

FRUIT CULTIVATION AND PRODUCTION

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DURING the past decade enormous strides have been made in many countries in respect to fruit production and export.

In Ceylon it has yet to attain any reasonable dimensions and the small amount of fruit produced in this Island in proportion to what might and should be produced is most depressing in view of the many advantages of climate, soil, varying elevations and cheap labour that we have in comparison to many other tropical and sub-tropical countries.

Such a state of affairs can however be improved upon and a beginning has already been made, though admittedly a very small one, and the lines on which this much hoped for progress can follow will be dealt with in this paper.

In the wider and world view it should be realised that the expansion in fruit production and correspondingly in the consumption of fruit throughout the world has, within the past ten years, and despite the world depression, exceeded enormously any previous decade, both in domestic consumption and in export.

On the one hand we find the opening of new areas, the improvement in cultivation, the more efficient handling and marketing, together with extensive publicity campaigns have, in the aggregate, enabled producers to market both larger crops and better quality fruits. On the other hand, the principle that the supply creates the demand, together with modern theories of nutrition in the vitamin values of certain fruits and a universal recommendation to eat more fruit stimulated by medical journals, by the daily press, and by food advertisements, undoubtedly accounts for the greater part of the present world increase in fruit consumption.

There is ample evidence of the pronounced improvement in human health brought about mainly by means of this increased consumption of fresh fruits, and of fresh vegetables, and there is little doubt that from a health point of view money spent on the purchase of fresh fruits and vegetables is money well spent indeed, and it can be assumed further that the

association of the problems of fruit cultivation and of health would present a very satisfactory line of future advance for Ceylon.

Before getting down to our local fruits and how to grow these it would be well to review as briefly as we can the progress in fruit growing of countries similarly situated, but outside Ceylon, as a guide to what might, or might not, be within our range of possibilities in the way of fruit production. It is essential in the space at my disposal to limit this article to tree fruits, but in passing a few notes might be given regarding other fruits which are a considerable source of revenue to other tropical countries.

PINEAPPLE

A recent publication by the Imperial Economic Committee gives us some interesting data. In pineapple production America and Hawaii provide the bulk, but Malaya comes next and has made great strides. In Formosa too pineapple production is assuming considerable proportions, but Malaya's exports amounted in 1934 to over 2½ million cases of canned pineapple, the greater portion of which is shipped to Great Britain.

There are unfortunately no accurate statistics as to local production of the various fruits grown here to give us any guide, but we all know that the pineapple grows well in certain parts of the Island. Is it possible for Ceylon to get a footing in the export trade in respect to this particular fruit? At the moment it seems very doubtful, as the countries participating have the great advantage of being already in it, the enterprise is worked on most up-to-date lines and is well established. Further, Ceylon's deficiency of tin for can making creates one of the largest drawbacks, as Malaya, for instance, produces not only an excellent fruit but the tin also and the latter advantage has no doubt been the main contributing factor in Malaya's progress in pineapple export.

To make any strides at all for growing in bulk and the commercialising of any fruit, capital and organisation are very essential factors, especially when the exporting stage is reached. In 1933 a Pineapple Packers' Association was formed in Malaya which provided for a pool with the object of preventing violent fluctuations in the price of the fresh fruit, controlling supplies and economising in overhead charges by closing certain factories where necessary and paying compensation to the owners. The money required to carry out this scheme was obtained by a cess of 25 cents per case of canned pineapple exported. The object of this was not so much to reduce potential supplies

as to cope efficiently with the substantial increase in acreage and increasing output of fruit that has occurred of late.

There is of course a large acreage in pineapples in Malaya, but only about one-third of this acreage is cultivated as a sole crop the remaining two-thirds of pineapples are grown as a catch crop, chiefly on rubber plantations. Ordinances also are in force to exercise close control over production, for the improvement of the product for export, for factory registration, grading, certification, and marking. The Pineapple Experiment Station in Singapore is working on lines designed to improve cultivation and pineapple strains, to evolve a pineapple possessing all the desirable characteristics of the local canning variety and the eliminating of its disadvantages. The variety used for canning is presumably the Smooth Cayenne of which our local Kew pine seems to be a variety. The above indicates I think some of the preliminaries necessary to a successful export trade in this fruit.

CEYLON'S PRODUCTION AND CONSUMPTION

This brings me to a point I wish to emphasise very forcibly with all fruits that can be grown here, and this is that few at this stage are likely to be a source of profit as an exported crop, though some types of citrus would be an exception, and it is on improving the quality and enlarging the demand for home consumption that our attention should be first concentrated. At the moment little fruit of any consequence or on any scale is exported from Ceylon, but on the other hand we import a certain amount and the imports are increasing each year. In citrus imports alone in 1930 we imported 5,948 cases, and according to data supplied by the Fumigation Officer stationed at the Customs we imported in 1934, some 10,529 cases, or practically doubled our imports. In detail these imports consisted of 7,500 cases of oranges and mandarins, 1,680 cases of grapefruit, 109 cases of lemons and 1,230 bags of limes, the latter from India. That we should import limes is a remarkable instance in our backwardness in fruit production, since this particular fruit can be grown well in so many localities and moreover from seedling trees. There is no reason why we should not, by increasing local production of citrus, supply not only sufficient to eliminate these imports, (which are after all very small in ratio to population), but create a local demand that would assimilate a vastly greater amount. The imported fruit is undoubtedly retailed at a very high price and this price factor is in itself a serious limit to any considerable consumption.

At the moment Ceylon's home production is amazingly small, for fruit orchards as such do not appear to exist and it

is doubtful if a dozen tree fruit orchards in the whole Island of over 5 acres each could be found. It is apparent from this and from the import figures that fruit does not in Ceylon form nearly the percentage in diet that it does in practically all other countries. If emphasis or an illustration is needed on this point it can be stated that Great Britain imports and consumes in citrus alone, over $\frac{1}{2}$ million tons of fruit which in ratio to population works out at 25 lb. per head. The relative purchasing power of the unit of population here has to be considered, but on the same consumption figures we in Ceylon would need 55,000 tons of citrus to meet the demand, or in other words, at 3 tons to the acre some 18,000 acres would be required to produce the crop.

PLANTAINS

With regard to plantains or bananas, Ceylon produces quite a fair quantity which are entirely consumed locally. Honduras, Jamaica and the Canary Isles are the chief exporting countries, whilst Brazil, Cuba and Formosa are increasing their production of this fruit. It represents in fact about 55 per cent. of Jamaica's total exports and trade and, though this has of late years temporarily declined owing to serious hurricane damage, the 1934 exports are again on the increase representing 322,000 tons or somewhere about 16 million bunches.

The chief market for the Jamaica exports is Great Britain, but all importing countries appear to be increasing their demands for this fruit. The 16 million bunches exported from Jamaica must, at 400 bunches to the acre represent some 4,000 acres of this fruit. The Gros Michel is I believe the variety mostly grown, a variety not unlike our Koli-kuttu. Transport under suitable cold storage conditions would probably be Ceylon's greatest difficulty in any export trade with this fruit, but again increased home consumption and supplies to boats calling at Colombo would call for a considerable acreage.

PAPAW

Papaw might also be mentioned owing to its nutritive value in a local diet and for papain production.

This fruit appears to have been in the Island for several centuries now and there is not a great deal to add to our present knowledge. We have in Ceylon probably the best varieties in cultivation for size and flavour and though it cannot be classed as a fruit for other than local consumption until more is known of the export of these soft fruits, it can, even at that, be grown in much larger proportions than at present. It is one of the easiest of fruits to grow and possesses most refresh-

ing, agreeable and digestive properties, and is essentially a fruit for the villager.

As most of you know, perhaps, the fruit is raised purely from seed and attains the fruiting age at from 10 to 12 months the shape of the fruit varying according to the variety from round to oval or oblong. The oblong fruits are generally considered the best for the table and these reach the dimensions of 14 or 15 inches in length in a well grown fruit.

It is always wise to select seed from a well grown fruit of good flavour for seedling purposes, in spite of the fact that the tree is dioecious and cross pollination is most general. It is a general assumption that a normal batch of seedlings invariably yield more male, which, of course, bear no fruit, than female trees. This is not so, however, and the average in general is 50 to 50.

In this respect experiments on the improvement of papain content of papaws by the Economic Botanist at Peradeniya in a plot of 126 holes, 4 plants to each hole, showed the plants to breed out as follows, the male and hermaphrodite plants being combined under the heading of males.

4 males per hole	8 holes
3 males and 1 female per hole	41
2 males and 2 females per hole	43 ,,
1 male and 3 females per hole	26 ,,
4 females per hole	8 ,,
		<hr/>
		126 ,,
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Of the 126 holes containing 504 plants therefore 265 were male or hermaphrodite and 239 females and in view of the fact that a percentage of hermaphrodites give good fruits the 50 to 50 percentage contention seems well supported.

Apart from the edible fruit-value of the tree is the production of papain the demand for which continues at fairly remunerative prices, though less in value than formerly. Like the Chicle gum later referred to it is used in the preparation of chewing gum as well as in medicine and in the preparation of certain foods, and is exported from Ceylon mostly to America.

The fruit, when fully grown and about 3 months old, is tapped or incised every 4 or 5 days by sharpened bamboo sections in the form of a knife, and the milky latex which exudes is caught in containers. This soon coagulates and forms a white curd with a somewhat pungent smell. It is quickly dried, in the open in dry weather, though not in the sun or the product becomes darkened and its value is reduced.

The yield in papain per tree is estimated at from $\frac{1}{4}$ lb. to $\frac{1}{2}$ lb. and 175 lb. to the acre is considered a good yield the cost of production amounting on the average to about Rs. 3.00 per lb. and the return on exported papain working out on the average of between Rs. 5.00 to Rs. 6.00 per lb.

Ceylon appears to hold its own in competition with Jamaica in this respect, but the market is I believe a limited one and the question whether any large extension in the cultivation of the fruit for this purpose is advisable needs to be further studied. Full particulars of the cultivation and preparation of this product can be found in Leaflet No. 44 issued by the Department some years ago, and the present work on the improvement both of quantity and quality of papain should benefit this industry by reducing the costs of production here.

Let us now confine our immediate attention to the cultivation aspect of those tree fruits which can be considered best suited to our local conditions and of considered merit as a crop for home consumption and where possible, for export purposes also.

Given the necessary capital and enterprise the main factors are, selection of the best type possible, selection of a site and environment suited to the type of fruit it is decided to grow, and thirdly nothing short of the best cultivation methods possible.

MANGO

Taking the mango as our first subject, all here know and appreciate this fruit but all also realise the difficulty in obtaining really first class fruit. The season is short, the supply is limited and the fruits invariably suffer from being picked, while too unripe. Much can be remedied, however, if it is recognised that the mango is best cultivated where a pronounced dry season is experienced, for the tree requires the stimulus of a dry season at the time of flowering and setting of fruits.

Full details of the cultivation of this fruit is given in *The Tropical Agriculturist* for April, 1931, supplemented later by a short article in 1933 under "Cultivation of Fruit" Group II, for dry and semi-dry zones, and available in leaflet form. Though varieties of the mango do fruit in the wet zones it is in the dry and semi-dry zones that this tree will flourish and the Northern Province and similar localities of the Island are well suited to its cultivation. In the many requirements of cultivation the above articles should be studied and I would here add that there are now well over a dozen different varieties being propagated which are of exceptional merit. The Agricultural Officer in charge of the fruit experiments and produc-

tion in the Northern Province is of opinion that the mango there is exceptional in that unlike most other fruits it can be grown in the dry zone without irrigation facilities after its third year, (the period necessary for the plant to become established and form a sufficient root system), and that this point when fully realised is the key-note to success in the cultivation of the mango in Jaffna and neighbouring parts. The best varieties as grown at the Farm School are the Villard and Dilpassand, though there are other excellent varieties also, particularly the Alphonso and Jaffna varieties and with mangoes, at least, the calcareous red soils of Jaffna produce a better flavoured fruit than those on the grey and sandy soils.

The methods of propagation applicable to the mango have latterly been improved upon, the cleft or wedge-grafting now superseding the bud-grafting previously advocated, since the former method seems to induce a better shaped tree, the union is more satisfactory and subsequent growth is more rapid. The root-stocks on which the scion is budded include the common Indian mango, or Amba, and the indigenous mango or Etamba, The comparative value of these root-stocks appears so far to be about the same, but a larger percentage of success in buddings is usually obtained from the Indian root-stock than from the local root-stock.

Experiments here and in Java in the use of the cashew nut and species of the hog plum have not been successful and at the present stage of our knowledge it seems doubtful if the common Indian mango and the local Etamba can be improved upon as a root-stock.

The budded plant is fairly free from pests and diseases, but two weevil pests are frequently troublesome, the leaf-eating weevil, and the flea weevil. The former cuts through the young leaves, thereby mutilating the plant to a harmful degree and often defoliating the plant of whole flushes of new growth. The latter also attack the young leaf-growth, and the leaves are badly spotted, curl up, and become distorted. Both of these pests are fully described, with coloured plates, in *The Tropical Agriculturist* for August, 1934, and the remedy in each case is to spray the leaves with lead arsenate at the rate of 1 oz. to 2 gallons of water. The spray is best supplied as soon as the young leaves and blossoms appear.

That successful orchards, given enterprise and sufficient capital, can be opened up is in little doubt, and that object should be mostly to supply the home market, since it is doubtful if any export of this fruit can attain any reasonable dimensions at present.

The latter statement is my own opinion based on the fact that I have not yet been fortunate enough on my periods of home leave to purchase a fruit in any way approaching the flavour and freshness of that obtained locally, though one pays the equivalent of 50 cents and upwards per fruit. It seems to me also that until a mango fruit can be produced with the ratio of stone or seed reduced and entirely free from fibres, as with the freestone peach for instance, thereby allowing the seed to be more easily separated from the edible portion and eaten in a more elegant manner, it cannot well compete with other fruits in the European and American markets, such as apples, pears, oranges, or soft fruits as apricots, nectarines peaches, plums and so on.

This need not, however, cause us any concern at the present moment for it is the home market that needs catering for and this alone could, if properly organised, absorb the product of a fairly considerable area. With a population, as in Ceylon, of 5 million, a consumption of one mango per head per year would obviously involve the production of that number of fruits. At 10,000 fruits annually per acre, *i.e.*—an average of 200 fruits per tree at 50 trees to the acre—an area of 500 acres of mangoes would be needed. Multiply this to 10 fruits per head per year and some idea of the possibilities are seen. There is, of course, the present production of mangoes to be set off against these figures and with due respect to present growers it is a very poor type of mango one mostly finds on the market and chiefly in one limited and very short season during which the market is entirely glutted. A further point, therefore, in addition to any up-to-date cultivation on orchard lines and the selection of a more superior type of fruit, is to select and grow varieties with a range of season of maturity. There are such, and orchard areas in different localities will assist this purpose, for Uva and the Eastern province could produce the same variety of fruit as Jaffna, but by reason of their local conditions at a season varying considerably from the latter.

One point might here be made which applies to most fruits and it was forcibly commented on by the late Director of Agriculture in a recent Annual Report. He states—with ample data at his disposal—“that much of the failure to establish fruit industries here is due to the non-realisation of the facts that other countries would not be satisfied with the type of fruit that is acceptable here and is for sale in the markets of our towns; that fruits must be produced by organised business methods to an extent that makes grading and the production over and over again of a uniform sample, possible propositions.” This is all too true and applies particularly to citrus, but also to mangoes and other fruits. Before leaving these notes on

mangoes I would again ask you to refer to the articles already published on this subject by the Department of Agriculture and in which are embodied the main principles of cultivation and upkeep.

MANGOSTEEN

Passing now to the mangosteen, this is a fruit requiring a totally different environment and conditions to that of the mango, and is specially adapted to a hot and humid climate from sea level to an elevation of 1,800 to 2,000 feet or so. Very favourable localities are those of the low-country districts of Colombo, Kalutara, Galle, Moratuwa and inland as far as Mirigama and Polgahawela, whilst in Kadugannawa and Kandy exceptionally fine fruits can be obtained if the trees are well cultivated. So far as is known, the tree is not cultivated on any large scale but mostly in small groups or single specimens and is moreover restricted to the Eastern tropics.

This may be accounted for by the great difficulty experienced in successfully raising the young plants and in getting these established, as they are extremely delicate.

Under the best conditions a period of 7 years would elapse before the first fruits are obtained from seedling trees, and often it takes from 8 to 10 years. This long wait for returns has no doubt also militated against any considerable plantings of this tree, particularly on orchard lines in commercial proportions. The seed breeds fairly true to type, but an earlier fruiting period is much desired. To assist this, gooteeing of the branches is sometimes the means employed, though not very successfully, and grafting on to own seedlings has been undertaken, with more success.

Attempts to find a root-stock of more robust growth and earlier fruiting characters than the seedling have not yet proved successful, though the Goraka, the Kanagoraka and the Cochin Goraka have all been used for this purpose. The grafting itself is fairly successful, but no growth of any vigour is made subsequently, these root-stocks being apparently incompatible to the scion and no improvement on the own seedling stock. Since, however, grafting in some form is called for, if only for the maintenance by this means of superior strains of fruit, it would at the present stage of our knowledge be advisable to use only its own seedlings as root-stock on which to graft sections of any known high yielding tree or of one with any particularly desirable quality it is wished to perpetuate such as, extra sweetness, comparative seedlessness, or thinness of shell.

The method when grafting should be as for the mango, the wedge or cleft-graft, and it can be undertaken on 3 to 4 year

old seedlings or on younger ones if they are well grown and thick enough, or left till the plant attains several feet in height. In both cases very successful results have been obtained and instances are to be seen among a very fine group of these trees at the Orchard at Halloluwa, Kandy, the result of much enterprise and care and in which high yielding trees of recorded yield value are kept. When good sized and older seedlings are to be grafted the terminal centre shoot should be operated on, retaining the side shoots of the seedling to counterbalance any check to the plant's growth. As the tree ages these lower side branches fall away and any that do not so perish could be removed, so that the tree-head from the fruiting stage onward is composed of the scion only.

The mangosteen favours a sheltered situation rather than an exposed windy hillside and does best in a valley protected by higher land all round. It is not known for certain, but it is generally believed that a high water table affords earlier maturing than otherwise. The mangosteen is a weak rooted tree and though the lateral feeding roots appear to progress and act in a normal manner there are really very few of them on the surface and it seems to be necessary for the main tap root to penetrate the permanently moist sub-soil layers. Further details on soils, etc., were available in the fruit articles referred to, but a very important point to bear in mind is that with mangosteens the soil should never be allowed to dry out and layers of coconut husks are recommended for a mulch and around all trees during dry periods.

In the past year or so the subject of the export of this fruit has been frequently raised both in the newspapers and in more technical journals and I have been very fortunate in having been able to discuss the matter with a grower who has carried out experiments in this respect for several years, as to type of fruit sent, the mode of packing, the reports of the Covent Garden dealers and of the Empire Marketing Board representative.

From these particulars it is obvious that only a limited quantity has to date been received in London in good condition ; only the very largest fruits command a market, and such have realised from 4*d.* to 6*d.* each. Smaller fruit though generally disposed of, realised only from 1*s.* to 2*s.* per dozen, and at that figure there is little or no profit to the exporter owing to the high charges for shipment in cold storage. There is as yet no regular demand and one consignment might be rapidly dis-

posed of while the next may hang about for some considerable time and prove a great loss.

Again, the condition of the fruit on arrival may lead to complications, as fruits with a perfectly sound exterior on arrival may be thoroughly unsound inside. This occurred in one consignment in 1932 when the Covent Garden dealer accepting the fruit on the value of its outside appearance was prepared to grade and dispose of these at the best rates indicated above. An assistant of the Empire Marketing Board in attendance, however, was with his more technical knowledge, able to indicate a considerable percentage of unsound fruits among the consignment, and it is obvious that because of this dealers may have some qualms in dealing with this fruit as the exports increase. As they become more acquainted with the fruit, however, this difficulty is being overcome.

The mode of transport adopted is by cases fitted with trays. Only the best fruits of approximately 3" in diameter are utilised, these being laid in trays holding 24 to 36 each according to size of case and 4 to 5 layer trays to each case. The usual dimensions are 20" x 13" for cases holding 24 fruits per tray and 26" x 13" per case holding 36 fruits per tray, the packing material being clean wood shavings. The question of the right amount of ventilation has yet to be decided.

EXPORT TO OTHER COUNTRIES

India affords a promising field for the development of a market for Ceylon mangosteens, particularly as they can be sent as deck cargo without the need for refrigeration or special packing, but much work will have to be done in popularising the fruit before a regular demand can be created.

Apparently the name mangosteen is loosely applied to other fruit than the true one, such as other members of the *Garcinia* family, while in some parts the name is given to the common velvet apple.

The true mangosteen is very little known in Bengal, only small quantities reaching Calcutta from Burma or Malaya, and while the tree grows near Calcutta it rarely fruits there. It is practically unknown in Western India. A consignment shipped to Bombay last May met with a very poor reception, a large proportion being spoilt though they reached there in good condition. There is I believe an import duty of 15% preferential duty on Empire fruits (against 25% general),

whilst Ceylon admits Indian fruits duty free ; and this is a matter that deserves the attention of our Government.

An experimental shipment in cold storage to Egypt too was not a success, as a large proportion of the fruit went bad before they could be sold, though they reached there in very good condition. Here too the fruit was unknown, but they created a very good impression at the start. They were distributed in the chief centres of population, Cairo, Alexandria and Port Said. The firm who handled them reported that the only person who recognised the fruit was a passenger from Ceylon, who had apparently experienced the local abnormal glut of fruit in April last, for he remarked that these could be bought in Colombo at 2*d.* a dozen and offered to buy the lot at that rate !

With the Australian port of Freemantle only '9 days' journey from Colombo and other large centres of population, but a few days' journey farther, one would imagine that there would be a ready market in that country for Ceylon mangosteens. A few early experimental consignments commanded a ready sale at high prices, as was reported in the Press at the time, but late advices from a well known firm of fruit merchants revealed the fact that more recent ones have proved very unsatisfactory, 25 to 50 per cent. of the fruit reaching Freemantle in a bad condition.

The reason for this is that shippers have been careless and have apparently sent a very poor quality of fruit obtained at random from the markets instead of paying the greatest attention to the picking, selection and packing of the fruit sent.

The mangosteen is a very delicate fruit and requires careful handling, and it is only the best quality of fruit that is worth sending out of the Island. If this is only more fully realised by local shippers all would be well.

SAPODILLA

The value of this fruit is not very well known outside tropical countries and it is the gum known commercially as "Chickle," a milky latex obtained from tapping the bark, by which the tree is more readily recognised. Chickle gum is used in considerable quantities in the United States of America as a basis for chewing gum, the source of supply being chiefly from Mexico and Central America where the tree is indigenous,

the wild trees being tapped for the Chickie mostly. It is, however, cultivated here and there for its fruit and particularly in Batavia, and latterly in South India.

As a fruit tree it attains some considerable merit and deserves to be far better known, and why it is not grown more freely it is difficult to say. It does not dislike heat and moisture but prefers semi-dry districts in Ceylon. It is not fastidious as to its soil requirements and will thrive on very light sandy soil if well cultivated and manured in the early stages. At Warriapola, Kalutara and Galle and similar localities the trees fruit freely and are of excellent quality and they have been found to do well in Jaffna also. Five or six years, however, elapse before the seedling tree will fruit though gooteed plants will fruit earlier and often in the same year as rooted. The latter method is expensive, however, as regards material and the gootee is slow in rooting, but seedlings appear to come very true to type so that for any large scale operations supplies from seedlings source would be satisfactory.

The fruit matures well before ripening so that export of the fruit over fairly wide distances should be feasible, as only when the fruit is fully ripe does the skin become soft and liable to damage. When used locally the fruit must not be wrongly judged by attempting to eat it before it is properly ripe.

Many attempts have been made to graft this fruit on to a root-stock that would shorten the fruiting period, but so far without success. At Peradeniya it has been established on the Mee and a species of Sideroxylon, but after the first flush of bud-growth has been made the budded shoot fades away and no compatible root-stock has yet been found for it, though experiments continue with species of date plum and the star apple. Further details on the cultivation of this fruit are available in the articles already mentioned, but I should add that the tree seems specially subject to scale attacks encouraged mostly by ants, and a very safe remedy for this is regular spraying with kerosene emulsion. There is doubtless a much wider market for this fruit than it has attained at present and as regards its possibilities for chewing gum purposes, a continued increase in the output and consumption has latterly resulted in cultivated trees being utilised to meet the demand since no suitable substitute for this gum has yet been found.

CITRUS

On the subject of citrus much can be done for there is to my mind far more scope here than for most other fruits

that can be grown locally, both for home consumption, and for the supply of boats in harbour and eventually for export. The subject embraces grapefruit, oranges, lemons, limes and mandarins, but for present purposes I propose restricting my notes to the low-country possibilities of grapefruit, limes and mandarins. There does not appear to be any great demand here for lemons as there is in other countries, although it is the easiest of the citrus to grow, very prolific in crops and is less subject to pests and diseases than the others. Oranges, as regards the well known types such as Washington Navel, Valencia and such like, I would classify as mainly a mid-country crop, for elevation is essential if a good quality fruit is to be obtained, and this combined with semi-dry conditions as in the Uva Province and any similar locality. A Department Leaflet No. 59, goes fully into the subject of grapefruit and oranges, the article covering the present position of the industry, root-stocks suited to Ceylon, orange and grapefruit varieties, propagation and planting, cultivation, manuring, pruning, crops, diseases and insect pests, and I would advise a careful perusal of this article.

Ceylon must realise the importance and the increasing extent to which the cultivation of citrus is now taking place in other tropical agricultural countries and particularly in the West Indies where conditions are in many cases so identical with our own. The Director of Agriculture, Jamaica, in a recent Bulletin states that his Department in association with the Jamaica Agricultural Society, is doing everything possible to encourage and assist the planting of citrus in districts where conditions are favourable, and it is hoped that these efforts, in conjunction with those of a large number of interested people in various parts of the Island, will bring about a great increase in production of citrus fruits within a few years, with consequent benefit both to those engaged in the industry and to the whole Island.

Considerable differences of opinion still exist in Jamaica in regard to the methods which should be employed during the various stages of propagation, planting and cultivation of citrus, and it was felt desirable that those officers charged with duties in connection with the Government Citrus Extension Programme should meet in conference with a view to full discussion of the various questions involved so that uniform methods of cultivation and culture in relation to local conditions could be agreed

upon, and a statement issued for the formation of those now engaged upon or proposing to take up the cultivation of citrus.

The conference comprised the Director of Agriculture, the Secretary of the Jamaica Agricultural Society, the Officer of the Government Citrus Experiment Station and four other agricultural officers. The proceedings of the conference were embodied in a memorandum setting out the main points which should be carefully followed by those who are devoting serious attention to the planting of citrus.

The memorandum subsequently circulated covers much the same ground as my leaflet No. 59 already referred to, due allowances being made for our lower latitude and more varied conditions. Trinidad already has a footing in the export of citrus to Great Britain and other countries, as well as other of the West Indian Islands which are rapidly following her example.

We in Ceylon have land in plenty with varied soil and climatic conditions, sufficient labour; and in my opinion there is now sufficient data on which to proceed in the opening up of a considerable number of orchards or groves on most up-to-date lines.

It is, of course, realised that the normal seedling of most fruit plants show many degrees of variation from the parent and it would be a mistake to contemplate citrus orchards anywhere nowadays from seedling trees. For commercial success in any fruit enterprise the quality must be of the highest, all trees must be productive to their fullest extent, kept healthy and vigorous and planted on a sufficiently large scale.

As is the case with most other fruits, propagation of citrus by means of budding is necessary. The desiderata seem mostly to be a need of capital and of enterprise, the latter at the moment in respect to the raising of locally budded plants. It is regrettable that, so far as my knowledge goes, not a single nursery dealer in this country can at present produce the budded citrus plant from his own resources, all being merely content to import the plants and retail them as the demand is made for such. There is no objection to this up to a point, since imported material of good strain is first necessary before local buddings can be produced, but it is a very costly means and inadvisable in other respects to attempt any large scale operations on orchard lines from imported plants. Apart from high initial costs it is not certain that the root-stock of the imported budded plant is suited to our varied conditions.

South Africa and Australia are the present sources of supply and the root-stock there used is the rough lemon and varieties of the lime.

Certain root-stock experiments have been made at Peradeniya and are in progress, to ascertain the best root-stocks for our varying conditions, and in *The Tropical Agriculturist* for August, 1935, a summary of work on fruit at Peradeniya details the results achieved to date. These are, that for the moist low-country up to 1,500 feet or so the pumelo is principally recommended, from 1,500 feet and throughout the moist zone in mid-country and also for semi-dry regions the Seville orange is recommended and for dry and semi-dry regions the rough lemon is recommended.

There are, of course, other root-stocks under trial and with further experiments it is most probable that in the dry and semi-dry zones some of our local Rutaceae may furnish a useful root-stock.

Grapefruit is recommended as an orchard tree under conditions varying from sea level to 3,500 or 4,000 feet in the moist and semi-dry regions and in the dry zones under irrigation, and on the respective root-stocks already mentioned. The Indian loose skinned orange or mandarin is likewise recommended for the same localities, whilst for the Australian and South African varieties of oranges these are best restricted to mid-country moist and semi-dry regions on the Seville orange root-stock. Limes are generally a more semi-dry region product or dry region also where irrigated, but are grown in the moist zones also up to 3,000 feet, though these do not give the same returns in the moist as in the drier regions. There are several varieties of lime and the local country lime is quite a good type. The spineless and the seedless forms are rare, but the British Guiana lime is an introduction that has now become widely distributed.

This variety is specially recommended on the ground of its bearing fruit practically all the year round in the moist zones, whereas the local lime does not as a rule fruit during prolonged periods of drought or during very wet weather.

The articles go fully into the planting, cultivation and upkeep methods of these various types of citrus and the information need not be repeated here.

A very important factor in citrus cultivation is, however, the question of pests and diseases. Good cultivation, well

maintained, will throw off many pending attacks, but where these occur they can be very troublesome. One of the commonest diseases in the wet zone is citrus canker denoted by yellow spots on the leaves which later become corky, eruptive growths of a brownish colour occurring on the leaves, branches and the fruit. It is the young leaves that are mostly affected and these where attacked should be picked within reason and burnt.

The control measures as advocated by the Government Mycologist are the use of windbreaks where possible, the cutting out and burning of any affected branches or leaves and regular spraying during wet weather of 1 oz. Solol, 1 oz. Sulsol to one gallon water, every week or once a fortnight in dry weather.

Mildew or Oidium can also be troublesome, but dusting with flowers of sulphur and a lime-sulphur spray keeps this in check.

The most important local pests are the citrus leaf-miner and the citrus leaf-roller, both of which are dealt with by the Government Entomologist in *The Tropical Agriculturist* for September, 1934, the control in each case being regular spraying with a concentrated ready-made oil emulsion containing a small percentage of nicotine used at the rate of 1 oz. to a gallon of water, or concentrated nicotine sulphate solution used at the rate of 1 oz. to 2 gallons of water, adding an ounce of soft soap when making the mixture in either instance.

A further trouble, particularly experienced in up-country gardens on oranges is "sooty mould," a fungus which lives on the secretions of the scale insects found on the trees. This in itself is not very harmful in small quantity, but if not attended to will retard growth by reducing the amount of light to the leaves whereby the work of the leaf chlorophyll is checked in its food manufacture.

The remedy is a kerosene emulsion spray or a 1 per cent. to 2 per cent. lime-sulphur spraying till the scale insects are driven off, after which the rains will usually wash off the sooty mould. It is advisable, however, to give regular sprayings to keep off the scale and thereby the black sooty mould.

In concluding these notes on citrus I should mention that Great Britain is the chief importer of citrus fruit in the world and the proportion of these supplies originating from Empire sources is increasing. There is then a good market for any future supplies of citrus, and particularly grapefruit,

that we can raise in the near future provided, of course, that the quality is up to standard and that the fruits can be marketed at a competitive rate. Though it would be difficult to cope with other countries in an open market in oranges, the same does not apply to grapefruit, since being a more tropical product supplies of this fruit are already being received in home markets in increasing amounts from similar localities to ours in the Western tropics. The West Indies alone now produce from 6,000 to 7,000 tons of grapefruit, a large proportion of which is exported to Great Britain.

One might well now ask, how to go about this work of citrus extension? As already stated lack of supplies of locally budded plants will be the first drawback. Peradeniya has done and is doing all possible, and our nurseries are worked to the limit, but the area available comprises little more than $1\frac{1}{2}$ acres into which not only citrus, but fruit stocks of all varieties have to be housed and maintained. In addition to this, being a Government institution financed by Government funds the policy pursued is to supply the greater number of applicants with a few plants each rather than few applicants with a large number each. This leads nowhere however as regards growing fruit on orchard or commercial lines.

There is at present a very large demand for locally budded fruits of all kinds, but particularly citrus, and I have received in the past year many requests, the latter varying from 50 to 1,500 plants from individual applicants, and we are, of course, unable to supply anything near that quantity from Peradeniya.

The policy was, therefore, decided on a year or more ago that a section of the present Experiment Stations and plots in the localities where citrus is considered a possible future enterprise should be opened up in citrus with a view to providing good budded material on a scale large enough to meet the local demands in orchard quantities. At the Pelwehera Experiment Station near Dambulla an area of $2\frac{1}{4}$ acres was planted with imported citrus types considered suitable to that locality, including grapefruit, mandarin, the Nagpur loose skinned mandarin and oranges.

These are growing remarkably well in spite of the recent drought and will, on fruiting and testing as to their true to type characters, be sources of potential budwood for the station and for the locality. Coincident with this a nursery area capable of raising 15,000 seedlings was opened and stocked as far as

seed supplies allowed, the rough lemon being the main type utilised, and quite latterly the first batch of these seedlings were budded from budwood of mature trees of the Nalanda Experiment Station. This work on budding will, of course, proceed more rapidly as the seedling root-stocks in the nursery become available.

An inspection of this area is invited as it indicates the lines on which orchards in the semi-dry zones should follow. The planting of the orchard is on the triangular or alternate system 18' x 18', with gliricidia in and between the rows, and holes 3' wide by 2½' deep were prepared for the plants, and well manured in refilling. The question of the suitability of a ground cover under the local rainfall conditions has yet to be decided.

There is much that could be learnt from a personal inspection of this area and the intention is, I believe, that other stations being similarly opened out or to be opened should in general follow on the lines here indicated.

These are some of the Department's activities in pushing on the cultivation of citrus, but it should not be left at this. Any private individual with land and sufficient capital at his disposal could work on similar lines and raise his own requirements, for well trained budders are available at Peradeniya to be sent out wherever required for this work when the budding stage is reached, and the local Agricultural Instructor is at his disposal for any advice required. Only by a pursuance of such a policy will any advance be made in the cultivation of citrus or other fruits.

AVOCADOES

The avocado is a fruit that must be restricted to mid-country conditions if the best results are to be obtained, but it is mentioned here as it is probable that this fruit or salad will become very popular in time to come owing to its nutritive value. The fruit is grown and consumed in large quantities in the Western tropics, but is not too well known in the East at the moment.

The variety at all common in Ceylon is a green skinned West Indian type of average merit and grows best between 1,000 and 3,000 feet elevation in the moist zone. There are now many varieties varying in their hardiness under the groups

West Indian, Guatemalan and Mexican avocados, the groups referring to tropical, intermediate and sub-tropical types respectively.

American and other horticulturists view the avocado as one of the greatest undeveloped sources of food which the tropics offer at the present day, and they predict that avocado culture may in time rival that of citrus culture. They have in fact of late years given systematic attention to cultural methods, vegetative propagation, and to the development of superior varieties with the aim of placing the avocado in the position of a staple food crop rather than a luxury or salad fruit. To assist this object the Californian Avocado Association has exerted considerable influence in effecting its improvement. It renders valuable service in the study of the numerous varieties in cultivation, recommending only those of outstanding merit and suitability for commercial planting and provides literature of much assistance to the grower. A Co-operating Marketing Agency was founded in 1924 to cope with the marketing of the rapidly increasing crops and is increasing its functions at the present time. It is in a comparatively young stage as an orchard fruit in America only a few thousand acres being under cultivation, though this is increasing rapidly, and the fruits can now be found in the European markets.

The present position of the fruit in Ceylon can no doubt be improved by the use of some of the many varieties raised in America, but the question needs study as in other parts it is found that one particular variety often suits only a particular locality and not all give of their best under the same conditions. Propagation by budding is of proved merit, but here again the root-stock is of importance. The root-stock commonly used in America is the Mexican (sub-tropical) variety and new varieties of plants so grafted have been established at Peradeniya for many years now. It is noted, however, that after the first or second fruiting the plants begin to sicken and show signs of unsatisfactory root growth and at 8 to 9 years of age the imported trees are of little use. Buddings made from these imported trees on to local common avocado as a root-stock have resulted in very fine and vigorous plants and it seems that the best varieties, so budded, should open up future prospects for this fruit.

The composition of this fruit as analysed in the University of California is interesting in that the fat content is in some

varieties very high, varying from 10 to 30 per cent. of fat and only the olive compares with it. The edible dry portion of a good avocado is greater than in any other fresh fruit, even the banana, being 30 per cent., with protein content 2 per cent. also higher than that of any other fresh fruit, and percentages varying from 5 per cent. to 9 per cent. of carbohydrates. The latter is not high compared to other fruit because the avocado contains almost no sugar. The ash, or mineral matter, in the fruit is very high varying from 0.85 per cent. to 1.56 per cent. this including Soda, potash, magnesium and lime.

The composition of this fruit is particularly stressed, owing to its outstanding value as a food. It can be eaten in the form of a salad with other ingredients or alone with pepper soda, potash, magnesium and salt to season.

Seedling trees attain some considerable height, but budding dwarfs the tree and renders it of very suitable size for orchard purposes. The fruit, in its many varieties differ in colour, form and size, the colour varying from our local deep green to a purple and maroon and the weight from a few ounces to 2 or 3 lb. per fruit. Averaged sized fruits of roughly $\frac{3}{4}$ lb. each are, however, mostly in demand.

Seed of the Mexican stock plant has been received at Peradeniya and a combination in budding of the Mexican root-stock with Mexican variety of scion should result in this tree being successfully grown at much higher elevations than our local variety can be grown. Because of this variety of root-stock and scion, America can supply the market for 10 months out of the 12 each year.

CONCLUSION

Space does not, I fear, permit me to comment on the remaining fruits, but I think all those that can be termed major fruits have been discussed, if one excludes the up-country cherimoya, a fruit little known as yet, but one with potentialities equal to any so far dealt with, for the higher elevations.

The main point in my opinion that accounts for our present backwardness in fruit culture, as compared to other countries similarly situated, is the the lack of enterprise and initiative of the individual and the hesitation and paucity of capital, locally, to take up a new venture. Too much is expected of the Agricultural Department which has in its time, by experi-

ment and trial, furnished quite a respectable amount of data on the majority of fruit and vegetable products.

Advice is available on all cultural and upkeep methods from the seedling to the mature plant, in the control of pests and diseases, and now extends to the preserving, bottling and canning of the mature product. Further activities will doubtless follow in the direction of packing, grading, marking and marketing of the product when this is produced in sufficient quantities, but the one outstanding desiderata at the moment are first to *grow your fruit*, and to *grow more fruit*. Obviously until crops are produced in fairly large quantities and over a fairly wide seasonal range such steps are premature.

A point I would again much like to emphasise here is that whatever the type of fruit taken up only the best varieties should be considered and these should be grown on proper scientific and up-to-date lines. With few exceptions, this is not the case at present, for applicants to Peradeniya for fruit supplies show that the majority are concerned, not with the quality of the fruit so much but with the cheapest possible rate at which the seedling or graft can be obtained.

Within the past few years the normal Departmental rate for fruit plants have been revised and reduced, a very acceptable fact in itself no doubt, but it tends to cut the throat of the private nursery or fruit tree supplier whose assistance at this stage is so urgently needed. It should also be recognised that a good fruit plant has its value at competitive rates, and beyond this stage a cheaper plant becomes dear in the end.

America, both in the supply and quality of material and in the production of the finished agricultural product, probably leads the world, and in conclusion I would like to quote Mr. Wilson Popenoe, American Agricultural Explorer, in his book on Tropical and Sub-tropical Fruits. In his outlook on tropical fruits he points out much that has been emphasised here to-day. He opines that many tropical fruits, not all of them important, yet all valuable in varying degree in the dietary of the race, must be grown in ever increasing quantities not only to supply Northern markets with their teeming population, but to enable the indigenous population of the tropics to obtain abundantly and cheaply this most wholesome source of human energy. For strange as it may seem to many who have never lived or travelled in tropical countries, the conventional idea that luscious fruits grow upon every tree is far from realised.

It is a well attested fact that inhabitants of many tropical countries suffer for want of sufficient fruit which could so easily be averted by plantings on a more wholesale scale. He notes indeed that only scattered and often neglected specimens of such exist, though mango and certain others receive some attention, but that even these rarely receive more than a fraction of the care that is in Northern countries lavished on apples, peaches, etc.

This is all too true, and the Agricultural Department and the private individual in the form of local fruit associations should get together on this very important question of the extension of areas and further supplies of all fruits. In our case, however, let us first cater for and attain an increased home consumption, after which supplies to boats in harbour and exports abroad will automatically follow.