etc. or with annual crops like groundnut and chillies.

"Andrews" Thrives in Young Coconut Gardens

The advantages of intercropping Sea Island 'Andrews' cotton in coconut gardens could be easily assessed from the results obtained by one of the enlightened cultivators of Irinjalakuda in the Trichur District. The crop was grown in the young coconut garden on an area of about 4½ acres in 1958–59 and in the following year, it was increased to 40 acres. This rapid increase from a small beginning by a cultivator on his own initiative is indicative of the high cash value of the crop, compared with competing crops and also of the advantages, that it would bestow on the coconut plantation itself. After levelling, ploughing and contour bunding of the land, suitable drainage channels should be provided and ridge sowing adopted. Prior to these preliminary operations

Sea Island 'Andrews' extra long cotton grown as intercrop in coconut garden

the land should be manured with organic manures like farmyard manure or compost at three to six tons per acre. Wherever possible, incorporation of a leguminous green manure crop is also recommended. In addition, superphosphate at 200 lb. per acre and potash 80 to 100 lb. per acre are also recommended as basal application. Further, during the crop period, a top dressing with ammonium sulphate at 200 lb. in two split doses would prove useful. Operations like weeding, earthing up and mulching with leaves would prevent soil erosion and conserve moisture.

Constant Vigilance Against Pests and Diseases

Finally, the crop should be constantly protected from pests and diseases by the application of plant protection chemicals from the commencement of the crop even if the pests and diseases were not observed. Thus, if adequate schedules are carefully adhered to, not only would the owners of coconut plantations receive substantial returns per acre from the Andrews crop, but the coconut garden would also improve considerably in its productive capacity and remunerative value.

Coconut Palms Benefited

The cultivator could save the labour charges on tilling and turning over of soil between the coconut trees, which work is usually undertaken twice a year. Besides, cost of manuring the coconut trees is also saved by growing the Andrews cotton crop owing to heavy dosage of fertilizers applied. Normally the coconut trees, if properly manured and looked after, start yielding from the 10th or 11th year of their growth. The practice of intercropping, however, induced rapid growth of the coconut trees which accelerated fruiting by three to four years, coming to bearing in about the 7th year of their growth. The annual savings in the cost of maintaining the young plantation were estimated at Rs. 410 per acre.

It is, therefore, recommended that coconut planters, particularly of young gardens should keep this in view and derive not only benefits for themselves but also help production of the much needed extra long staple cotton in the country.

The cultivation of this cotton is, however, still in the experimental stage. If it proves to be a commercial success, it will enable ultimately to save sizable foreign exchange involved in the import of cotton stapling $1\frac{3}{16}''$ and above.

THE REHABILITATION of THE CEYLON COCONUT INDUSTRY

By
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Acreage under Coconut in Ceylon

THE last complete agricultural census of Ceylon was taken in 1946. The area under coconut cultivation in the Island at that time was 1,070,942 acres. There has been practically no new planting of coconut since 1946, and the total area under coconut cultivation today is still in the region of 1.1 million acres.

In fact there has been no significant change in the total area under coconut in Ceylon during the last twenty-five or thirty years. The area reported to be under coconut at the 1929 census was practically the same (1,076,222 acres) as the figure reported at the 1946 census.

Why did the opening up of new land under coconut practically come to a standstill about the year 1930 after a period of almost continuous expansion over the previous sixty or seventy years? The low prices fetched by coconut products during the nineteen-thirties and the dislocation caused by the Second World War were, of course contributory causes. They do not however provide a complete answer. In other countries where the same causes operated, there was a steady expansion of coconut cultivation during the same period. In the Philippines, for example, which is the world's largest producer of coconut products, the area under coconut cultivaton more than doubled in the quarter-century between 1930 and 1955 and now stands at nearly 3 million acres. The principal reason why there was no corresponding expansion in Ceylon was the fundamental change of the Island's land policy which was made in the early nineteen-thirties on the recommendation of the 1929 Land Commission. Under the Government's new land policy, crown land was no longer alienated to private capitalists for the expansion of plantation agriculture. Crown land was reserved almost exclusively for alienation to small-scale peasant cultivators. This new land policy, which was embodied in statutory form in the Land Development Ordinance of 1935, brought to an almost complete standstill the expansion of plantation agriculture in Ceylon.

Even if the new land policy adopted by the Government in the early nineteen-thirties had not brought the expansion of the Ceylon coconut industry to a complete standstill, the rate of expansion after 1930 would have been considerably slower than it had been in the previous 60 or 70 years. This would inevitably have been so because the total area of land suitable for coconut cultivation which was still available for development, was limited. It is difficult to state precisely what area of new land is still available for planting in coconut, but it is the consensus of expert opinion that the area is not large. This was the view expressed by the Ceylon Coconut Commission in its Report (Sessional Paper No, XII of 1949). The Commission did not, however attempt to make an estimate of the actual acreage likely to be available. Such an estimate was made by the Crown Lands Utilisation Committee which in its report (Sessional Paper No. III of 1953) placed the total area still available for development under coconut at 130,000 acres — a little more than 10 per cent of the present acreage under the crop. If this entire acreage is opened up in coconut, the resulting increase in production would, at present yield levels, not even meet the increased local demand resulting from the increase in population over the next ten years. If, therefore, we are to meet the steadily increasing local demand for coconut and at the same time to maintain (and if possible expand) our exports of coconut produce, then it is absolutely essential that we should take steps to increase substantially the productivity of the land already planted in coconuts. An increase in yields therefore, rather than a substantial extension of acreage, should be the goal of the Ceylon coconut industry in the next few years.

Measures to Increase Productivity

There are two principal ways in which the productivity of the coconut industry can be increased. They are:—

(i) by encouraging the widespread use of fertilizer on coconut lands; and

(ii) by the replanting of senile palms in worn-out coconut areas by various young seedlings.

These were two methods suggested by the Ceylon Coconut Commission in its report (Sessional Paper XII of 1949) and they were the two methods eventually approved by the Government under the Coconut Rehabilitation Scheme which was introduced in 1956.

Coconut Fertilizer Subsidy Scheme

In order to encourage the widespread use of fertilizer on coconut lands, the Government, in 1956, introduced a Subsidy Scheme for coconut fertilizer.

Under this scheme, owners of coconut estates (i. e. coconut lands over 20 acres in extent) get a Government subsidy of one-third of the cost of fertilizer used on their lands, while smallholders (i. e. owners of coconut lands 20 acres or less in extent) get a Government subsidy amounting to half the cost of fertilizer used on their lands.

The response to the Fertilizer Subsidy Scheme, since its operation has been encouraging. The following quantities of fertilizer have been issued under the Scheme :—

1956	...	31,320 tons
1957	...	31,341 tons
1958	...	34,758 tons
1959	...	44,030 tons
1960	...	42,176 tons
1961	...	38,800 tons
1962	...	45,000 tons

No accurate figures are available of the fertilizer used on coconut lands before the Subsidy Scheme was introduced. The Ceylon Coconut Commission estimated in 1949 that about 7,500 tons of artificial fertilizer were used annually on coconut lands. This figure rose sharply in 1950 as a result of the high prices realised for coconut products after the outbreak of the Korean War. According to rough figures supplied by fertilizer firms, the average quantity of fertilizer used on coconut lands in the period 1950-54 was in the region of 15,000 tons a year. In 1955, however, owing to the sharp drop in copra prices from the levels prevailing after the Korean boom, the quantity of fertilizer used on coconut lands dropped to between 10 and 12 thousand tons.

It will be seen from the above figures that the introduction of the Coconut Fertilizer Subsidy Scheme in 1956 increased four-fold the quantity of fertilizer used on coconut lands.

Replanting Super-annuated Areas

No accurate data is available on the age of coconut palms now in production, in Ceylon. If however the economic life of a palm is assumed to be 60 years and the acreage in production to be 1.1 million acres, approximately 1½ per cent of the total area or 17,000 acres approximately should be replanted annually. This would be the figure if replanting in the past had been carried out on a regular programme. In view, however, of the heavy backlog, we feel that the annual rate of replanting should be around 25,000 acres a year.

Subsidised Planting Material

The Government has launched a scheme for the supply of subsidised coconut seedlings to persons who wish to replant worn-out coconut lands.

Typical Coconut Nursery of the Coconut Research Institute

Subsidised manures being applied in trench and forked in

Manure circle mulched with husks

Under this scheme, the Government supplies seedlings which cost about 75 cts. each to produce, at 25 cents each. Twelve coconut nurseries have been established by the Coconut Research Institute at Ratmalagara, Walpita, Hettipola, Wilpotha, Kalawewa, Killinochchi, Alampil, Mylambavily, Koggala, Eriminigolla, Karmel and Handapangala, in the principal coconut growing districts of the Island.

The seedlings distributed under this scheme are not used exclusively for replanting. Some of them are used for supplying vacancies on coconut estates and small-holdings and a few for the new-planting of coconut on lands which previously did not carry coconut. As against this, there are some estates which carry out their replanting programmes with seedlings from their own nurseries and not with seedlings obtained from the Coconut Research Institute. It would not be far wrong, therefore, to compute the total acreage of coconut replanted in the Island on the basis of the number of seedlings distributed under the Subsidised Seedling Distribution Scheme.

On this basis, the area replanted in each year since 1956 would be as follows:—

Year	No. of seedlings distributed	Approximate Acreage planted
1956	900,000	15,000
1957	1,050,000	17,000
1958	1,175,000	19,600
1959	1,296,768	21,500
1960	1,322,919	22,000
1961	1,148,997	19,150
1962	1,140,000	19,000

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Soil Physical Properties and Coconut Cultivation

By
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Introduction

SOIL is the most important natural resource on the earth and it provides the natural medium for the growth of land plants. Scientifically the soil is a living body covering the surface of the earth in a thin layer, which is composed of inorganic materials derived from rocks, organic matter derived mainly from plant residues, moisture, air and millions of living organisms. The main functions of the soil from the agricultural point of view are to give bracing and anchorage for the roots of plants and to provide water for its transpiration, minerals for its nutrition and oxygen for its metabolism. Only that soil which is in proper physical, chemical and biological condition can perform these functions effectively. A thorough appreciation of this fact is a very necessary prerequisite for managing a given soil to the maximum advantage.

Soil Fertility

Fertility of a soil is defined as "the quality of a soil that enables it to provide nutrients in adequate amounts and in proper balance for the growth of specific plants when other growth factors and the physical condition of the soil are favourable". Thus productivity of a soil does not depend upon the nutrient status of the soil alone, but also on the physical condition of the soil which affects the proper utilisation of the nutrients by the crops. Thus two soils which may have the same fertility level from the point of view of nutrient contents, may exhibit wide differences in productivity depending upon the physical conditions of the soils. This is only to be expected as the growth of plant roots is affected by soil conditions such as soil moisture, soil air, soil temperature and mechanical impedance which in turn are influenced by physical attributes of the soil such as apparent density, aggregation, porosity, friability, etc. Thanks to the widespread propaganda that is being done by different agencies, the growers by and large are now fertilizer conscious and understand the need to use fertilizers to improve crop yields, but they don't appear to be so well informed about the importance of physical conditions of the soil in relation to soil fertility. This article is intended to draw their attention to this important but little understood aspect of soil productivity.

Soil Physical Properties

The physical properties of soils are determined by the size and arrangement of the primary particles of which the are composed, i.e., by the texture and structure of soils.

Texture

Texture refers to the size of the particles of which a soil is composed. The international textural classification of soils is based upon the extent of occurrence of the four groups of soil particles, i.e., coarse sand, fine sand, silt and clay. Each group of particles has its own physical properties and the physical condition of a soil will be a reflection of the combined effect of properties of the constituent groups of which the soil is composed.

Coarse sand fraction facilitates aeration and easy movement of water but its capacity to hold moisture and nutrients is very low. Fine sand fraction behaves exactly like coarse sand but in a less pronounced manner. Excess of fine sand tends to compact the soil after rains and to form a surface crust on drying. Silt fraction has to some extent the properties associated with clay soil such as cohesion, water holding capacity and base exchange. Clay is the finest fraction of the soil. It is colloidal in character and is the most reactive fraction and is the seat of all chemical activity. It has enormous surface and exhibits colloidal properties like absorption and ion exchange. Beyond a certain proportion it has undesirable effects on the soil.

Structure

Structure is a very important physical characteristic of the soil. The term structure of a soil refers to the arrangement of soil particles in a soil. A structural unit may be defined as one or more groups of soil particles held together in such a manner that the resultant physical properties differ from those exhibited by a corresponding mass of individual particles. The structural units or aggregates are more stable and much less mobile than the individual soil particles. A crumby and granular soil structure is the most desirable structure. In such a soil, lumps of soil will disintegrate and crumble on being gently pressed with the finger and the thumb. On cultivation it will break into small lumps and granules instead of forming into clods or powdery material. Good soil structure is necessary to ensure optimum water relationship for the satisfactory growth of crops growing on it.

Soil Types and Their General Characteristics

As already referred to previously, the distinguishing characters of soils of different kinds depend upon their physical composition. On this basis soils can be broadly classified as gravelly, sandy, loamy or clayey soils. These terms themselves will indicate in a general way the nature and suitability of the soil for agricultural use and the manner in which each class behaves under different conditions or has to be treated under cultivation.

Gravelly soil

This soil will have a large admixture of large fragments of stone, gravel, pebbles, etc. This soil is too open, poor and hard on tillage implements and plough bullocks.

Sandy soils

Soils are classified as sandy when they contain more than 60 per cent of sand fraction. These soils are highly drained and less retentive of moisture and nutrients. The soils can be easily tilled under a wide range of soil moisture conditions without any adverse effect. Provided water and manures are available in plenty, these soils can be used to raise a variety of crops profitably.

Loamy soils

These soils are intermediate between sandy soils and clayey soils. The sandy component may lie between 30 and 60 per cent. In the matter of physical attributes such as moisture holding capacity, drainage etc., these are intermediate between sandy and clayey soils. These soils are very well adapted for raising a variety of crops.

Clayey soils

In these soils sand component goes below 30 per cent and the clay goes up between 70 to 85 per cent. Clayey soils are difficult to till and require much skill in handling. When moist they are excessively sticky and ploughing will reduce them into a pasty mass. When dry they tend to become very hard and difficult to break. As they dry they shrink in volume resulting in the development of cracks. They possess very high water holding capacity and are very retentive of moisture. Drainage is difficult and imperfect. They are generally very fertile soils in respect of plant food but will require physical improvement before crops can derive their advantage in full.

Factors Influencing Soil Physical Properties

Though soil physical properties are largely influenced by soil texture and structure they do get, and can be, modified by a variety of factors, some tending to improve them while others having an opposite effect.

Intensive cultivation of soil without taking proper steps to maintain the organic matter content at a satisfactory level will often lead to deterioration in due course. With the loss of the binding material, the soil particles get reduced to separate ultimate particles which get easily carried away by wind and rain. The creation of dust bowl in certain parts of America is a well-known instance in point. Organic matter has, therefore, a lot to do with the improvement of soil physical properties. It helps to open up stiff soils, improving their drainage and aeration aspects. In sandy soils it helps to improve structure, resulting in better retentive capacity for moisture and nutrients.

Lime application is another important matter affecting soil physical properties. It ameliorates clayey soil by its flocculatory effect and overcomes the tendency of the soil to become stiff and pasty. It further prevents the development of acidity which favours the destruction of tilth in farm soils.

Soil cultivation has important effects on soil structure, particularly in the case of soils with high clay content. Working clay soils in wet conditions will spoil soil structure and favour the formation of clods. Clods will also result when the soils are ploughed when they are too dry. Tillage at the correct time will favour the formation of crumb structure. Leaving a land under sod for some time is claimed to improve soil structure.

Occurrence of clay pan, hard pans, etc., in the soil will interfere with the growth of plants by obstructing the movement of water and air and the penetration of roots. This adverse soil physical condition can be improved by growing deep rooted crops as well as by deep tillage.

Another factor that tends to modify soil physical properties is the development of alkaline conditions. In arid regions where irrigation is practised, alkaline conditions are likely to develop. Then the soil becomes saturated with sodium ions which cause dispersion of soil aggregates resulting in a soil that is easily puddled and unfit for agricultural use. The reclamation of such soils will require drainage improvement, copious irrigation to leach out soluble salts and treatment with materials such as gypscm, sulphur, etc., depending upon the type of alkali concerned.

Where drainage is defective, improvement of the conditions will allow roots and air to penetrate to greater depths which with the accompanying biological activity and oxidation processes will result in improved soil structure. Mulching of the soil surface has also been observed to improve the physical condition of the soil by preventing compaction of the surface soil and promoting soil aggregation.

The use of artificial soil conditioners such as krilium for improving soil physical properties has been the subject of considerable research but the possibilities of its successful application on a field scale have not yet been demonstrated.

Soils of different types differ in their response to measures taken to improve their structure and one important contributory factor is the size of the particles of which the soil is naturally composed. Incorporation of fine fractions such as silt and clay to coarse soils and of silt and sand to fine soils such as clays on a long term basis will help to modify the textural composition of the respective soils and bring about improvement in soil physical conditions.

Coconut Soils and Their Requirements

The coconut crop has extensive root system and requires for satisfactory growth soils that possess good retentive capacity for moisture and nutrients, are deep and well drained and free from toxic conditions. The various soils on which the crop is now being raised largely are to be studied from these considerations with a view to see how far they are able to satisfy the palms' requirements and whether and to what extent they need attention for removing the defects that they might be suffering from.

The important soil types on which coconut is being raised in India are the laterite soils, loamy soils, coastal sandy soils and alluvial soils.

Laterite soils are generally open and well drained and possess much better water holding capacity than loams and sandy soils. Where the soil is underlain with soft laterite rock, it may be necessary to dig for planting seedlings, pits of much larger size than the usual one (3′ x 3′ x 3′) and to fill them with loose friable soil to permit easy root development in the earlier stages. Application of common salt to seedling pits a few months before transplantation has also been found to be beneficial as it has the property to soften the laterite and facilitate easy penetration of roots. In the case of this soil type more attention is required towards improving the nutrient status than to the improvement of soil physical condition.

Gravelly laterite soils are likely to suffer considerably from drought because of its very porous nature. Incorporation of large quantities of organic matter may be necessary to improve the water and moisture holding capacity of the soil. Adequate fertilization to correct nutrient deficiencies is also indicated.

Coarse sandy soils are subject to severe drought during rainless period because of its very poor moisture retaining capacity. The deficient physical properties can be improved by adopting the following methods.

(1) Incorporation of large quanties of organic matter into the soil.

(2) Increasing the content of finer soil fractions by carting and incorporating large quantities of clay or silt on a long term basis.

(3) Providing irrigation at frequent intervals to offset the poor moisture retentive capacity.

(4) Frequent application of small quantities of fertilizers to avoid loss by leachage.

Alluvial soils are naturally very fertile soils. Where the proportion of finer fraction increases, the soil will tend

(Continued on page 144)

SUGAR INDUSTRY IN INDIA

By
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SUGARCANE is one of the most important cash crops in India. It supplies raw material for the manufacture of sugar, the second largest industry in the country. Sugarcane plays a vital role in the agricultural economy of the country, occupying as much as about 60 lakh acres of land under its cultivation. The fate of about 2 crores of rural population, apart from a large number of labourers, industrialists research and technical workers etc., depends upon this industry. Besides increasing the prosperity of the Indian cultivator, it also largely contributes to the revenues of the Central and State exchequers in the shape of excise and cess, which amount to about 60 crores per annum.

AS OLD AS THE VEDAS

The history of sugarcane in India is as old as its civilization and according to Indian mythology, sugarcane descended from heaven to earth in this country through the super-natural powers of Viswamitra, the mighty sage. There is mention of sugarcane in *Atharva Veda* (5000 B. C.). Charak and Shushrut, the foremost Indian physicians have referred to it in their medical books. The Chinese Emperor, Tai Tsung sent a technical mission to India about 640 B. C, to learn the manufacturing process of sugar. Alexander was the first European who saw sugarcane on the Indian soil and carried it with him to Greece in 327 B. C. The Saraceus introduced it to Egypt in 640 A. D. and later to Spain. Sugarcane went from Europe to America and thence to Brazil, Mauritius etc.

WHEN CULTIVATION WAS NEGLECTED

The cultivation of this important crop in India, however, remained neglected till the beginning of the 20th century when it was observed that the entire sugar industry in the sub-tropical parts of the country was dependent upon poor yielding *Desi* canes and in tropical India on the exotic or imported canes which, though rich in sucrose, were highly susceptible to a number of pests and diseases. Moreover, sugarcane was then exclusively being utilised for the manufacture of *gur* and *khandsari*, cattle feed and chewing purposes.

IMPROVEMENT MEASURES

In 1912, the Govrnment of India established the Sugarcane Breeding Station (now Institute) at Coimbatore in Madras State with a view to evolving improved varieties of sugarcane for varying climatic conditions of the country. The replacement of the indigenous vareities by the improved *Co.* canes evolved at Coimbatore revolutionised sugarcane cultivation and the sugar industry in the country. The Indian sugar Industry got a further fillip by the grant of fiscal protection to it by the Government of India in 1930-31.

In 1929, the Imperial (now Indian) Council of Agricultural Research constituted a Sugar committee for introducing further improvements in sugarcane and sugar industries in India. As a result, a chain of sugarcane research stations was established in some of the important sugarcane producing States of the country to carry out researches on various aspects of sugarcane cultivation with a view to introducing improved methods of cultivation. In 1944-45, the Government of India constituted the Indian Central Sugarcane Committee to undertake all work relating to improvement of sugarcane and sugar industries in India. The Committee further augmented the sugarcane research and development programmes in the country.

DEVELOPMENT ACTIVITIES IN THE FIVE-YEAR PLANS

The sugarcane grower in India duly recognised the high potentialities of the improved varieties and readily replaced the indigenous varieties with the improved ones. But he failed to provide the essential wherewithals in the shape of adequate quantities of manures and fertilisers, higher doses of irrigation water, and plant protection measures, so essential for the proper growth and development of the improved sugarcane varieties. Schedules for the application of manures and fertilisers and irrigation etc., for the various parts of the country had already been worked out and control measures against sugarcane pests and diseases investigated; but the conditions in the country demanded the application of the recommendations of the research stations into the fields in order to enable the cane growers to get the best results from their land. In order to carry out the results of sugarcane research to the doors of the cane growers and to increase the production of sugarcane by intensive methods of cultivation, the Indian Central Sugarcane Committe initiated the Sugarcane Development Schemes in important states of the country in 1948–49. Later on, these schemes formed a part of our national plan and were extended to almost all the sugarcane producing States of India. Special attention under these schemes is being paid to the provision of (i) adequate irrigation facilities, (ii) seed nurseries for the supply of disease–free and improved varieties of seed, (iii) adequate manures and fertilisers, (iv) efficient watch and ward service for protection of the crop against pests and diseases, (v) soil extension service, (vi) field demonstrations and publicity, and (vii) employment of trained and technical personnel to carry the results of research to the cane growers.

HIGHER PER ACRE YIELD

As a result of the sugarcane development work in progress in the country, higher yields of sugarcane per acre are being obtained in the development zones by adoption of the improved techniques of sugarcane cultivation. The area under sugarcane rose from 37.5 lakh acres in 1948–49 to 59.4 lakh acres in 1961–62, correspondingly increasing the production of cane from 487 lakh tons to 960 lakh tons. The yield of sugarcane per acre has also increased from 11.75 tons per acre during 1952–53, it touched the all time high figure of 17.7 tons per acre in 1960–61. Similarly, the number of sugar factories rose from 136 in 1948–49 to 191 in 1960–61. The annual production of white sugar also rose from 10.1 lakh tons in 1948–49 to 29.8 lakh tons in 1960–61.

Thus, India which was a dificit country in respect of sugar, not only became self–sufficient, but also started exporting sugar to other countries. 3.03 lakh tons of sugar in 1961 and 3.51 lakh tons in the first eight months of 1962 were contracted for export from India to other countries. In this way, the huge imports of sugar, which used to drain out the Indian Exchequer to the extent of several crores of rupees in the past, came to a close. India is now in a position to meet its own demand of sugar and also to earn the much needed foreign exchange by exporting this commodity to other countries.

SUGAR INDUSTRY-2ND BIGGEST

"The sugar industry ranks second among the major industries in the country, next only to cotton textiles, employing 8.0% of the total fixed capital, 11.6% of the working capital, 7.4% of the total number of workers in the 31 important industries in the country, sharing 4.9% in the national wages and salaries and contributing 7.9% to the total value of products of major industries in the country." (Indian Sugar Industry, 1961, by M. P. Gandhi).

NEED FOR INCREASED PRODUCTION

The increasing population and rise in the standard of living in the country have created more demand of sugar for internal consumption, whereas the need of foreign exchange for the all round development of the country, particularly in the present state of emergency, has made it all the more necessary to export as much sugar as possible to other countries.

To meet the situation, both short and long term plans for the development of sugarcane and sugar industries are being prepared in order to produce sufficient cane in the country to manufacture about 35 lakh tons or more of sugar annually by the end of the 3rd Five-Year Plan. Schemes of intensive cultivation of sugarcane are being expanded to cover more area under cane and package programmes are also being introduced in many districts of the country, for raising per acre yields of the crop. With the implementation of these programmes, it is hoped that more and cheaper sugar will be available to meet not only the internal demand but also enable export of large quantities, as sugar is one of the important foreign exchange earners.

Soil Physical Properties

(Continued from Page 140)

to be heavy and will be difficult to till. Free drainage may also be impeded. Under such conditions, in order to open up the soil, coarse sand may have to be incorporated by carting sand from outside on a long term basis. Incorporation of organic matter will also help to open up the soil and improve its physical properties.

Conclusion

It is hoped that the foregoing paragraphs would have brought home to the readers how soil physical conditions are as important as nutrient status in influencing soil productivity. When we are in the thick of fight to increase crop yields we cannot afford to neglect one important aspect concerning soil fertility viz., soil physical properties without adversely affecting the final outcome. Our motto should be to provide optimum environmental conditions for the crop to grow and to allow the soil to play its full part in supplying besides air and water macro and micro nutrients in sufficient quantities and in proper balance in accordance with its special requirements. To the extent we succeed in this task we can hope for the best results.

coconut toddy

as

an industrial raw material

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Introduction

THE literature contains scattered references to observations made by several workers on the yields, characteristics and composition of certain palm saps which have been popularly described as "palm wines" by the early European visitors to eastern countries. Though these saps have also been referred to under various other names such as *lagbi* (North Africa), *lubki* (Egypt), *tuba* (Philippines), *nira* (Malaya) and *tari* (India), they are all generally termed toddies at the present time.

A survey of the recorded facts reveals that the practice of "tapping" for toddy is restricted to the palm family. Many different genera and species of palms have actually been utilised for this purpose, from most remote times, in various countries of the orient. In some countries like India, Ceylon, Philippines, Malaya, Indonesia and North Africa, the practice of tapping palms is of considerable commercial importance.

The term "tapping" collectively denotes the artificial extraction and the various processes of stimulating the different toddy yielding palms to exude juice from a selected part. Toddy itself is an exudate of plant sap, but it is not necessarily collected from a definite region or part of the palm. In the cultivated date palm *(Phoenix dactylifera)* and the buri palm *(Corypha elata)*, the entire growing point is cut off and the juice is collected from the naked stem of the exposed tender "cabbage" by cutting out (or ringing) a shallow circular depression. In the wild date palm *(Phoenix sylvestris)* and the African palmyra, tapping is done by puncturing a lateral portion of the young stem. In the sugar palm *(Arenga saccharifolia)* and Wight's sago palm *(Arenga wightii)* it is the stalk of the inflorescence (peduncle) that generally exudes sap. In the water coconut *(Nipa fruticans)*, Indian sago palm *(Caryota urens)*, palmyra palm *(Borassus flabelliformis)* and the coconut *(Cocos nucifera)* it is the inflorescence at a particular stage of development that is stimulated to yield the juice. In the present context we are dealing with the coconut palm, and the stage at which its inflorescence is suited for tapping is indicated thus (T) in Figure 1. It is actually the tender flower spathe just before it opens out. The development of female flowers inside the spathe generally causes a bulge at the base of it, and the appearance of this swelling may be taken as a good indication of the appropriate stage.

Yield of Toddy

Judging from the various figures available from India, Malaya, Philippines, Indonesia and Ceylon, there would appear to be a wide divergence in the yield of sap obtainable from the coconut palm. Though the tall variety yields more toddy than the dwarf palm, yet there is found to be considerable variation in the yield of juice from day to day, season to season, spadix to spadix and palm to palm. The yield is also largely contingent on the expertness of the collector. With eight months' tapping in the year, five palms may generally be expected to yield daily a gallon of toddy.

Composition of Coconut Toddy

Before considering the actual and potential products obtainable from an industrial raw material it is necessary to have a reasonably clear idea of the nature and composition of such material. In considering the composition of coconut toddy, it is important to distinguish between the fresh unfermented juice usually referred to as 'sweet toddy' and the sap in various stages of fermentation called 'toddy'. Variations in the quality of sweet toddy (especially with regard to sugar content) have been observed by many workers, and the weather perhaps is the principal factor affecting its composition because it is well known that during the rainy season the sap is always more dilute. Young palms are also supposed to give a weaker juice than the older ones, and the first juice which commences to flow on tapping is not reckoned to be so rich as that obtained from subsequent tappings.

In its fresh state, sweet toddy is a liquid containing as its essential constituent between 12 and 18 per cent of sugar, and 15 per cent may be taken as

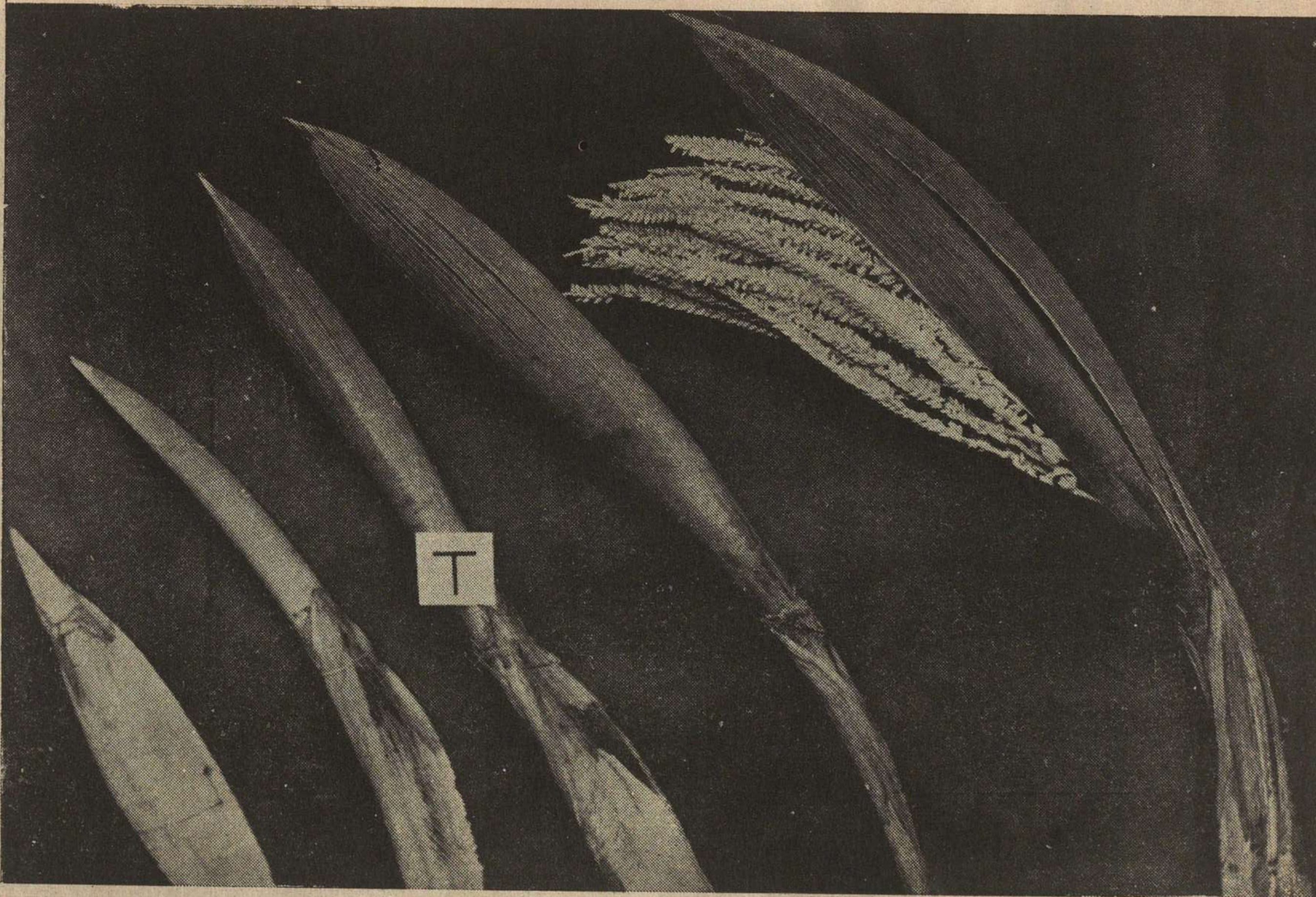

FIG. 1. *Different stages in development of coconut inflorescence. The stage at which it is most suited for tapping is indicated at T*

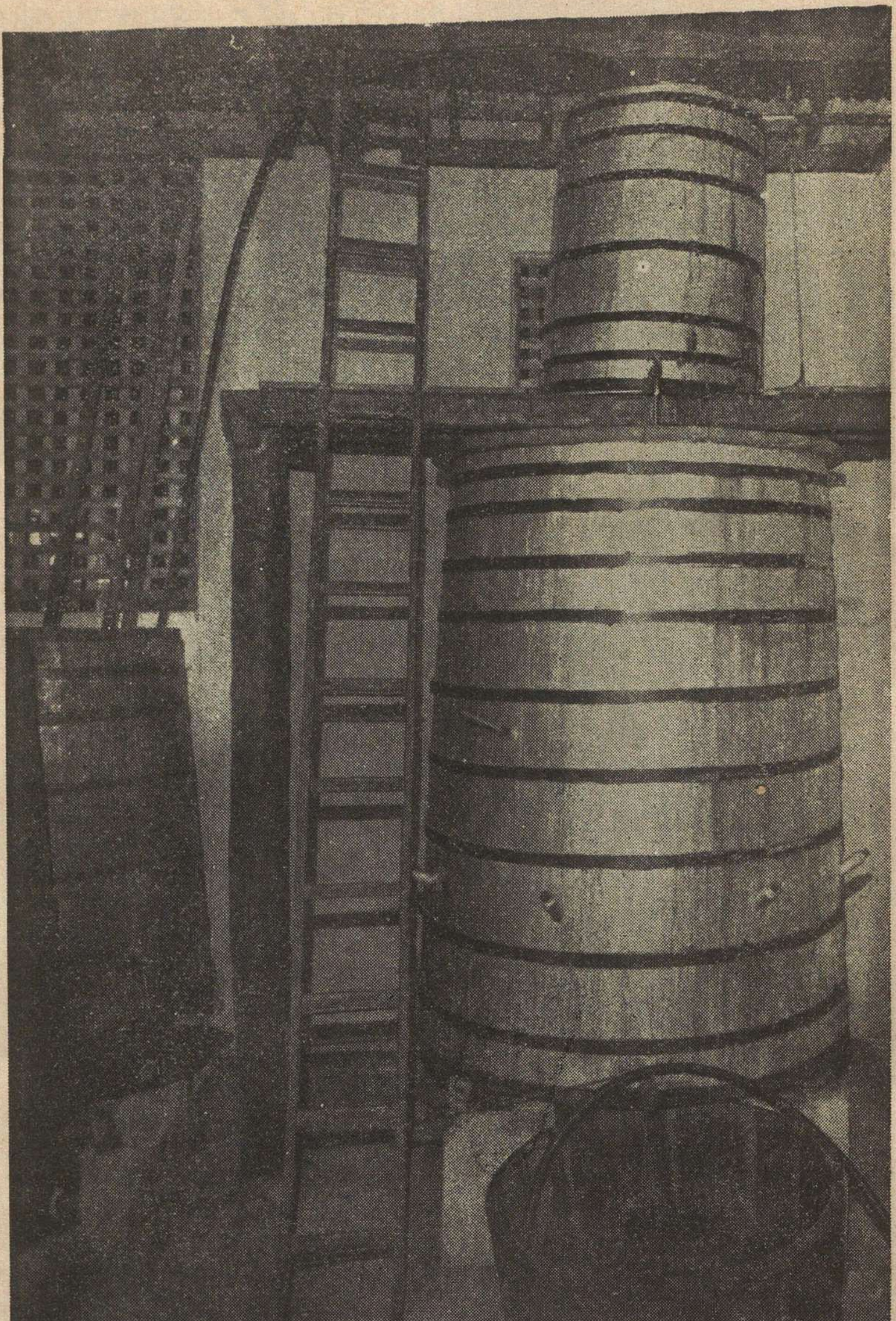

FIG. 2. *A Vinegar Generator as installed in a Ceylon factory*

a working average. Chemically this sugar is sucrose and is the same as cane-sugar or beet sugar, i.e. common or garden sugar. For industrial use sweet toddy really compares very favourably with sugarcane juice not only regarding its sugar content but also in purity. Further it may be considered superior to sugar beet, because the latter contains a large amount of foreign matter in proportion to the sugars.

If carefully collected under sterile conditions sweet toddy will remain unfermented for a considerable time. As usually collected, however, unless special precautions are taken, it rapidly ferments owing to the action of micro-organisms collected from its surroundings, the sugar disappearing and its place being taken by some 5-8 per cent of alcohol.

Fermented toddy, on further keeping, undergoes a process of acetic fermentation, the alcohol being converted into acetic acid of which the resulting vinegar contains about 4 to 7 per cent.

Sweet toddy is thus essentially a water solution of sugar; fermented toddy a weak solution of alcohol; and vinegar a weak solution of acetic acid. Other minor constituents are also present, of which some — for example about 0.2 per cent of potash salts — remain unaltered through both fermentation processes. Others may be more or less altered or disappear, whilst still others may be produced during the fermentations. Table 1 illustrates the quantitative composition of coconut toddy.

TABLE 1

SWEET TODDY

(100.0%)

- Water (81.5%)
- Total Dry Solids (18.5%)
  - Non-Fermentable matter (2.5%)
    - Inorganic Solids — Ash (0.5%)
    - Organic Solids (proteins, fat, gummy substances and minor constituents) (2.0%)
  - Fermentable Matter — Sugars (16.0%)

Separation of Main Constituents

All of the main constituents mentioned — sugar, alcohol and acetic acid — can by suitable means be separated in a relatively pure state. Partial separation is indeed effected in some industrial or semi–industrial processes. Thus, the preparation of treacle or jaggery is merely a process of concentrating the sugar in sweet toddy by evaporation of water; whilst the preparation of "Arrack" from fermented toddy represents the concentration of alcohol by a process of distillation. In the latter case the alcohol is largely separated from the minor constituents of the toddy which remain in the spent wash in the still, but is yet mixed with some water.

By suitable means such processes can be carried further to obtain pure sugar or alcohol respectively. Technically in fact, there is no impossibility in making sugar from sweet toddy, power alcohol from fermented toddy or even glacial (99 per cent) acetic acid from toddy vinegar.

Manufacture of Sugar Products

It has been mentioned that sweet toddy contains an amount of sugar similar to cane sugar juice and beet sugar juice, and technically could be worked up in the same way to refined sugar. On the basis that 5 palms yield a gallon of sweet toddy per day in eight months, one palm would yield approximately 50 gallons (535 lb.) containing 80 lb. of crude sugar. Further, taking 70 palms to the acre, the raw sugar recoverable per acre would be in the region of 5,600 lb. or 2½ tons.

The process that could be adopted to recover and refine the sugar in sweet toddy may be summarised as follows. The fresh juice containing 15 per cent of sugar is 'defecated' i.e. treated with lime (usually about 2 per cent) in order to coagulate albuminous impurities. The limed juice is then carbonated, i.e. carbon dioxide gas is pumped through to remove excess lime, and subsequently heated and filtered. The 'carbonation' is usually done in two stages with filtration after each.

The clarified juice is now evaporated to about 75 per cent sugar content, and the resultant syrup concentrated in vacuum pans to 'graining' point, i.e. the stage at which crystallistion will commence. The syrup containing crystallised sugar or 'rassecuite' is discharged into crystallisers and the crystalline sugar fully separated by centrifuging. The process is one that requires chemical control at all stages.

Regarding the economics of sugar recovery, it should be mentioned, that the high cost of tapping is the only factor that would militate against the commercial production of crystallised sugar from sweet toddy.

Toddy Syrup (Treacle)

In many producing countries sweet toddy is commonly boiled down to a syrup–five or six bottles of toddy producing a bottle of syrup. On the basis of the aforementioned figures a palm could produce about 110 lbs. or some 50 bottles of syrup a year. If superheating is avoided and the juice is progressively strained during the boiling down process, then a product resembling 'golden syrup' with a very attractive flavour could be prepared.

Jaggery

A further stage is the production of solid jaggery (caramelized sugar) from the sweet toddy. Here the losses in working are greater as there is considerable removal of sugar during the skimming necessary to take off scummy impurities. The yield of jaggery is generally about 1/12 the weight of the original sweet toddy.

Manufacture of Arrack

The term arrack, as designating a distilled liquor is usually employed in a generic sense to a variety of spirituous liquors, distilled from a diversity of raw materials such as ground rice, molasses, mahua flowers (*Bassia latifolia* or the honey tree) and various palm juices. In the present context, however, it is used to denote an alcoholic beverage manufactured by distilling fermented toddy, tapped exclusively from the tall variety of the coconut palm.

Though arrack is prepared in many coconut growing countries, its manufacture on a proper industrial scale is practised only in Ceylon. In fact the industry which has grown up in connection with this product is a very considerable one, providing employment for comparatively large numbers of people and involving a fairly considerable capital in this island. The descriptive account that follows actually refers to the manufacturing process as practised in this country.

The transformation of simple sugars into potable alcohol is the one step common to all liquor production and is specifically referred to as alcoholic fermentation. As we have seen, the sap of the coconut palm contains sugars which are directly capable of conversion into alcohol by the action of ferments supplied by yeast which grow and multiply naturally by casual inoculation from spores adhering to particles of dust in the atmosphere. These start off a fairly successful spontaneous fermentation which proceeds to completion, provided other conditions are favourable.

Under the system employed at the present time, the toddy which is lowered from the palm in the morning at the '*topes*', is centralised in a 'collecting station' during the forenoon, where the grosser suspended impurities are strained through wicker baskets, and the volumes measured and checked by excise inspectors. The toddy is then transferred into wooden barrels (about 50–100 gallon capacity) and transported to the distillery before 2 p. m.

At the distillery, after a process of graduated straining (through stainless steel screens of different gauges and coarse cloth), the toddy is allowed to run into fermentation vats of about 400 gallon capacity before 4 p. m. After a few hours fermentation and settling in these vats, the toddy is run into a large stainless steel tank, where it is bulked and then pumped into pot stills of 1000–1500 gallon capacity. Whilst the main still is fabricated with tin lined copper, the doubler, rectifier and condenser are of stainless steel. According to regulations, the distillation of the toddy should be commenced before midnight, in order to keep the acidity of the distillate low.

Fermented toddy generally begins to boil between 200–205° F., and as the boiling point gradually rises, the distillate fractions passing over and condensing have increasingly pleasant characteristics up to a point. Above 209° F., however, the distillate lacks the more pleasant character of the earlier fractions whilst still remaining rich in alcohol. Unless it runs foul, the distillation is usually continued till the hydrometer reads about 3 per cent for the distillate. When the distillation is discontinued at this stage, the boiling point would be in the region of 211° F., and the total volume of distillate ("High wines") collected would generally represents approximately 25 per cent by volume of the original toddy distilled.

As a rule, the high wines are reduced to about 35 per cent alcohol content ("Low wines") by the addition of water and distilled again. In this distillation however, the aim is to collect the most suitable fraction ("middle runnings") which will after maturation constitute the finished "Double distilled arrack" which is the best quality produced at the present time. The first fraction ("foreshots") and the last fraction ("tailings") which are collected separately are later combined and added to subsequent batches of low wines or toddy.

It should be pointed out, that the ordinary grade of arrack that is marketed commercially is prepared by a fractionated *straight toddy distillation* only, without the production of high wines–the clean spirits and feints (foreshots and tailings) being collected separately. The latter mixture is of course added to subsequent charges of toddy, so that alcohol is not wastefully discarded. Excise statistics reveal that over 7 million gallons of toddy were distilled in Ceylon for arrack manufacture during 1960.

Toddy Vinegar

Nearly every writer who has dealt with the subject of the useful products of the coconut, alludes to the vinegar prepared from the juice. Doubtless, coconut toddy by itself is an excellent raw material for the manufacture of high grade vinegar. It needs no fortification with adventitious sugar or salts and possesses the overriding advantage of being a well balanced medium containing sufficient nutriment for the growth and activity of yeasts and bacteria.

The writer has expressed the opinion elsewhere[1], that the chief difficulty experienced by vinegar makers is their inability to get proper acetification of their toddy, due partly to lack of control during processing and partly to the fact that the popular 'Vat Process' of manufacture is not well suited for commercial production.

On the basis of successful laboratory and pilot plant investigations (the results of which have been published in full[2]), recommendations have been made, that by employing the 'Generator Process' the aforementioned disabilities of the toddy vinegar industry could be gainfully surmounted.

The Generator Process

The vinegar 'generator' is designed to provide the maximum surface exposure for a volume of fermented toddy, in order to supply enough air for the acetic acid bacteria to efficiently and quickly oxidise the alcohol to acetic acid.

The generator assembly is actually comprised of a feed (or supply) vat, an acetifier and a receiving trough. The constructional and operational details of these have been fully described in one of the publications of the Coconut Research Institute of Ceylon[3].

In essence, the vinegar generator is a counter-current gas absorber wherein the acetic bacteria cause the oxidation of alcohol to acetic acid. Air for the alcohol oxidation is admitted to the generator below the false bottom through air vents and it circulates naturally owing to the heat of oxidation in the packing chamber.

The vinegar stock from the feed vat is uniformly sprayed over the surface of the inert porous packing medium (maize cobs), at the surface of which the oxidation takes place. The stock which drains off from the packing by gravity into the base of the generator is run out and pumped (or poured) back into the feed vat, from which it is recycled until acetification is complete.

When the vinegar has reached its maximum strength, it is aged before bottling, and is at its best quality for table use.

The analytical and flavour characteristics of coconut toddy vinegar manufactured by this process have been found to compare very favourably with reputed vinegars prepared from other raw materials. Figure 2 shows a vinegar generator that has been installed in a factory in Ceylon.

Conclusion

From the agricultural point of view, the cultivation of the coconut palm has received considerable attention in the various countries where it is grown. It cannot however be said that the development of the subsequent industrial process for the economic utilization of its products has received equal encouragement. The industry has a great wealth of raw materials which provide a unique opportunity for exploitation in directions hitherto untried and, therefore, ripe for the application of scientific methods and research.

The sap of the coconut palm and its products are doubtless a useful adjunct to the coconut industry. From the short account that has been given it should be obvious that there is ample scope for concerted effort on the part of all concerned for the general improvement of the industries associated with these products.

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Modified Krauss-Maffei Process for Wet Processing of Coconut

(A report of work in progress at the Central Food Technological Research Institute, Mysore)*

IN an earlier communication[1] from these laboratories, the newly developed methods of processing fresh coconut kernel for the recovery of oil and meal were reviewed and it was stated that studies on the wet processing of coconut kernels were in progress at the Institute. Considerable progress has since been made and the present report deals with the present status of the investigations. Detailed accounts of the investigations are being published elsewhere.

Krauss-Maffei Process

Messrs Krauss-Maffei of West Germany developed a process for the extraction of oil from coconut kernel. The process had been worked by them on

* Communicated by Dr. D. S. BHATIA, Head, Division of Food Processing, Central Food Technological Research Institute, Mysore.

a small scale and they were interested in exploring the practical possibilities of the process. When the firm learnt about the contribution of the Institute in the closely allied line of the wet processing of groundnut (peanut) to obtain oil and protein, they offered the gift of one pilot unit to the Government of India with the request that the plant be given over to the Institute for further studies. The Government of India accepted the gift and the plant eventually reached India early in 1961. As the report from the firm suggested that large supplies of coconut would be required and as these would be more easily available in Kerala than at Mysore and in view of the interest shown by the Indian Central Coconut Committee and M/s. Tata Oil Mills who also offered all possible facilities, it was decided to install the plant at Tatapuram in the premises of Tata Oil Mills. After running a series of preliminary trials, it was found that some of the units in the K. M. Process may need certain modifications to make the process more efficient and economical.

Krauss-Maffei Plant

The plant as gifted by the firm consists of :

1) Autoclave for steaming the coconuts.
2) Cutter coupled with rolls to comminute the kernel (Fig. 1).
3) Screw press (Fig. 2).
4) Centrifuge for separation of the oil and water phases (Fig. 3).
5) Pre-heater for breaking oil emulsion.
6) Centrifuge for purification of oil.
7) Filter for final purification of oil.
8) Hot air drier for drying residue from screw press.
9) Laboratory screw press.

The overall view of the pilot plant is shown in Fig. 4.

Subsequently a ring-drier was also supplied for drying the residue.

The plant is reported to have a capacity of handling 5,000 nuts per day of 8 hours.

Outline of Process as Originally Developed by M/s. Krauss-Maffei

The husked coconuts are steamed in an autoclave at a pressure of 3 kg/cm^2 for ten minutes to facilitate the removal of the kernel from the shell. The nuts are then opened, the kernel pried out (Fig. 5) and fed into a cutter. The disintegrated material is further comminuted by passing through a roller mill with closely set rollers, and then fed into a screw press to squeeze out the "coconut milk". The "milk" is separated into an oil phase and a water phase by centrifugation. The oil phase is heated to 92°C, centrifuged and filtered to get good quality coconut oil. The water phase is heated to 98°C in a flow heater to coagulate the proteins which are separated by centrifuging and dried. The whey is concentrated (Fig. 6) under vacuum to a 'syrup-like' product called "Coconut honey". The flow-diagram of the process is given below.

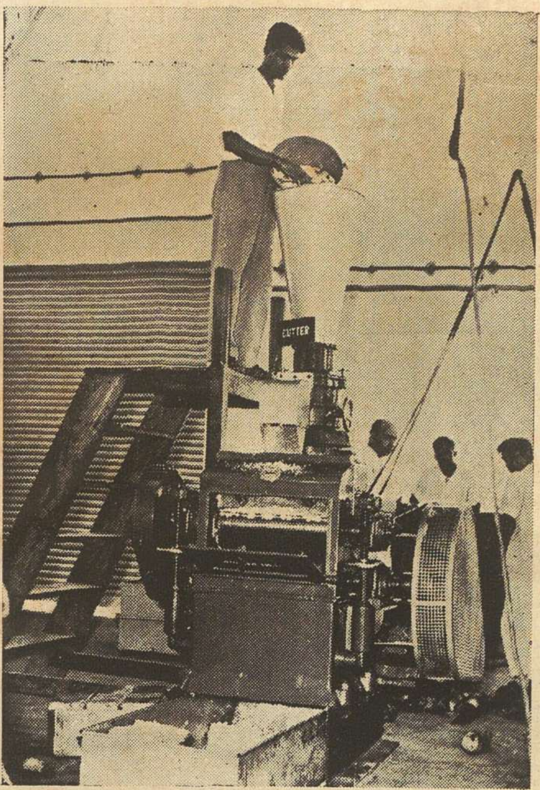


FIG. 1

View of cutter mounted on flaking rolls—coconut kernel pieces being fed into hopper of the cutter

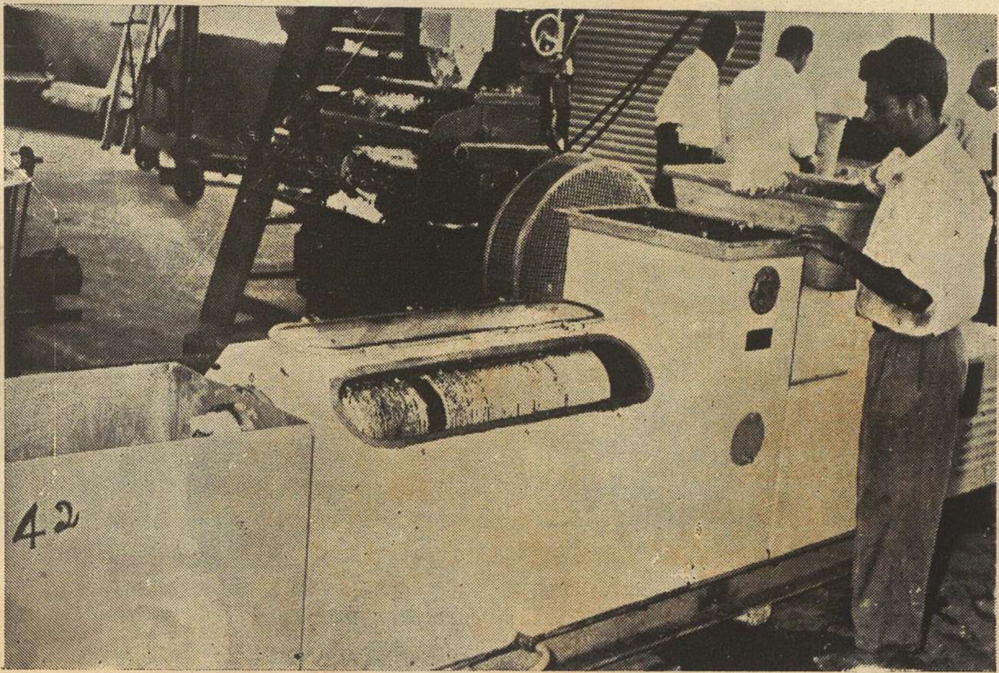


FIG. 2. *K. M. Press for squeezing milk out of grated coconut*

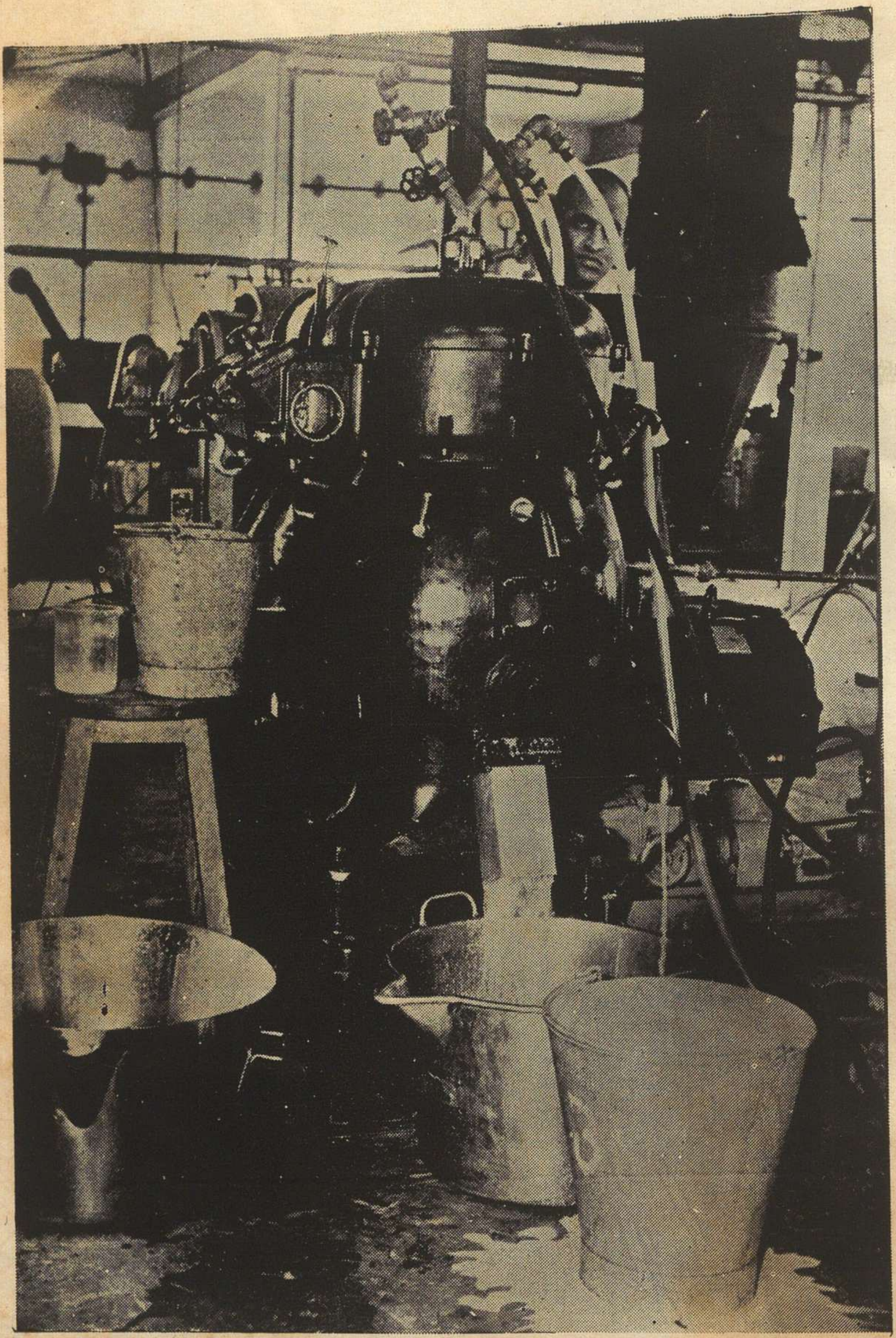
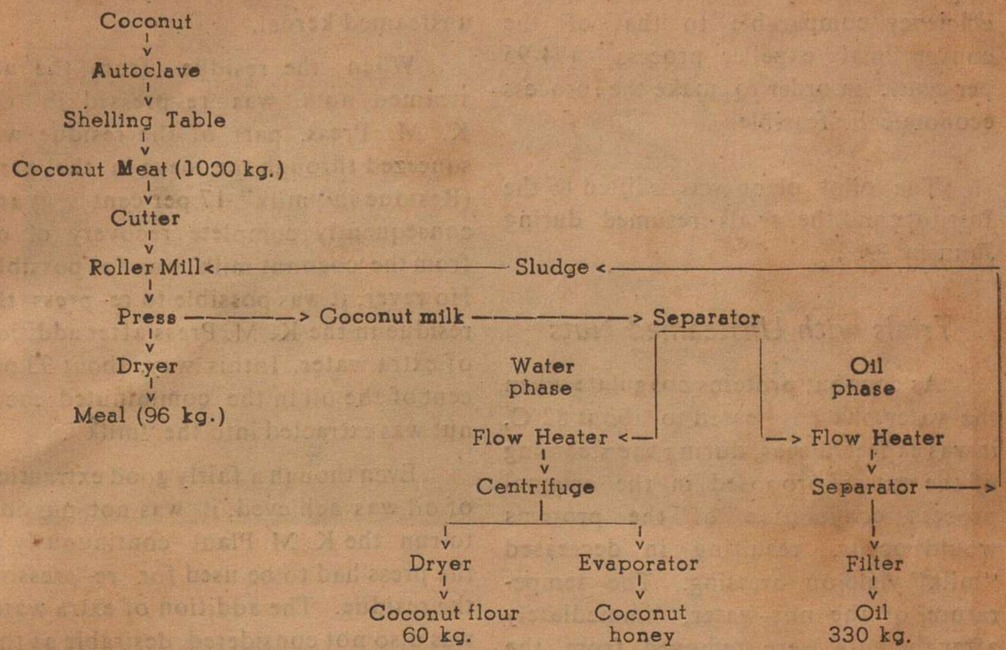


FIG. 3. *Three-way centrifuge for recovering*
1. fat-rich emulsion *2. skim milk* *3. sludge carrying starch*

Flow Diagram — K. M. Process



The advantages claimed for this process over the conventional expeller process are :

1) The facility of using the coconut in the fresh condition instead of having to dry the kernel to obtain copra.

2) Yield of an oil of superior quality to that obtained from copra.

3) Isolation of non-oil fractions of coconut, free from fibre and which can be utilised in processed foods.

Earlier Trials at Tatapuram

Preliminary trials showed that the screw press does not function efficiently and consequently the oil recovery was poor. The meal from the press (28-30 per cent on kernel basis) had on oil content of 46-48 per cent (on dry basis) corresponding to an oil recovery of only 75-77 per cent.

Further trials were carried out by passing the milled coconut twice through the press; in addition, lower speeds of the worm of the screw press, to increase the time of application of pressure, were also tried.

It was observed that the highest yield of oil obtained by the K. M. Process, even after pressing the milled kernel twice in the press was about 84-86 per cent which is of the same order as obtained by crushing copra in bullock driven ghanies. It was therefore obvious that the efficiency of the press must be improved to get an oil extraction efficiency comparable to that of the conventional expeller process (94-95 per cent), in order to make the process economically feasible.

The pilot plant was shifted to the Institute and the trials resumed during January 1962.

Trials with Unsteamed Nuts

As coconut proteins coagulate when the water phase is heated to about 82°C, it was expected that, during the steaming of the nuts as proposed in the original process, coagulation of the proteins would occur, resulting in decreased "milk" yield on pressing. The temperature of the nut-water, immediately after the nuts were removed from the autoclave ranged from 75° to 88°C. It was therefore obvious that the kernel was being heated to more than the coagulation temperature of the proteins, during the steaming. Microscopic examinations of the kernel, thus heated, also confirmed this conclusion.

Trials were next carried out with nuts which were not subjected to steaming. The oil content in the residue in the case of unsteamed nuts, after single pass in the K. M. Press was 35 percent (on dry basis) as compared to 46 to 48 per cent obtained when steamed nuts were processed. There was a marked difference in the physical characteristics of the steamed and unsteamed nuts. The milled kernel from the fresh nuts had a more fibrous feel than that from steamed nuts. The development of cooked flavour in the kernel during steaming, which persisted even in the water and oil phases, was also avoided by processing unsteamed kernel.

When the residue from the unsteamed nuts was re-pressed in the K. M. Press, part of the residue was squeezed through the sieve in the press (Residue in "milk" 17 per cent v/v) and consequently complete recovery of oil from the 'coconut milk' was not possible. However, it was possible to re-press the residue in the K. M. Press after addition of extra water. Inthis way, about 93 per cent of the oil in the comminuted coconut was extracted into the "milk".

Even though a fairly good extraction of oil was achieved, it was not possible to run the K. M. Plant continuously as the press had to be used for re-pressing the residue. The addition of extra water was also not considered desirable as this water has to be evaporated at a later stage for the utilization of the non-oil fractions.

Experiments with Re-pressing of Milled Kernel

The compression of milled kernel at a lower pressure to squeeze out the easily removable "milk" before pressing in the K. M. Press was next tried. This was done by pressing the milled kernel in a de-waterer, having much less compression ratio (2: 1) than the K. M. Press (12:1); the residue from the de-waterer was then passed through the K. M. Press. The extraction of oil into coconut "milk" by this method was over 93 per cent.

The fat content of the final residue was about 25 per cent (on dry basis) which

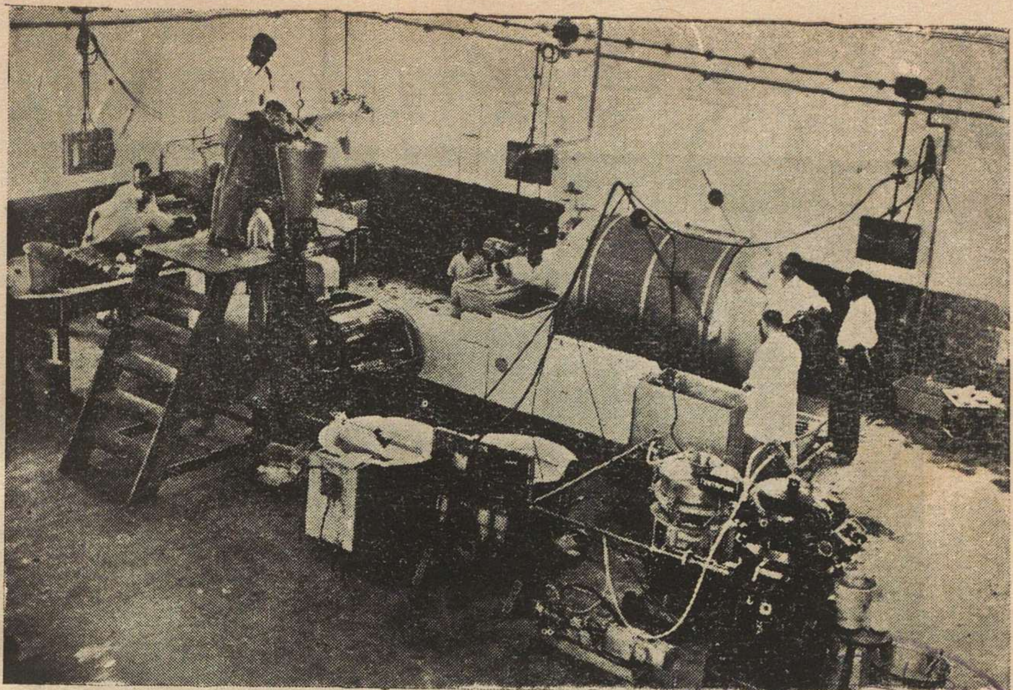


FIG. 4
View of K. M. Pilot plant

FIG. 5
Prying out of coconut kernel from shell

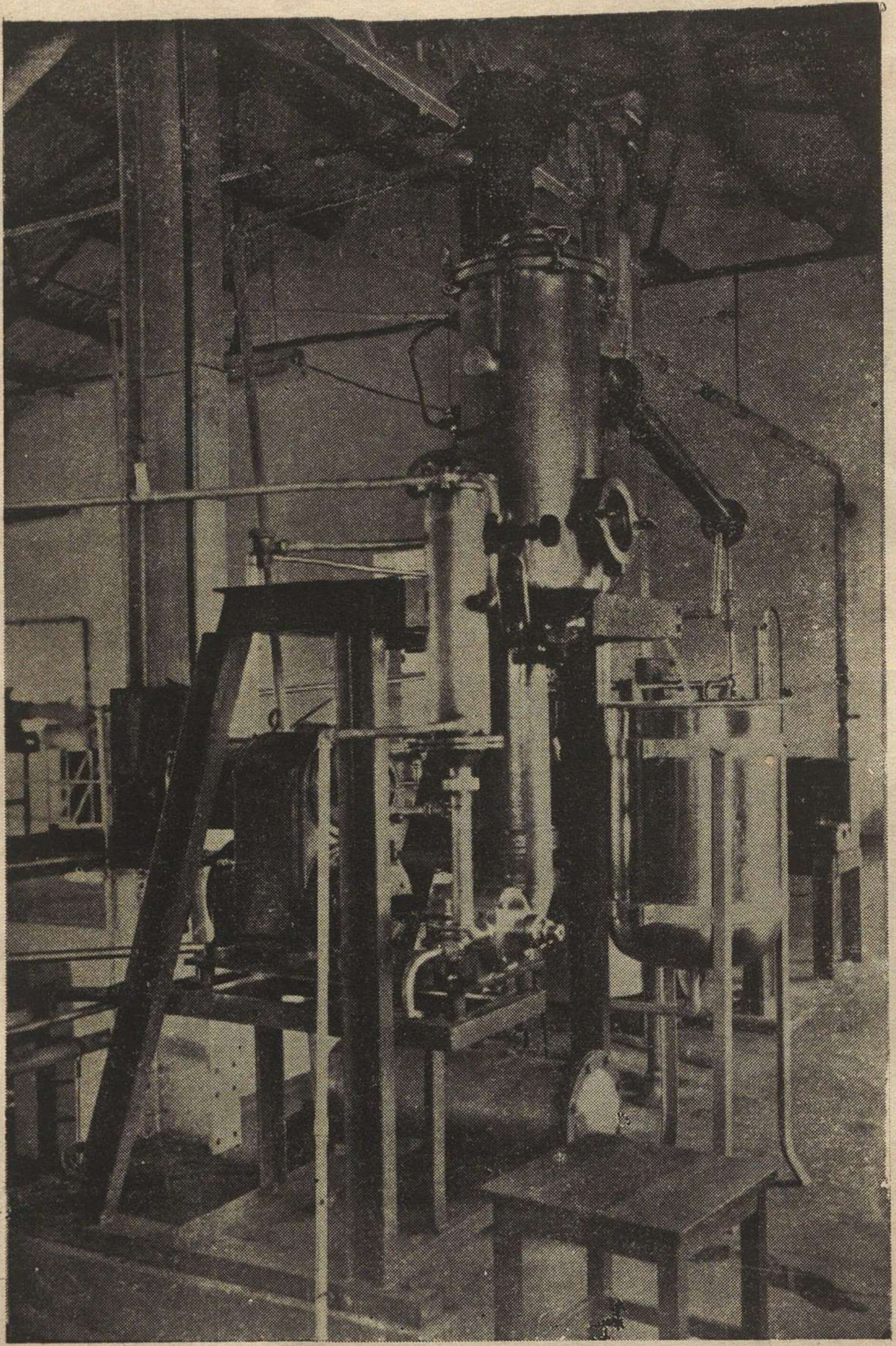


FIG. 6

Evaporator for concentrating coconut "Skim milk" into "Coconut honey" corresponded to a recovery of more than 90 per cent of oil into the "milk". The recovery of protein was also higher by this method, viz. 85 per cent as compared to 75 per cent obtained by two pressings in the K. M. Press with added water.

Extraction of Oil from K. M. Residue

The residue from K. M. Press has an oil content of 24–25 per cent (on dry basis) and hence is too rich in oil for livestock feeding. The wet residue was dried to 7–10 per cent moisture in a ring drier and then passed through a suitable expeller; the pressed cake had the following proximate composition; moisture 9.7 per cent; fat 8.7 per cent; crude protein (Nx6.25) 5.2 percent, crude fibre, 25.1 per cent and ash 1.6 per cent. The oil obtained from the residue was of good quality and could be mixed with the main stream of oil• in the K. M. Process. The residue from the expeller can be utilized for cattle feeding.

Possibility of Using K. M. Residue as a Substitute for Desiccated Coconut

An advantage claimed by the Krauss–Maffei for steaming of nuts is that the brown skin (testa) attached to the kernel would peel off with the shell during shelling, leaving a white kernel, which will yield a white residue. During our trials, it was found that this was only partially achieved, and the advantage was nullified even if 10–15 per cent of the brown skin remained with the kernel. Our investigations have shown that the difference in the specific gravity of the kernel particles and the testa of the K. M. residue can be utilized to separate them by Sink Float method, using water as liquid medium. By this means a complete separation of testa from the K. M. residue has been achieved. Further trials on the utilization of this residue as a cheap substitute for desiccated coconut are in progress.

Krauss-Maffei/CFTRI Process

The above account describes how the original process of Krauss-Maffei has been modified to increase its efficiency and improve the economic aspects. The flow-diagram of the modified process is given on page 158.

Utilization of Non-oil Fractions of Coconut in Processed Foods

The water phase obtained after fat separation of the "coconut milk", containing proteins, carbohydrates, vitamins and salts present in the coconut kernel has been concentrated under vacuum to about 60° Brix and incorporated in processed foods. The proteins from the water phase have also been separated by centrifugation either at the isoelectric point of coconut proteins (pH 3.8 to 4.1) or after heat coagulation of the proteins at 82°C. The chemical composition of the water phase concentrate ("coconut honey"), acid-precipitated and heat-coagulated proteins are given in Table 1.

Flow Diagram: KM/CFTRI Process

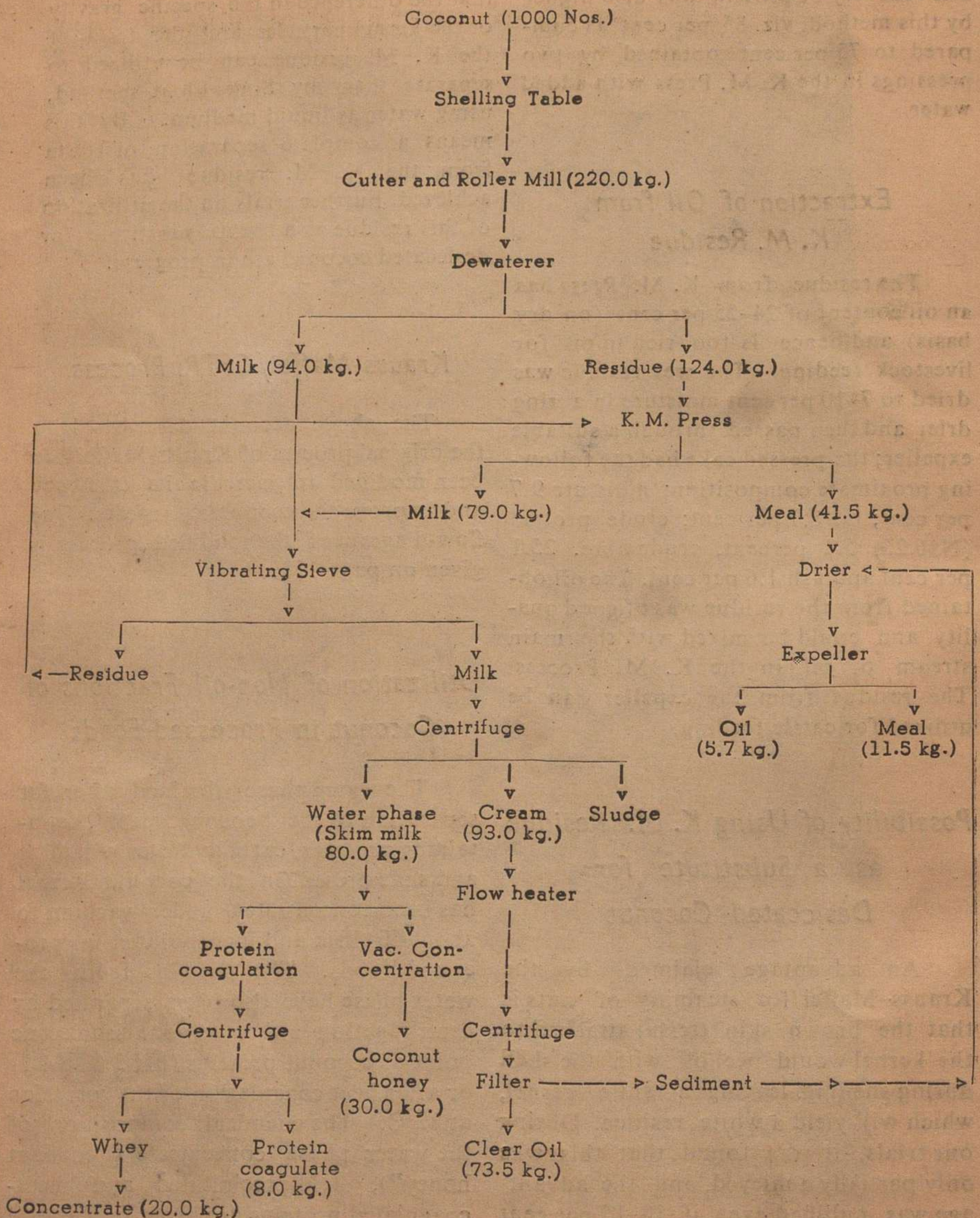


TABLE 1

Composition of Products from CFTRI / K. M. Process

Material	Moisture	Protein N x 6.25	Fat	Minerals	Carbohy-rates (by diff.)
		Percentages			
Coconut kernel	45	4.0	37.0	4.0	10.0
"Coconut milk"	41.0	5.8	38–40	6.2	9–11
"Skim milk"	85.0	6.1	0.2	1.4	7.3
Honey	40.0	15.6	2.0	6.8	35.6
Acid coagulated proteion	6.0	74.3	3.1	6.1	10.5
Heat coagulated protein	8.4	66.1	3.4	8.2	13.9

Two types of processed foods have been prepared using the water phase concentrate viz., (a) Infant food and protein food and (b) Cereal flakes.

(a) *Infant Food and Protein Food*

Air-dried groundnut protein isolate was peptised in water at pH. 6.5. To this required quantities of "coconut honey" and skim milk powder were added and the blend was homogenised. For infant food the required quantity of vegetable fat was also added along with skim milk powder. Dextrimaltose was added to the blend to adjust the protein content to 26 per cent in infant food and 36 per cent protein in protein food. Of the total protein, 2/5th was derived from coconut, 2/5th from groundnut and 1/5th from skim milk powder. The blend was spray dried and mixed with vitamins and minerals at levels to meet the daily requirements of infants.

(b) *Cereal flakes*

These are intended as supplementary foods for children weaned from milk. The cereal flour (rice, wheat or ragi) was gelatinised and mixed with peptised groundnut protein and water phase concentrate or protein isolate from water phase. After addition of vitamins and salts, the blend was homogenised and roller dried. The resulting flakes are highly palatable and can be consumed as a porridge. Shelf-life studies have indicated that the product keeps well in polythene bags over a period of six months. The protein in the product is made up of 1 part from the cereal, 2 parts from coconut and 3 parts from groundnut. The proximate chemical composition of these products is given in Table 2.

TABLE 2

Composition of Foods Containing Water Phase Concentrate

Type of Food	Moisture	Protein (N x 6.25)	Fat	Minerals	Carbo-hydrates (by diff.)
		Percentages			
Infant food	2.1	26.5	18.2	6.2	47.0
Protein food	2.3	36.4	3.0	6.4	51.9
Cereal flakes (Rice)	3.2	25.6	4.0	6.1	61.1
Cereal flakes (Wheat)	3.1	26.1	4.5	6.2	60.1

Continuous Working of the K. M. Plant

The largest batch handled so far in the K. M. Plant was of 1000 nuts, sufficient to feed the K. M. Press for about 75 to 90 minutes, when run at 5 r. p. m. of the worm. The driage and mechanical losses when handling small batches are considerable. With the inclusion of dewaterer it is now possible to run the plant continuously with larger batches. The plant as worked now has a capacity of 900 coconuts per hour. It is proposed to carry out a few trials with about 7,500 nuts per day. These trials will provide data for determining the economics of the process as compared to the expeller process.

Acknowledgements

Grateful appreciation is recorded for the generous gift of a pilot plant by M/s. Krauss-Maffei, Munich, West-Germany. The facilities provided by M/s. Tata Oil Mills, Tatapuram, Ernakulam are also gratefully acknowledged. The cooperation extended by Kasargod Research Station for the supply of coconuts is recorded with appreciation.

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RED OIL PALM

A promising and prospective plantation crop for the country

By

M. S. PATEL* & H. SETHI**

THE West African Red Oil Palm *Elaeis guineensis* Jacq., is the source of two very important vegetable non-essential oils, viz., palm oil and palm kernel oil. Both the oils are obtained from the ovoid-oblong, 2.5 to 5 cm. long fruit, palm oil from the fleshy pericarp and palm kernel oil from the kernels.

Rich in Carotene and Vitamin A

Palm oil is an important edible oil, the superior grades being used for the manufacture of margarine and vegetable shortening. It has excellent soapmaking properties and is largely used for soap and candle making. It is also used in the tin-plating industry and the cold reduction process of making sheet steel. It is very rich in carotene and is considered to be a rich source of vitamin A, comparable to the better grades of cod-liver oil and considered richer than butter.

The better grades of palm kernel oil are also used in the manufacture of margarine and the inferior grades for soaps. The solid stearin, separated from the oil is used in confectionery as a substitute for cocoa butter in chocolate making while the liquid olein finds use in making biscuits, cakes, etc., or it may be used for making hydrogenated products. The refined oil is also used to a limited extent in the pharmaceutical and toilet industries.

Prospects for Red Oil Palm in India

The red oil palm promises to be a good source of income to the planters in suitable areas in India. With a little

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care it is not difficult to raise a successful plantation; the oil is much in demand and the tree continues to give good returns for a number of years.

Though the plant is reported to have been first introduced into India in the Sibpore Botanic Gardens, Calcutta in 1834, and sporadic attempts have been made since then to cultivate it in parts of Madras, Kerala and Maharashtra, yet no commercial plantations have so far been raised in the country.

India's entire requirements of palm oil and palm kernel oil are met at present by imports from abroad, amounting to about Rs. 3 to 4 crores worth annually in respect of the former and about Rs. 60,000 in respect of the latter. The quantity and value of the two oils imported during the years 1959–60 to 1961–62 are given in Tables I and II.

TABLE I

Quantity and Value of Palm Oil Imported Into India

Sl. No.	Countries from where imported	April 1959 to March 1960		April 1960 to March 1961		April 1961 to March 1962		April 1962 to March 1963	
		Quantity (kg)	Value in Rs.	Quantity (kg)	Value in Rs.	Quantity (kg)	Value in Rs.	Quantity (kg)	Value in Rs.
1.	Australia	356	400	3123	3633	Nil	Nil	Nil	Nil
2.	Ceylon	1067	1395	Nil	Nil	Nil	Nil	Nil	Nil
3.	France	Nil	Nil	840946	919907	Nil	Nil	Nil	Nil
4.	Ghana	1405404	450538	1430797	1370430	Nil	Nil	Nil	Nil
5.	Indonesia	2651941	3028900	766431	784879	676801	712729	300000	297739
6.	Malaya	17950403	21340263	20944112	23849500	18601158	22320290	19522415	21713863
7.	New Zeland	Nil	Nil	Nil	Nil	2045	2507	Nil	Nil
8.	Nigeria	2503344	2434445	4008700	4474312	18492719	17734766	1168076	1081303
9.	Singapore	5371704	6239370	3073466	3859320	3562671	3994327	5610151	5903586
10.	Switzerland	Nil	Nil	1024	1156	Nil	Nil	Nil	Nil
11.	Thailand	Nil	Nil	Nil	Nil	20377	24119	Nil	Nil
12.	United Kingdom	Nil	Nil	Nil	Nil	25172	31164	1133	4819
13.	U. S. A.	Nil	Nil	Nil	Nil	50830	57762	Nil	Nil
14.	Small value Transactions	Nil	Nil	15980	19577	99373	125183	Nil	Nil
		23884219	33495311	31084579	35282714	41531146	45002847	26601775	29001310

Source:— Monthly Statistics of the Foreign Trade of India issued by the Department of Commercial Intelligence and Statistics, Calcutta.

TABLE II

Quantity and Value of Palm Kernel Oil Imported Into India

S. No.	Countries Wherefrom Imported	April 59 to March 60 Quantity (kg)	Value Rs.	April 1960 to March 61 Quantity (kg)	Value Rs.	April 61 to March 62 Quantity (kg)	Value Rs.	April 62 to March 63 Quantity (kg)	Value Rs.
1.	Malaya	11227	15064	25121	30410	46500	60774	52000	57845
2.	Small Value Transactions	Nil	Nil	340	351	390	502	Nil	Nil
	Total	11227	15064	25461	30761	46890	61276	52000	57845

Source.— Monthly Statistics of the Foreign Trade of India issued by the Department of commercial Intelligence and Statistics, Calcutta.

Major portion of the imported palm oil is used by the organised sector of the soap industry. Their consumption is estimated at 25,000 metric tons of the oil valued at Rs. 2.5 to 3 crores.

Introduction into India

Our requirements of this valuable oil warrant us to raise large-scale commercial plantations of *E. guineensis* which would not only augment the oilseed resources of the country but would also help conserve the large amounts of foreign exchange at present being spent towards its import. Considerable areas suitable for raising these plantations are available in the coastal regions of South India, particularly the West Coast. As a matter of fact, the red oil palm was introduced into Kerala State some 40 years ago and a few plants are found growing here and there, e.g., Trivandrum, Pilicode, Kasaragod, etc.

Hybrid Varieties

In recent years, improved dwarf hybrid varieties, yielding higher oil content have become available for raising plantations. The Indian Central Oilseeds Committee have already taken steps to introduce these hybrid varieties by sponsoring a Scheme for their trial cultivation in Kerala State. The object of the Scheme is to select a high-yielding dwarf variety of the red oil palm for the tract from among the various varieties imported from abroad and to determine the optimum cultural and manurial requirements of the plant under the conditions prevailing in Kerala. The three hybrid varieties being tried at present under the Scheme are, Dura x Dura, Dura x Pisifera and Dura x Tenera.

A plantation of about 8 acres has already been raised at the main station of the scheme at Thodupuzha, (Kottayam

District) where the area is being extended by about 40 acres this year. Some seedlings have also been planted for trial at Kozha and Ollukkara (Trichur). Outside Kerala, a few seedlings have been planted in Mysore State in order to study their comparative performance. It is further proposed to try the plant in Madras, Andhra Pradesh, Gujarath and Orissa States. With a view to introducing still better varieties, attempts are being made to procure seeds of improved strains from Nigeria which has made considerable progress in this field.

The coconut growing areas in the west coast region of India offer good opportunity for raising plantations of the red oil palm. In view of the large quantities of palm oil used in India and because of the high yield of oil obtained per unit area, it is very important that strenuous efforts be made to take up the cultivation of this plant on a planned and scientific basis.

The extraction of palm oil requires the use of specialised machinery and as the size of an economic palm oil plantation is fairly large, it would require considerable capital to raise and maintain a viable unit. The industries consuming this oil can, therefore, play a positive role in encouraging commercial plantations of this crop.

Cultivation of the Red Oil Palm

A brief account of the cultural requirements of the tree is given below with the hope that it will be helpful to the prospective planters.

Soil: A moist, deep, well-drained medium loam with a pH of 4.0 to 5.0 and rich in humus is considered to be the most suitable. In Malaya, excellent results have been reported from coastal lines and inland river flats with good drainage. In India preliminary trials on the West Coast have shown that the palm comes up well in deep red, sandy-loam while on gravelly and sandy soils the growth is not satisfactory. It has been opined that the plant should grow well in the red soil areas as those of Kottayam District (Kerala). It may, however, not do well on exceedingly sandy soils of the coastal zone. The range of temperature and rainfall in the old Tripura State areas suggest that this palm might do well there also.

Freshly cleared forest soils are very suitable because of their being rich in humus. The plant is more sensitive to the salt content of the soil than the coconut palm, but tolerates very well a salt content of 0.5 per cent.

Climate: The palm thrives best in areas with an average temperature of 26°C and under conditions of adequate sunshine and well distributed rainfall in abundance.

Temperature: An average annual temperature of 20°C is considered to be the lowest limit for vegetative growth of the palm while an annual average temperature of 22° to 23°C is necessary for fruiting. The optimum mean annual temperature is about 26°C. This factor delimits the distribution of the plant and accordingly, the principal areas lie between 10° and 12° on each side of the equator and extend only to some extent in favourable localities to latitudes of

FIG. 1

Elaeis guineensis — *An improved hybrid (Dura x Tenera) seedling at Thodupuzha, Kerala*

Photo: M. N. Kunjan

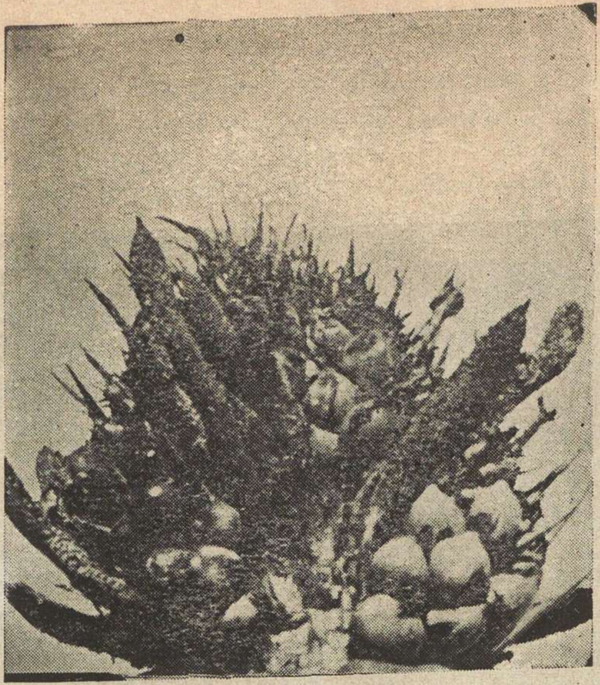

FIG 2

Elaeis guineensis — A fruiting bunch

(From R. Sankaran, Indian Oilseeds Journal, 1958, II (4):57)

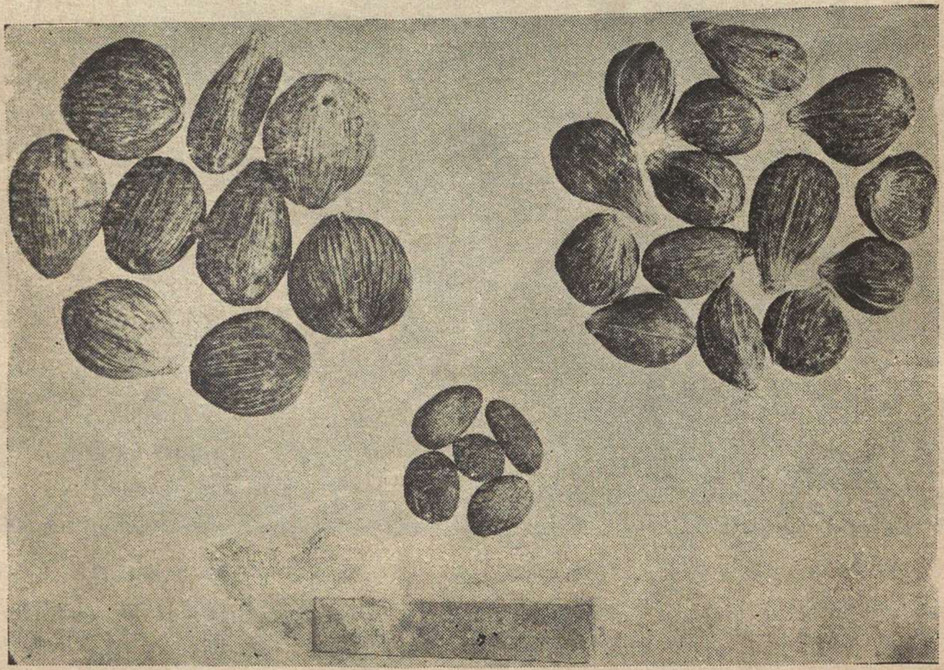

FIG. 3

Elaeis guineensis — Groups of nuts varying in size and shape

(From R. Sankaran, Indian Oilseeds Journal, 1958, II (4):57)

15° to 16°. Uniform warmth is considered important as the plant is very susceptible to variations of temperature which lower the yield.

Rainfall: A well distributed rainfall of about 2,030 to 3,050 mm. is considered to be optimum though the plant can tolerate up to 10,160 mm. of rain per annum. The distribution of the rainfall is very important; it is best when no month gets less than 100 mm. of rain. A frequent alternation between sunshine and rain is desirable. The relative humidity does not appear to have any great influence on the development of the plant but an excessively high humidity can be inimical to fruit setting.

Light: The red oil palm is a strong light demander. It puts on vigorous growth and gives high yield only under conditions of copious sunshine. According to one authority, the fruits are cetainly smaller in regions of high intensity but both the pericarp as well as the kernel are richer in oil than in areas with a low insulation.

Wind: The oil palm has a strong and tenacious root system and is, therefore, well able to withstand storms and hurricanes.

Propagation: Red oil palm is propagated from seeds specially collected for the purpose from fresh ripe fruits. The seeds are sown in well-prepared nursery beds and germinate in 2 to 3 months. At the 2 or 3-leaf stage, the seedlings are pricked out into the second nursery beds where they remain for 12 to 18 months until they are sufficiently developed to be planted out in the field. Their height at this time is about 30 to 90 cm.

Field planting is done at a spacing of about 9 metres in triangular planting. This gives the most compact arrangement at the same time allowing the maximum amount of sunlight to reach every plant, this being important for good development and growth. The arrangement gives a stand of 143 plants per hectare and is the most common one used in the Far East although other spacings are also adopted. Leguminous cover crops planted between the rows provide protection against soil erosion and at the same time enrich the soil.

Fruiting: The red oil palm begins to bear fruit at the age of 3 to 4 years and reaches full bearing at 10 to 15 years. The fruit takes about 6 months to ripen. The yield gradually declines after the age of about 30.

Harvesting: The fruit bunches are ready for collection when a few fruits detach themselves from the bunches and fall to the ground. By this time, the pericarp has reached its maximum oil content and the acidity starts to increase. Ripeness is also indicated by a change in the colour from red to orange.

As the palms increase in height, harvesting becomes more difficult. For 12 to 13 years, the harvester can climb the tree using the bases of the cut leaves as foot-rests. But thereafter with increasing height and rotting of the leaf bases, ladders have to be used to reach the crown.

Pests and diseases

Precautions against damage from plant diseases, insects and animals such

Flow diagram of palm oil & palm kernel oil extraction

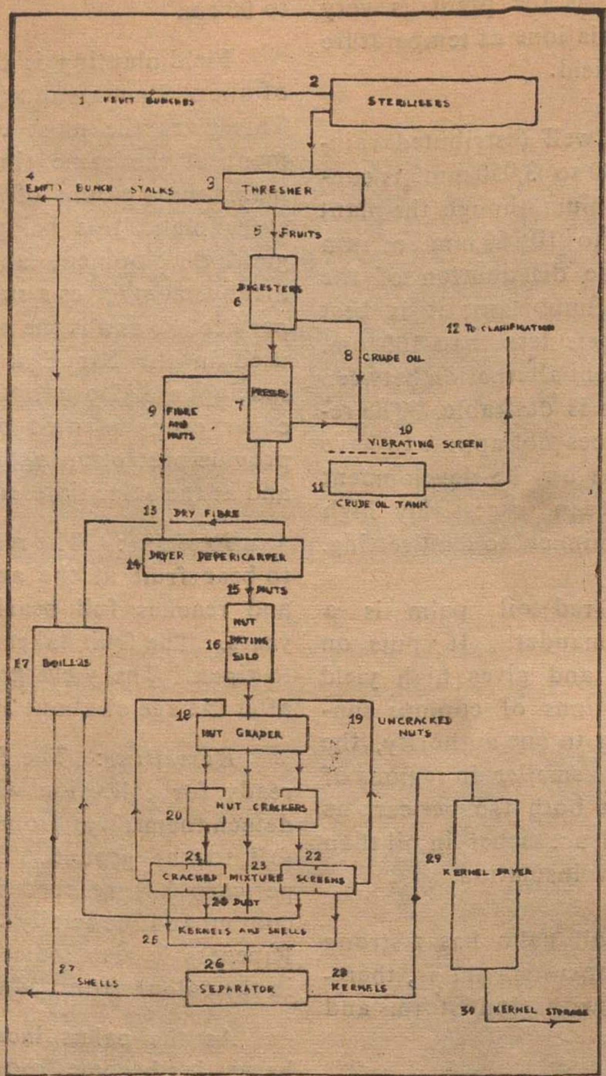

Fig 1 — Flow Sheet

1. Fruit bunches
2. Sterilisers
3. Thresher
4. Empty bunch stalks
5. Fruits
6. Digesters
7. Presses
8. Crude oil
9. Fibre and Nuts
10. Vibrating screen
11. Crude oil tank
12. To clarification
13. Dry Fibre
14. Dryer Depericarper
15. Nuts
16. Nut drying silo
17. Boilers
18. Nut grader
19. Uncracked nuts
20. Nut crackers

21 & 23. Cracked mixture
22. Screens
24. Dust
25. Kernels and shells
26. Separator
27. Shells
28. Kernels
29. Kernel Dryer
30. Kernel storage

as elephants, monkeys, rats and wild boars are necessary. Rats and squirrels are reported to cause considerable damage when the fruits ripen. The beetles *Oryctes rhinoceros* Linn. *Rhynchophorus ferrugineus* F. also appear to cause severe damage in some areas. Among the diseases may be mentioned bud and crown-rots, stem-rots, bunch-rot, root and trunk-rot, vascular wilt and a physiological deficiency disease known as yellowing disease.

Yield

The average annual yield of fruit per tree in an uncultivated state is reported to be 27 to 36 kg. From the experimental plots in South Kanara a yield of 4,000 nuts weighing 27 kg. per bearing palm has been reported but the average yield is only 8 to 11 kg.

Extraction of Oil

As mentioned earlier, the processing of the fruits to obtain the two types of oil which they contain, involves use of special type of machinery. In the modern process now being used, the fruit is first processed to extract the palm oil from the fleshy pericarp after which the nuts are cracked to separate the kernels from the shells.

The oil from the kernels may be extracted in the countries of origin or the kernels may be exported as such and processed in the importing countries themselves. The various steps involved in the extraction are: sterilisation threshing, extraction of the palm oil, pressing, centrifuging, clarification, depericarping, nut drying, nut grading and cracking, separation of kernels and shell, kernel drying and extraction of palm kernel oil. The flow sheet of a modern process given by Messrs. Gebr Stork & Co., of Amsterdam, Holland, is given on facing page.

The extraction of palm oil and palm kernel oil is a highly skilled process in which the prospective planters may not be interested at the present stage and detailed account of the various steps is, therefore, not being given here.

Yield of Palm Oil and Palm Kernel Oil

The fleshy pericarp is reported to yield 30 to 70 per cent of palm oil on moisture free basis while the yield of oil from the kernels is 44 to 53 per cent on moisture-free basis, depending upon the size, development and quality of the fruit.

In view of the importance of palm oil to the country, the existing shortage of vegetable non-essential oils, the high yield of palm oil obtained per unit area (1 to 2 tons per acre per annum) and the availability of considerable suitable areas in the country, particularly along the west coast, it is to be hoped that with the concerted efforts and co-operation of all concerned large scale plantations of this important palm would be raised in the country in the near future.

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INCREASING INCOME from COCONUT LANDS

By
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According to estimate made in 1958 by the Agricultural Economic Division of the Philippine Department of Agriculture and Natural Resources, there are 165,000,000 coconut trees in the Philippines. There are undoubtedly more than this number by now.

Many of these trees are old, overaged and unproductive. In the former San Pablo Experiment Station of the Bureau of Plant Industry, 48.6 per cent of the 4,703 trees produced from 0 to 20 nuts a tree per year; 42 per cent of the trees yield from 21 to 40 nuts per tree a year and only 8.62 per cent or 31 trees out of 4,703 trees produced from 41 to 60 nuts per tree a year. In the Quezon Experiment Station in Tiaong, Quezon, 10.02 per cent of the coconut trees produced annually from 0 to 20 nuts per tree and 30.90 per cent produced from 21 to 40 nuts per tree. About 37.64 per cent of the trees showed a yield range of 41–60 nuts; 17.36 per cent, 61 to 80 nuts and only 3.67 per cent, 81 to 100 nuts. The situation is practically the same in Sariaya Quezon where in a co-operative plantation management, the Bureau of Plant Industry workers reported that of 2,316 bearing trees, 10.10 per cent are very poor yielders — 0 to 20 nuts per tree a year; and 7.77 per cent had a yield range of from 21 to 40 nuts per tree a year; 20 16 per cent produced from 41 to 60 nuts; 31.65 per cent, 61 to 80 nuts; 21.93 per cent, 81 to 100 nuts; 6.56 per cent, 101 to 120 nuts and 1.68 per cent had a yield range of 121 to 140 nuts per tree a year.

This level of productivity, however, can be raised considerably by the adoption of proper cultural practices.

Effects of ploughing and cover cropping on yield

The beneficial effects of ploughing the land and cover cropping it with *Pueraria phaseoloides, Calopogonium coerrulum, Centrosema pubescens* and other leguminous annual crops such as mungo (*Phaseolus aureus*) peanut (*Arachis hypogaea*) and soya bean (*Glycine max*) were demonstrated in the old San Pablo Coconut Experiment Station of the Bureau of Plant Industry. Through tillage and cover cropping, old and unproductive coconut groves were rejuvenated and the increase in yield in five years went as high as 20 to 30 per cent. The 4,703 trees in the 25 hectares of land covered by the study gave an annual mean yield of nuts per tree as follows: in 1947 – 31.38 nuts; 1948 – 31.81 nuts; 1949 – 37.24 nuts; 1950 – 40 nuts; 1951 – 48.27 nuts, indicating that the increases in the yield were fairly high in the 4th and 5th years. These are to be expected as the response of coconut plants to tillage and other cultural treatment is slow.

Effects of commercial fertilizers on yield

Results of a six-year study conducted by the Bureau of Plant Industry in its Quezon Coconut Experiment Station have demonstrated that the application of commercial chemical fertilizers in run-down coconut plantations of 35 to 45 years old could rejuvenate old coconut stands and increase their fruiting capacity. This study has also shown that the combinations of NPK, NK, PK and the single application of K (muriate of potash) induce the most significant increase in nut yield, ranging from 10.5 to 16.2 nuts per tree per year.

In a trial study made by the College of Agriculture, University of the Philippines, it was found that application of fertilizers to dug areas round coconut trees corrected the yellowing malady of the coconuts and improved their yields. The NPK application at the rate of 1 kg. of N plus 1 kg. of P_2O_5 and 1 kg. of K_2O per tree per year gave the highest yield of 84 nuts per plot more than the unfertilized plot, followed by the NP which produced 66 nuts and N, 43 nuts. The increases in nut yield ascribable to the individual elements when compounded successively, were 43 nuts per plot for N, 23 nuts for P, and 18 nuts for potassium.

Research findings brought to farmers

For the proper guidance of coconut planters in their farming operation the

FIG. 1
One of the coconut groves in San Pablo City, Laguna in which a good rice crop was raised in 1962

FIG. 2
Citrus and other fruit trees when planted in coconut groves increase the income of the farmers. A citrus plantation in coconut groves in Tanauan, Batangas

FIG. 3

A coconut plant badly damaged by the slug caterpillar (Thosea Sinensis Walker) in Lebagon, Leyte

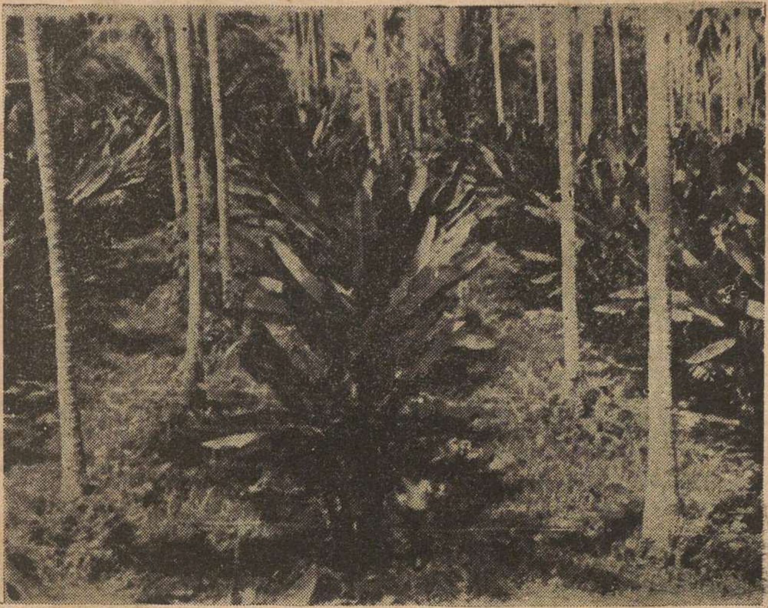

FIG. 4

Abaca plants (Musa textilis) thrive well in coconut groves and provide the Manila hemp fibre for export.

FIG. 5

A 64– foot platform used in spraying coconut leafminers in Balabagan Coconut Estate, Balabagan, Lanao del Sur.

........with tree guard
from cattle
.... with Pyrocone-E
from red palm weevil.
.........with DDT from
leaf-eating caterpillar.
PROTECT
YOUR PALM.....
....with beetle hook and BHC
from rhinoceros beetle.
......with protective metal
bands from rats.
th Bordeaux paste
m bud root.
.........from leaf rot by cutting and burning the
affected leaves and spraying Bordeaux mixture.
......with Bordeaux mixture
from root and leaf disease

Philippine Coconut Administration (Philcoa) organized a campaign to disseminate these findings on clean culture and proper application of fertilizers. Briefly, clean culture comprises the ploughing and cultivation of coconut plantation to eradicate obnoxious weeds, improve the texture of the soil, promote aeration and inerease the fertility of the soil and its water holding capacity.

To encourage the practice of clean culture in coconut groves, farmers were advised to plant rice, corn and other food crops. Fertilizers were applied to promote growth. It was believed that the fertilization of the above mentioned crops would ultimately benefit the coconut trees. Fertilizers would improve their growth and subsequently their fruiting ability. As a result, farm produce would increase. With proper attention the cocónut plants and the rice and corn intercrops would potentiate each other to raise the farmers' income.

There are numerous coconut groves in different parts of the country that are more or less level land and suited for the culture of upland rice and corn. If these vast tracts of cultivable land can be planted regularly to food crops, the Philippines can raise enough food for its rapidly increasing population. It may be a wise step by the agency in-charge of the food production campaign to tap the potentialities of coconut land in the production of rice and corn. Raising two distinct crops in coconut groves where only one crop grew before may help solve the perennial problems of hunger and poverty of the people in some parts of the country.

Organized only a year ago the Philcoa-farmers tie-up has already established several pilot areas in the coconut provinces of Laguna, Batangas, Sorsogon and Catanduanes. Trial plantings of rice and corn in coconut groves last year produced high yield (Fig. 1). Additional demonstration plots are in process of organization for planting to rice and corn this year. The response of coconut planters to the campaign to raise food crops in coconut groves varies but on the whole is very encouraging.

The fertilizers applied in the demonstration areas in the 1962–63 crop year were provided jointly by the Philcoa, the co-operating coconut planters, the Atlas Fertilizer Corporation of the Philippines, the General Fertilizer Corporation and the Maria Christina Fertilizer Corporation.

Additional income from other crops

Years before the Philcoa started its campaign to popularize the planting of rice and corn in coconut groves other money crops were already in scattered cultivation in coconut plantations: vegetables, cassava, bananas and pineapple and fruit trees like lansones (*Lansium domesticum*), coffee, cacao and citrus (fig. 2). Abaca or the Manila hemp plant (*Musa textilis*) has been in extensive cultivation in coconut areas in the Bicol Peninsula (Southern Luzon) Lanao, Leyte and Samar. Abaca is widely known as the source of a commercial fibre known under the trade name Manila hemp in the world market. Given proper care abaca plants thrive well in coconut groves (fig. 4).

The cultivation of these intercrops makes farming in coconut groves not only highly profitable. The various activities attendant to the proper maintenance of the coconut plants and the intercrops demand from the farmers full attention and the use of all time in the plantation all the year round.

Control of pests and diseases

Among the factors affecting production is the occurrence of diseases and insect pests in coconut groves. If allowed to develop, a destructive pest or disease can dip production. The cadang-cadang disease of coconut in the Philippines has rendered dead or unproductive not less than 9 million coconut trees in several provinces in the short span of 30 years. Outbreaks of infestations by leafminer, coconut beetles, slug caterpillar and scale insects often result in extensive damage to coconut trees (fig. 3).

Their control therefore, is an important part of farming operation in coconut producing lands. The application of insecticides and fungicides occasionally (fig. 5) and the use of different cultural practices such as cultivation to keep down the weeds, cover-cropping and green manuring reduce the occurrence of such insect pests and diseases.

non-conventional uses of coir

(Contributed)

COIR, like tea and jute, is by and large an export commodity, and more than half the entire production including yarn is exported every year, thus earning for our country foreign exchange worth about Rs. 12 to Rs. 13 crores. Taking coir products alone, over 90 per cent of the entire production is exported. As the economy of the industry largely depends on the export which has been the main outlet for our conventional goods such as cordage, mats, mattings, rugs and carpets, now produced in India, any depression in foreign markets will adversely affect the livelihood of about 5 lakhs of people depending on this industry. To offset this eventuality, the exploitation of the non-conventional uses of coir and the expansion of the internal market are of great significance.

India utilises only about 190 crores of husks out of an estimated total production of 476 crores in the preparation of fibre accounting for about 1,50,000 metric tons a year.

packing pads

Besides its main use as floor coverings and in rope making, coir fibre finds extensive use as packaging material to protect goods against shock in transport. The common form in which it is used is by making a soft cushion of the mattress fibre between two thicknesses of low quality jute hessian. This pad is manufactured in rolls that can be cut and used. During the World War II, this material was in great demand for resilient packing as prescribed in specification DTD 780.

Investigations have been carried out on the utilisation of coir fibre for production of activated carbon, artificial horse hair, paper pulp, roofing tiles, writing boards, containers, thermal insulators etc. and many of the processes are subjects of Indian and foreign patents. Recent work in the Forest Research Institute has shown that high stretch paper can be made from coir. According to the report of Coir Board Delegation to Foreign Countries (1959) about 60 per cent of coir yarn imported into Italy goes to the manufacture of oil filters and about 10 per cent for Tunna-fishing.

rubberized coir for cushion

In Germany coir is rubberized for making cushion seating for automobiles and railways. The rubberization is brought about by spraying layers of coir fibre and rubber with the help of a specialized machine. It is reported that most of the cars manufactured in Germany are upholstered with this rubberised mattress, because it is more economical having a life of over 20 years. Its additional advantage is that furniture upholstery could be moulded in any shape and this process is cheaper than that of foam rubber. The possibility of producing similar articles from inferior grades of coir fibre in India needs investigation. Steps have already been taken by the Board to set up plants for the manufacture of rubberised coir goods in the important coconut growing states of India and also de-fibering plants for the production of bristle and mattress fibre, so that a greater percentage of husks could be put to industrial use. One such plant has already started production in Tirunnelveli. Coir fibre of inferior quality may be used for manufacturing hard board by mixing with fossil resin, melted at a high temperature and suitably processing into boards. Loosened fibre and fresh wet husk can be used for making into boards without the use of resin by hydraulic pressing.

The use of coir mattings for sand stowing purposes in coal mines was under investigation in collaboration with the collieries of Tata Iron and Steel Works. The results of the preliminary experiments at the Coir Research Institute at Kalavoor near Alleppey were encouraging and extensive trials are proposed to be carried out to study the economics of the process. The Coir Research Institute has sent coir beltings to the Iron Mines of Tata Iron and Steel Company for experimental use as conveyors for mine ores, the results of which trials are awaited.

coir yarn as lead for hop vines

Coir yarn has been found to be the ideal lead for hop vines for taking them to the required height. There is good demand for coir yarn in the United Kingdom for this purpose. According to the report of the Board's delegation to foreign countries, about 5,000 tons of imported coir yarn are normally used in the hop fields for training hop vines. Another 5,000 tons are estimated to be utilised by the United States of America and Canada together for this purpose.

Tea estates in India, especially those in South India, are using bags made out of coir yarn for collecting and transporting fresh tea leaves from the garden to the factory. Coir bags are also used for lifting coal from mines in Bengal, Assam and Central India. Coir yarn is used extensively for making fenders which are attached to ships and boats for preventing from shock or damage due to collision.

Coir mats with pile for commercial packaging purposes have come into vogue. Circular brush mats have come into use as cushion istead of protective cardboard tubes for packing.

coir mats for sound proof walls

Another interesting development in the use of coir mat is as a construction material in buildings. A process, called Mulvan process, developed by Mulvaney is useful for constructing partition walls of rooms using coir mat as the base on which a mixture of cement and sand is gunnited. It is claimed that this method effects a saving of 15% compared to brick or reinforced cement concrete work. Besides, the walls are sound proof and do not crack.

Coir mattings after bituminization offer possibilities of being used as floor coverings in godowns where stored goods are stocked, as they withstand moisture absorption by the stored goods. The possibilities of utilising bitumirised coir mattings for canal lining were under correspondence for carrying out the work in collaboration with Vaigai Canal authorities.

Rubber backing of coir mats is also an interesting improvement of the ordinary mats. Rubber-backed coir mats are soil-proof, sound absorbent and do not scratch polished floor.

Heavy matting made out of thick coir rope is being used for transporting gas cylinder.

filterpoint strainers

One of the recent applications of coir rope is its use as a strainer in tube wells in place of wire mesh strainer or filter point as it is called. It is claimed that the coir filter point tube wells have definite advantage over the wire mesh type which is in common use in that they are more easily constructed, they are cheaper and give higher output.

Large quantities of coir dust are available. Its utilization has been the subject of investigation in India, Ceylon and Indonesia.

Coir dust or cocopeat may be used as packing, stuffing and heat-insulating material. It has been used for improving soil drainage and as mulching, rooting, soil conditioning and seed germinating medium.

Some processes for the utilization of coir waste have been patented in India. The Central Food Technological Institute, Mysore has developed a process for the production of insulating materials using coir dust and other waste materials. Experiments conducted at the Central Research Institute, Trivandrum, have shown that the pith, suitably compounded with rubber latex, is effective as heat or insulation material for the commercial transport of fish to distant places. The possibility of producing power gas from coconut dust has been investigated. Manufacture of fabricated cement articles and water resistant boards are other suggested uses for waste.

fibre boards

Fibre boards from coconut pith are produced by Coconut Pith Industries, Trivandrum. A process for the manufacture of "Coirolite" from coir waste has been worked out under the auspices of the Coir Board at the Department of Chemical Technology, Bombay University.

The process consists in incorporating coir waste with resins and other ingredients by the usual techniques of plastics manufacture. The powder obtained is hot-pressed to obtain articles of any shape by using appropriate moulds. Coirolite is a tough and hard material and possesses good strength and electrical resistance. It can be made to acquire different colours, but the choice is limited to a few deep shades, pastal shades being difficult to obtain.

also for defence purposes

It will be interesting to know in this connection that coir has also a place in the defence field. Coir matting fabricated as salitahs for packing tentage, bags to pack tent poles and pins, wall bags to hang weapons, dumping-mat for keeping heavy machineries from shocks and scratches, camouflague-nets, and bags for carrying articles of butchery, worth about Rs. 2 crores were reported to be supplied to the army during the Second World War.

India has great potentialities for the development of the coconut fibre industries if we would fully exploit our raw material resources that is, by the fabrication of our coir fibre into various articles such as have been mentioned above.

Recent Developments in The Ceylon Desiccated Coconut Industry

By
R. H. De Mel
H. L. De Mel & Co., Colombo - 1

IN 1953 there occurred in Australia an epidemic of typhoid that was to have far reaching effects on the coconut industry in Ceylon. This outbreak of typhoid, a very unusual occurrenc in Australia, was traced to a sweetmeat very popular with children, and the infection in the sweetmeat was traced back to a particular batch of desiccated coconut. This batch had been imported from a source other than Ceylon, and further importation from this source was prohibited by the Australian authorities.

Contamination of Desiccated Coconut

Apparently at this time material from sources including Ceylon did not disclose any contamination. Hewever, the matter was kept under investigation and finally in 1959 a number of samples drawn from shipments of the Ceylon material to Australia disclosed contamination with Salmonellae. Soon after, a series of examinations of Ceylon desiccated coconut in the United Kingdom disclosed very similar results. As a result, systematic examination of all desiccated coconut reaching United Kingdom ports was commenced. Similar examinations were instituted in Germany.

The industry in Ceylon was concerned, but at first the rejections were small, and as this loss would be covered by payment of a relatively small insurance premium, it was felt that the problem was not really serious. However, insurance gradually became more expensive and then the problem was much more serious than it had appeared to be. It was obvious that prompt and effective action had to be taken if a major disaster was to be averted.

It was agreed that the Ceylon Coconut Board was the appropriate authority to deal with the problem, as it was empowered to regulate the processing and marketing of all coconut products. It may be mentioned here that the sister organisation, the Coconut Research Institute, deals with the agricultural aspects of the industry, including any processing normally carried out by the growers. Accordingly, early in 1960, the Ceylon Coconut Board started its investigations, with the close co-operation of the department of Health, particularly the Medical Research Institute, the Division of Public Health Services and the Division of Public Health Engineering. Advice was regularly sought and was regularly received from the Central Public Health Laboratory of the Public Health Laboratory Service of the British Ministry of Health, and the Federal Health Authorities of Australia also gave valuable assistance, ultimately sending out to Ceylon a senior Health Officer to ensure that the steps taken in Ceylon would render the finished product completely acceptable in Australia.

Ways of Contamination

It was soon clear that the contamination could be conveyed to the coconut in three ways:-

(i) from the water used for washing the coconut;

(ii) from the surface of the shell of the coconut, which is transported husked from the plantations; and

(iii) from the hands of employees engaged in shelling, paring and washing the coconut.

Thus, if an effective sterilisation process could be introduced after these processes, and if the processed coconut was thereafter not handled manually, the problem would be solved.

Thermal Sterilization Needed

It was agreed that as regards sterilisation, a thermal process was desirable, and, indeed, a chemical process that was suggested was rejected as it had proved unreliable in tests carried out elsewhere, and in any case left a residue that made it unacceptable in major consuming countries, quite apart from its expense. This meant that three methods were available-immersion in boiling water, steaming at atmospheric pressure, and steaming under pressure, in an autoclave. It was found in actual tests, that the immersion of the pared half coconut for 30 seconds in boiling water destroyed all bacteria. The pared half coconut with its smooth surface presents the minimum surface area for sterilisation, which is therefore much easier at this stage than after disintegration when the same weight of coconut in small particles would present an enormously increased surface area. Thus, sterilisation immediately prior to disintegration was considered desirable.

Steam sterilisation would require boiler equipment, and the installation of autoclaves of the capacity required to deal with 20,000 nuts to about 80,000 nuts per eight hour day could hardly be justified. Further, a continuous process was considered more desirable than a batch process. A rather ingenious method of steam sterilisation by injecting steam, raised cheaply in a pipe passed through the desiccator furnace, into the hot air stream entering the desiccator, was found not acceptable on account of difficulties in controlling the process so as to ensure uniformly effective sterilisation. Besides, steam sterilisation of the finished material is rendered rather difficult by the habit of the desiccated coconut of forming lumps while drying, which lumps remain moist at the centre. The steam cannot come into contact with the meterial at the centre, which is slow to heat up due to the moisture, unless the coconut is agitated and the lumps broken up, and this would mean additional equipment.

Boiling Water Method

The boiling water method was therefore adopted as being effective, cheap to instal and to operate and lending itself to continuous operation. The requirements were simple, a 1000 gallon tank mounted on a wood fired furnance of the type normally used in the industry, and a screw conveyor to carry wire baskets containing the coconut through the tank. Control was equally simple and effective. The conveyor was geared to transport a basket in not less than $1\frac{1}{2}$ minutes–a sufficient margin over the 30 seconds found necessary, and a thermostat in the tank, that is a thermometer with electrical contacts, prevented the conveyor motor from starting until the water was boiling, and stopped the motor if the temperature dropped 10° F. below boiling point.

Contamination in the water used for washing could be controlled by paying careful attention to the source, and as a further precaution, by chlorination. Fortunately, a simple automatic chlorinator for fitting on the pipe line between the source and the storage tank, with a minimum of moving parts, of local design, was available.

Elimination of Factory Contamination

There now remained the problem of ensuring that coconut once sterilised would not be liable to re-contamination in the factory. This was done by "Sectionalising" the factory lay-out. The initial processes of shelling, paring and washing are normally carried out on open verandahs, and the large number of workers required for these processes must have access to this area. The rest of the factory, that is the disintegrating and desiccating area and the cooling, sifting and packing area, was fenced off, rendered fly proof, and access to these areas restricted to the relatively small number of persons required for the work in these sections. Foot baths containing disinfectant would be provided at the entrances to these sections and hand baths and separate washing facilities as well as separate sanitary arrangements provided for these "sterile area" workers. Scoops sterilised at regular intervals would prevent manual contact with the coconut, and the packing of the finished product into bags would also be done mechanically.

Loans to Desiccated Coconut Millers

Once the Coconut Board was satisfied that these methods would be effective in dealing with the problems, all desiccated coconut millers were notified of the steps to be taken by them to put their mills into order. Financial aid was also secured for them from approved credit institutions to the extent necessary for complying with the Board's requirements, the Board guaranteeing to service the loans granted out of the proceeds of an export cess levied on all desiccated coconut at the point of export. On receipt of these cess collections from the Principal Collector of Customs, the Board apportions the amount among all millers in proportion to their production during the previous quarter, and pays over to the credit institution concerned the interest due on each loan, and any surplus is utilised to reduce the capital sum. If a miller has not raised a loan, he receives the full sum contributed by him, less a small percentage that the Board is entitled to deduct, if necessary, in order to make good any payments due by millers whose contributions are insufficient. In other words, under the scheme all millers mutually accept liability for the loans taken by them individually, which speaks very well for the co-operative spirit prevailing in the industry.

Regulations Regarding Desiccated Coconut Mills

Of course, it was realised that the development of a suitable method of eliminating contamination, and the appropriate re-arrangement of the mill lay-out would not in themselves ensure the desired result. Satisfactory implementation was essential, and fortunately the Coconut Board had considerable experience of enforcement of its statutory regulations. The Board was established under the Ceylon Coconut Ordinance in 1935, and its first task was the organisation of a Sales Room, where all copra destined for export, or from which oil for export was milled, had to be offered for sale by public auction. That all such copra was so offered, was ensured by the licensing of exports, licences being issued only to shippers and millers who had purchased their copra at the Sales Room. In order to ensure that dealers were actually in possession of the copra they offered for sale, and so prevent speculative offerings, all dealers were registered and required to maintain detalied records of their transactions, both as buyers and sellers. Similarly, oil millers and shippers were registered and required to maintain their records. All these records were scrutinized by inspectors employed by the Board, and all concerned were penalised for any breach of the Board's regulations.

The Board proceeded to draw up a series of regulations covering the construction of mills, the operation plant and equipment, the sterilisation of the coconut, the packing and transport of the finished product, the health, the personal hygiene of the workers, the sanitary facilities for the workers, the standards for the process water and finally, the standards as to the quality of the product, both physical and bacteriological. These regulations were accepted by the Minister of Commerce and Trade, and duly approved by Parliament and there remained the task of implementing them,

Control Laboratory to Examine Desiccated Coconut

A Control Laboratory was set up in the Colombo Office Building of the Board, which was equipped to carry out both the bacteriological examination and the physical examination of desiccated coconut. A staff of inspectors, provided with suitable transport was appointed to the milling areas, every inspector being required to visit each mill in his area every day and draw samples of the production for despatch to the laboratory in Colombo. All material rejected as not conforming to the standards was required to be disposed of for oil milling, so that only material of good quality was available for export. All packages intended for export had to bear labels issued by the Board, carrying the identification number of the mill together with a serial number. The shipper was required to stencil his identification number on every package as well, so that in the event of any defect being pointed out by a buyer abroad, the package could be traced back to its source and the date and even the approximate time of manufacture established. This provides a valuable check not only on the miller, but also on the Board's inspection service.

This organisation has been functioning since the latter part of 1962, and it would appear that the problem of the control of contamination has been successfully solved. Reports from Public Health authorities in the major consuming countries such as the United Kingdom, Germany and Australia show that shipments of desiccated coconut are now free of contamination.

Greater Standard Achieved

The examination of the physical properties has also resulted in a greatly improved standard, and there is now much greater uniformity in the production of all mills. This is particularly important, as uniformity is easily achieved by Ceylon's great competitors in the Philippines where the same volume of trade is handled by just five large mills, while in Ceylon there are nearly twenty times as many mills.

In conclusion, it may be said that the present system enables the Board to work together with the millers to improve the industry in all possible ways. A study has been initiated with the co-operation of the Ceylon Coconut Research Institute into the processes used for manufacture and the effect of these processes on the quality of the product. It is felt that this study will yield results of considerable importance to the industry in due course.

Grow Spice Crops in the Shade of Coconut Palms

By
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Indian Central Spices and Cashewnut Committee, Ernakulam

ONE of the purest forms of human pleasure is claimed to be associated with flowers and gardens. Perhaps that is the reason why every home, however small it may be, has a garden. No house or school compound can be said to be complete without a proper garden. It is believed that devotion to gardening as a hobby ennobles the human spirit; and to the worker in his daily task is brought home the adage "As a man sows, so he reaps".

Fruits & Vegetables from Home Gardens

The lay-out of a home garden is different from that of a school garden. The choice and arrangement of plants in a home garden will depend not merely upon the area available, but also on the domestic needs and the extent of the attention and care the members of the family can bestow on them. Due to the rapid increase in population in our country, there is now an urgent need to augment the food resources from the available cultivable land. Home gardens should, therefore, aim at an efficient and effective use of land for producing the essential articles of diet. By planned utilisation of thc available land, it will be possible to produce adequate quantity of food in the form of fruits and vegetables. Sullage water, the litter and trash from the kitchen and byres, together with the spare time of the members of the family can all be utilised with advantage for developing a useful garden. Among the selected perennial trees grown in any house garden in Kerala, the coconut unquestionably occupies the pride of place. That it richly deserves the attention and care bestowed on it needs no mention. It is perhaps the only tree on earth which bears fruit every month throughout the year and all through its life. Any house compound with an area of about 15 cents can easily accommodate, along with other flower and vegetable plants, 6 coconut trees of which 4 can be in the back-yard and 2 in the front portion of the compound. It is desirable that the coconut trees grown in the back-yard are of the tall variety as the available sullage water from the kitchen and bath rooms can be easily diverted to irrigate them.

Ignorance of Know-how

Coconut trees growing in house compounds generally yield more heavily than those in plantations, This is due to the fact that their number is small and that personal attention and care are bestowed on them by the master and mistress of the house. Nevertheless, in spite of the publicity and propaganda by the State Agriculture Departments on improved methods of coconut cultivation, most of the people residing in towns and cities, who are very keen on growing coconut palms in their house compounds, are surprisingly ignorant of the know-how to grow coconut. It is needless to point out that if only the literate public living in their own houses in the cities and towns learn the art of growing and tending the coconut palm they would be producing not only sufficient coconuts to meet their domestic requirements but would also be able to spare some nuts for sale. Coconut produced in homestead gardens are of good quality and they are definitely superior to the bulk produce sold in the market for a higher price.

Other Plants under Coconut

The coconut palm has a unique quality; every part of it is useful and is used by man. It has also a benevolent quality : it tolerates the growth of shallow rooted annual plants in its shade. It is thus a tree of paradise, a name it richly deserves. Not many may be aware that other plants can be raised under the coconut tree without in any way adversely affecting the general condition or yield of the coconut. In this connection, the authors make bold to suggest the growing of spice crops such as ginger, turmeric, coriander and fenugreek in the shade of the coconut. These spices are of everyday use by house-wives. Any excess production of these will enable India to earn more of the much needed foreign exchange. At this time of emergency, when every possible effort has to be made to step up production of dollar earning commodities it is very essential that those growing coconut on a plantation scale or in small numbers in house compounds take to raising of the spice crops mentioned above in the shade of the coconut palm.

Growing Spice Crops

Turmeric and ginger have a duration of 8 to 9 months while coriander and fenugreek can be harvested after 3 months. These crops can be grown on circular bunds (1½′ wide and 1′ high) raised around the base of the coconut palm at a radius of 3′ to 4′. 100 lbs. of well-rotted cattle manure or compost may be powdered and mixed with the soil of the bund. The seed rhizomes of turmeric or ginger can be planted in a single row in the centre of the bund adopting a spacing of 9″. On either side of the ginger or turmeric row (say about 6″ away) one line of coriander or fenugreek can be sown. After the coriander and fenugreek have germinated, the inter-spaces should be covered with a thick mulch of leaves. The turmeric and gingers will begin to germinate in about 3 weeks and will grow rapidly. One or two weedings may be given and the plants earthed up along with application of 3 pounds of ammonium sulphate and 2 pounds of superphosphate per bund after the harvest of coriander and fenugreek. When the crops are fully mature, the leaves will begin to turn yellow and dry up one by one. The harvest of turmeric and ginger has to be done carefully. The whole clump must be lifted up without injuring the rhizomes. The leaves and the roots should then be cut off and the rhizomes separated from each other. Green turmeric has to be cured properly before the commercial product can be obtained. Curing consists mainly of boiling and drying the harvested produce and cleaning it to get a good appearance. Green ginger requires curing before it can be disposed of as dry ginger. Since there is a ready market for green ginger, it can be sold straightaway after washing and cleaning. Coriander leaf is a condiment and is used daily in every home. Fenugreek leaf, when tender, is used as green vegetable.

Potentiality of Home Gardens

Growing of these spice crops even in small areas, will go a long way in adding sizeable quantities to their overall production in the country. The homestead garden is the potential ground which should be profitably utilised and even here there is competition by all kinds of vegetables and flower plants. It is, therefore, all the more important that the land under the coconut is utilised for growing the spice crops like turmeric, ginger, coriander and fenugreek which thrive in the shade. The manuring and irrigation provided to the spice crops will indirectly benefit the coconut palms as well and this can be seen by the increase in their yield.

We would, therefore, appeal to all homesteads in Kerala: please plant, grow and tend coconut palms and in their benevolent shade, do the same with turmeric, ginger, coriander and fenugreek.

can afford to scorn at the possibility of earning an additional income from these, particularly the cultivator who is raising a new coconut garden and who cannot hope to get any income from it for the first seven or eight years. The very attractive prospects of growing long staple Sea Island Cotton of the Andrews variety in Kerala coconut gardens, provided meticulous attention is paid to manuring and plant protection, held out by Dr. B. L. Sethi in his article on the subject, should prove an eye-opener to enterprising cultivators. Kerala, the land of coconut can become the land of cotton too ! Equally attractive are the prospects of growing spices like ginger, turmeric, coriander and fenugreek as subsidiary crops in the land under the coconut palms, so enthusiastically described by Sarvashri E. K. Balasundaram and S. G. Aiyadurai in their contribution to this issue. Growing these inter-crops on an extensive scale is sure to make a favourable impact on our foreign exchange position — the Sea Island Cotton by reducing the need to import long staple cotton and saving foreign exchange and the spices by making available more for export and earning foreign exchange.

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AS TWO OF THE MOST PROGRESSIVE COCONUT-GROWING COUNTRIES OF the world Ceylon and the Philippines can teach us quite a few things. We are therefore glad to include in this issue four outstanding contributions from these countries — three from Ceylon and one from the Philippines on aspects of the coconut industry. The first of them entitled "Rehabilitation of the Ceylon Coconut Industry" by Mr. B. Mahadeva tells us how Ceylon faced with the limited scope of increasing the area under coconut, seeks to enhance productivity by encouraging the widespread use of fertilizers on coconut lands and replanting with young and vigorous seedlings coconut gardens having old and worn-out palms. A subsidy scheme for coconut fertilizer has been worked in that country since 1956 under which owners of coconut gardens, over 20 acres in extent, get a government subsidy of one-third of the fertilizer cost and those owning gardens of lesser area are given a 50 per cent subsidy. Under the replanting scheme coconut seedlings at the subsidised rate of 75 cts. each are supplied.

THE SECOND CONTRIBUTION FROM CEYLON BY MR. W.R.N. NATHANAEL is on the use of coconut toddy as an industrial raw material. From toddy can be made sugar, alcohol and vinegar. From an acre of 70 coconut palms 2½ tons of raw sugar can be obtained in 8 months. The high cost of tapping would, however, seem to militate against the commercial production of crystallised sugar.

In the third contribution from Ceylon Mr. R. H. De Mel describes how the desiccated coconut industry of his country was faced with a crisis consequent on the discovery that several shipments of desiccated coconut exported to Australia and elsewhere were found to be contaminated and unacceptable. The Ceylon Coconut Board, however, succeeded in developing suitable methods for eliminating contamination. The article has a valuable lesson for India which is trying to develop a desiccated coconut industry of its own.

From the Philippines writes Mr. Martin S. Celino about increasing income in coconut lands. The lines of action recommended in the Philippines to increase nut production and income are more or less the same as those with which we are familiar — cultivation and cover-cropping, application of fertilizers to the palms, control of pests and diseases and the growing of inter-crops. Inter-crops in the Philippines include vegetables, cassava, bananas, pineapple, fruit trees, coffee, cacao, citrus and abaca or the Manila hemp plant.

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"Know your Soil", tells Shri M. M. Krishna Marar to coconut cultivators who seek to get the maximum yield from their palms. In his contribution to this issue, on soil physical properties, he emphasizes that only that soil which is in proper, physical, chemical and biological condition can perform its functions of giving anchorage to the roots of plants, provide water for their transpiration, minerals for their nutrition and oxygen for their metabolism.

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It is now more than 30 months since the Krauss-Maffei process for the recovery of coconut oil and meal from fresh coconut kernel has been under trial by the Central Food Technological Research Institute. The process has evoked a great deal of interest not merely because of the novelty of producing superior quality coconut oil directly from the fresh kernel, skipping the traditional stage of copra-making, but because the water phase, obtained after separation of the oil phase from the "Coconut Milk" contains proteins, carbo-hydrates, vitamins and salts and can be incorporated into infant food and protein food.

A description of the work done so far with the Krauss-Maffei plant at the Central Food Technological Research Institute is given in a report, included in this issue and should prove highly interesting.

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The coconut-growing areas of the West Coast of India offer good opportunity for raising plantations of the red oil palm, say Dr. M. S. Patel and Shri H. Sethi in their article, also in this issue, on the prospects of growing the red oil palm in this country. Palm oil and palm kernel oil are the two oils extracted from the fruit of this palm, the former from the fleshy pericarp and the latter from the kernel inside. Palm oil is as good as coconut oil for soap-making and it has edible properties too. Palm kernel oil is also used for edible and soap-making purposes. The Indian Central Oilseeds Committee is sponsoring a scheme to cultivate the palm at Thodupuzha. The progress of this venture will no doubt be watched keenly by coconut growers.

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To most of us our morning cup of coffee is a daily reminder of the sugar problem and therefore the article on the sugar industry in India by no less a person than Shri K. S. Subba Rao, Secretary of the Indian Central Sugarcane Committee, should enable us to grumble a little less and see things a little more in perspective. The sugar industry today is the second major industry in India and not only do we produce for our internal needs but to export also. Though internal demand is still on the increase, there are schemes in hand to meet that too and it is hoped that with the implementation of these schemes more and cheaper sugar will be available to meet not only the internal demand but also to export large quantities. Here is a hope as sweet as a sugar itself !

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Multifarious are the uses to which the parts of coconut palm are put. But multifarious, too, would seem to be the uses to which each individual part may be put. The article entitled "Non-conventional uses of coir" printed in this issue lists an impressive number of the uses to which coir could be put. The conventional uses themselves are many and varied, as we know. Coir would seem to be well set on the road to become a hot favourite among fibres and we wish it *bon voyage*.

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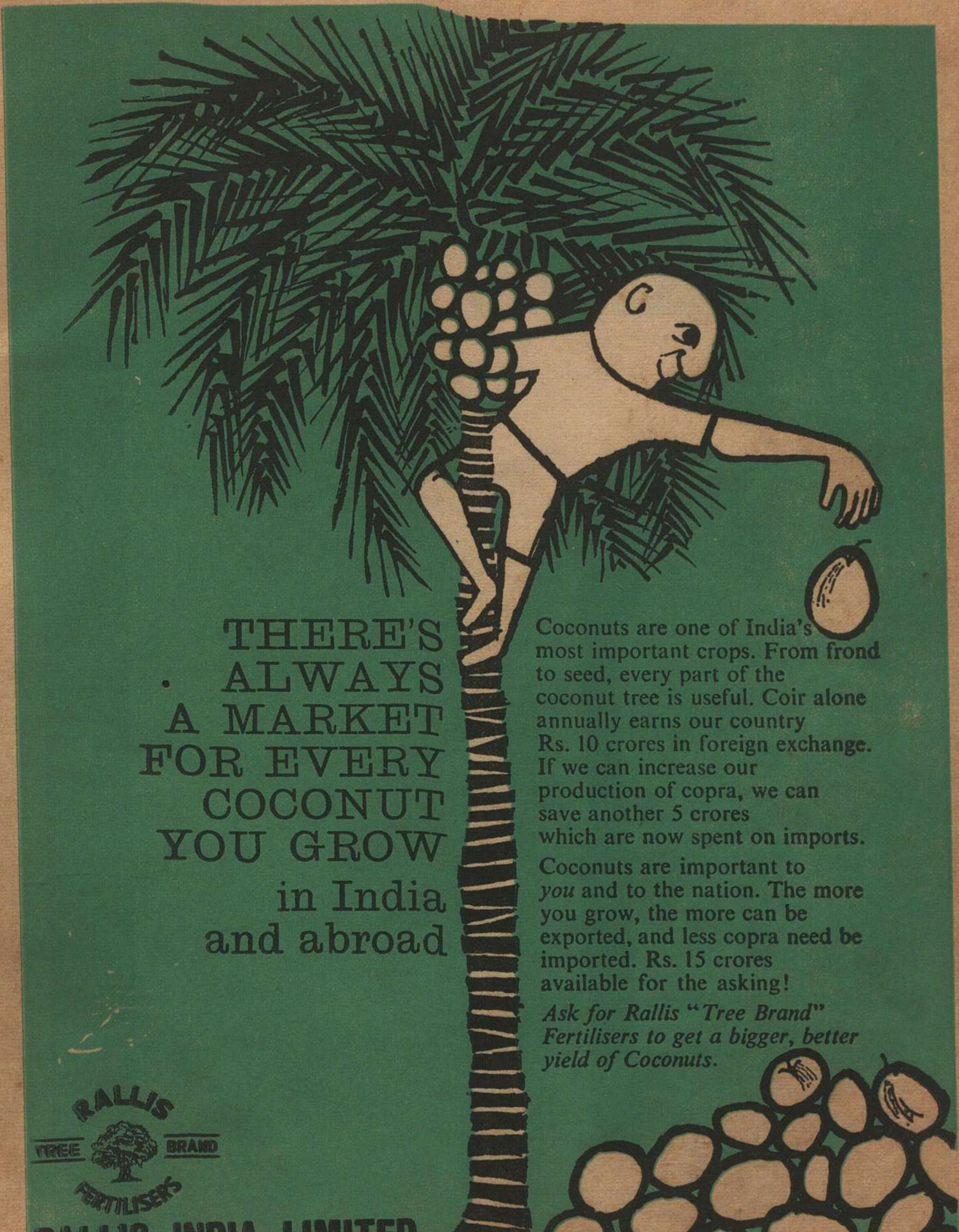
We have in the foregoing paragraphs endeavoured, haltingly though, to provide a *hors d'oeuvre* to the varied fare that follows. It is as good a collection of dishes as the most exacting gourmet may desire and we trust that our readers will have a quite satisfying treat.

It now only remains for us to thank most sincerely all those who have contributed to the making of this number and to express the hope that the same co-operation will be forthcoming from them in future too.


A terrible fight's going on there between the coconut climber and the owner
What! between Kesu & Mani?
OBSERVE COCONUT DAY!
Kesu - Stop it - -
He climbed 100 palms, got only 30 and he now demands Rs 10/- as charges. I gave him 10 punches.
Kesu you have disgraced your fore-fathers - - -
What ?
When they went to their palms they used to bend their heads for them to pluck NUTS
They did not take away the nuts for nothing - They gave the palms manures
An occasional parade to the garden to pluck nuts, as is done now is not enough
I am going to tend my palms - I must see them bowing their heads down -
Come along & I'll show you how to do it.
To day it's not the coconut palm that bows! but the grower has to bow to pluck the NUTS!
Sivaram
12.COC.C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