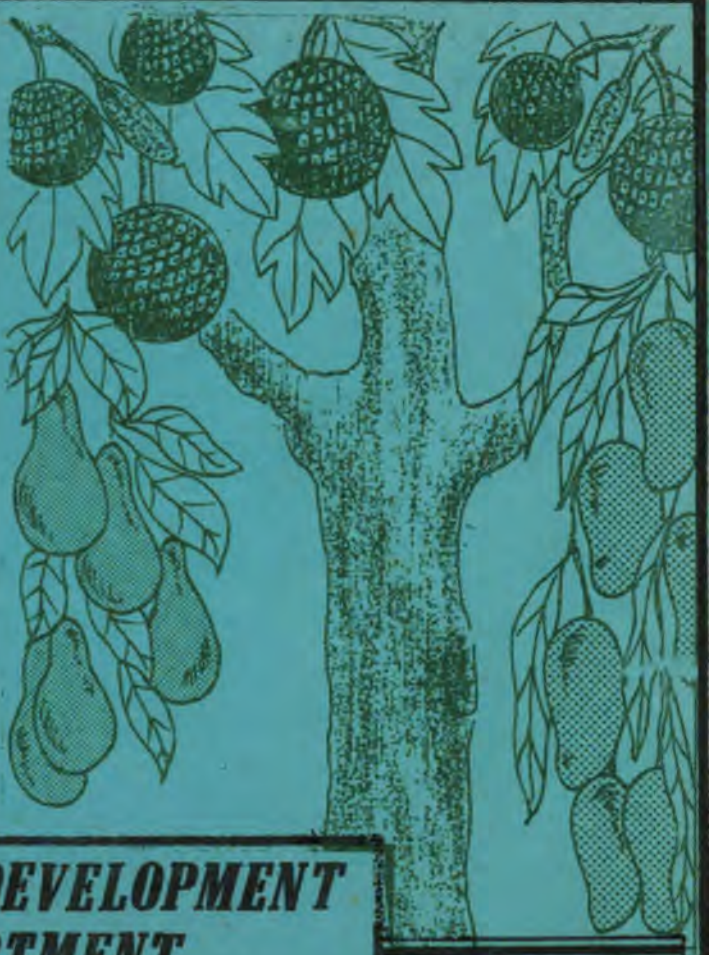
Seminar on **Research & Development of FRUIT TREES**

(Citrus Excluded)



RESEARCH & DEVELOPMENT DEPARTMENT MINISTRY OF AGRICULTURE.

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in Collaboration with CARDI & MINAG

ON THURSDAY JUNE 26, 1980 AT THE JAMAICA SCHOOL OF AGRICULTURE

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FOREWORD

Rural Development is thought of as a process of change which covers four independent aspects: technological, economic, socio-cultural and political. Technologically we can say that new methods and forms of production would allow increase in productivity, greater employment and greater income which allows for the creation of new roles for the members of the community. In the economic aspect, the generation of income and also of employment will in turn generate greater mobility for the affected individuals and may also allow for the movement of some individuals from the primary to the secondary and tertiary sectors of the economy. These changes will have great impact on the socio-cultural aspect because new aspirations can be created, new social organizations may spring up and a change of the social structure can be expected. The political aspect is as always the repository of the normative part of decision making and provides the guidelines that orchestrate the development. In a harmonious development a greater political participation can be expected.

Jamaica being a hilly country (80% hillside) has to develop a technology and a strategy which projects rural development using the most efficient ways to take advantage of the land land resource availability. The Ministry of Agriculture is at present dedicating resources to the development of hillside agricultural technology. Within this technology fruit tree farming plays a very important role because it potentially allows technologies which serve the purpose of soil conservation and the use of defined soil areas in an economic manner. It creates gainful employment, it produces an income, it supplies the domestic market, it supplies the international market, it produces foreign exchange, it becomes an import substitution activity and it produces raw materials for potential agro-industries. The above effects of fruit tree culture serve the purposes and targets outlined by our Government for the development of the agricultural sector.

Within the development of the agricultural sector two institutions have been closely co-operating with the Government. These institutions, of which Jamaica is a participating member, are the Caribbean Agricultural Research and Development Institute (CARDI) and the Interamerican Institute of Agricultural Science (IICA). Their mandate is to assist Government and to work in the research and execution of activities that tend to comply with the targets and goals set by the Government in its policy of agricultural rural development.

The seminar on Fruit Trees which is a joint effort of the Ministry of Agriculture, CARDI and IICA is one more activity in which the two international institutions and the Ministry provide the opportunity for a scientific and pragmatic dialogue. The papers being presented in this seminar are the result of individual or joint efforts which merit recognition and which in the long run will benefit the farmers and Jamaica in general. This is our greatest aspiration.

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AGENDA

Opening Session		
9.00 am	Introduction	Dr. Wellington
	Welcome to J.S.A.	Dr. Dunbar
	Address	The Hon. Minister of Agriculture
First Session		
9.45 - 10.15 am	Chairman	Dr. Percy Aitken-Soux (IICA)
		Proposal for the Production and Utilization of the Breadfruit family in the Caribbean: (Faculty of Agriculture) Dr. Ferguson - Leaky
10.15 - 10.50	The Breadfruit - A Jamaican Food Crop:	Miss Ena Swaby (S.R.C.)
	Nutritive Values of Jamaican fruits:	Mrs. Sadie Campbell (S.R.C.)
10.50 - 11.15	The Community Forest -	Tom Allen (F.I.D.C.O.)
	COFFEE BREAK	
Session Session	Chairman	Dr. Colin Weir
11.25 - 11.55	The Effect of Soil and Environment on Fruit Trees:	A. Parke and R. Baker (MINAG)
	Topworking of Fruit Trees:	T. Groves (Production - MINAG)
11.55 - 12.20	Diseases and Pests in Fruit Tree Nurseries:	J.R.R. Suah (CARDI)
12.20 - 12.40	OPEN	
	LUNCH	
Third Session	Chairman	Mr. Peter King (JNEC)
2.00 - 2.20 p.m.	Export Marketing of Non-traditional Fresh Fruit crops:	E. Hamilton (JETCO)
2.20 - 2.40	The Processing of Fruits:	Miss Mabel Tenn (Grace Kennedy)
2.40 - 3.00	The latest development in the Preservation of Fruit Crops:	Miss Hope Kerr (J.N.E.C)
	COFFEE BREAK	
Open Session	Chairman	Mr. Derrick Stone - (Permanent Secretary - MINAG).
	CLOSING SESSION	
	REFRESHMENTS	

SPONSORSHIP:-

FUNDING	**IICA (Interamerican Institute of Agricultural Science).**
PLANNING & EXECUTION	**Ministry of Agriculture and CARDI (Caribbean Agricultural Research & Development Institute).**

THE BREADFRUIT, A JAMAICAN FOOD CROP

E.M. Swaby (Scientific Research Council)

DESCRIPTION

The breadfruit (Artocarpus altilis, syn A. communis, A. incisa), although generally used as a vegetable, is really a multiple fruit, differing from most others of that grouping in that its main nutritional constituent is starch. It belongs to the family, Moraceae, including fruits as widely differing as the fig, jackfruit, and mulberry.

ORIGIN

The breadfruit is regarded as being indigenous to the Malayan Archipelago where it has been cultivated since very remote times. It is thought to have been taken to the South Pacific Islands by Polynesian migrants, and has been a staple article of diet amongst the Polynesians for hundreds of years so much so, that Polynesia is sometimes considered as the place of origin. The plant has spread through other Pacific Islands, Malaysia, Sri Lanka, and Southern India.

During the eighteenth (18th.) century, planters in the West Indies desiring to obtain maximum labour and sugar cane production from the slaves desired a food plant which was an inexpensive local source of bulk diet for their slaves, very productive during a large part of the year, and one requiring little ground space and minimun of cultivation. Knowledge of the breadfruit and consequent persuasion of the British Government resulted in the introduction of the superior seedless type from Tahiti in 1792 by Captain William Bligh, after his previous attempt which proved abortive through the mutiny on his ship, the Bounty. Up to 1968, the original breadfruit tree planted by Bligh in 1792 still stood in the Botanic Gardens in St. Vincent.

In February 1793, Bligh arrived with His Majesty's Ship "Providence" at Port Royal, Jamaica, with 346 breadfruit plants. Space limitation, and the risk of a concentration of the plants in one place - the Botanical Garden at Bath, St. Thomas - resulted in the distribution of 66 at the Botanic Gardens, Bath, 30 at Mr. East's Garden at Spring Gardens, Liguanea; 83, 84, and 83 in the counties of Cornwall, Middlesex, and Surrey, respectively.

G.P. Wilder states that the first suckers were taken from Tahiti by Hawaiians who had landed at Ewa, and took them across the mountains to one of the chiefs of Oahu. The breadfruit has not been as important a food item in Hawaii as in Tahiti and other South Pacific Islands. In Tahiti breadfruit is called uru, and in Hawaii, ulu. The plant was introduced into Queensland, Australia, under 90 years ago, but it was never accepted as a favourite food item, and might now even be extinct.

ECOLOGY

The breadfruit requires a warm, humid, climate, with temperatures of 16-38°C (60-100° F), and a well distributed rainfall of 200 - 250 cm (80-100 inches), but tolerates a short, dry period and flourishes under irrigation in lieu of natural rainfall. In the uniformly wet tropics the tree is evergreen, but, with sparse rainfall during a pronounced dry season, it will be deciduous. The great need for moisture is associated with the very large leaves, giving rise to excessive evaporation, and the comparatively shallow root system, restricting feeding depth. It is intolerant of cold and extreme conditions, such as those found at high altitudes. These facts account for the distribution of this food tree, even in small Jamaica. The young plants like shade, but the mature trees require full exposure. They grown best in deep, moist, soil with good humus content and fertility coupled with good drainage.

SPECIES, VARIETIES, and GROWTH HABITS

The seeded species (Artocarpus nobilis) is called breadnut, or "Pana de Pepita", to avoid confusion with the seedless, which is regarded as the horticultural variety. It is a prolific seed-bearing variety,, growing in some areas of the tropics, and up to 18 meter (59.05 feet) tall. Although it closely resembles the seedless variety, the tree is coarser in character, and the rind of the fruit is covered with fleshy spines. The flesh is of poor

quality, but houses seeds 2.5 cm (1 inch) or more long, and up to 2.5 cm (1 inch) the widest portion. These seeds are edible after boiling or roasting, and are a good source of niacin, calcium, and phosphorous.

The breadfruit is propagated by seeds, which should be planted early after extraction from the ripe fruit, and not allowed to dry out. Each fruit contains from 50 to 100 seeds, which contain no endosperm. Leon records that, some varieties such as Nyiwan grown on the Marshall Islands, are intermediate between both species, containing only 10-15 seeds per fruit.

The seedless species rarely grow more than 15 meters (about 15 feet) tall. The leaves are long, ovate, leathery, dark-green, entire at the base, three to nine lobed at the upper end, and cluster towards the ends of the branchlets which grow to a diameter of about 2.5 cm (1 inch), and are very pliable. The male and female flowers grow in separate receptacles on the same tree, in the leaf axils near the end of the growing shoots. The male inflorescence has the form of a yellow club or column.

The tree requires a wide spreading area. The branches, which grow low on the trunk, are brittle. All parts of the tree contains a viscid, milky latex. The shallow, wide-spreading root growth of the seedless vegetatively propagated type develops a network of feeding roots just below the soil surface. Whenever any of them protrude and are injured, suckers sometimes spring from the spot. If suckers are not removed, one tree can easily develop into a grove. Seedling trees commence bearing in 8-10 years, but vegetatively propagated ones can crop within 5-6 years. The tree is hardy, grows rapidly and robust, and bears generally from March to August, although some varieties are all-year bearing. In its indigenous home in the South Seas, the breadfruit yields up to three crops per year from an 8-year old tree. Early and late-bearing types can be selected to extend the fruiting season. The fruits grown one to three together, near the end of the branches, and vary in shape from large sub-rotund to short-oblong, sometimes exceeding 18 cm (7.5 inches) in length, and 2 kg (4,409 lbs.) in weight.

Wilder describes 31 clonal varieties, which vary widely in flavour and shape, while Leon refers to differences in shapes of fruits, skin and pulp colour, fiber content, and culinary quality, and noted the association between fruit characteristics and leaf-shapes. The West Indian variety is regarded as being starchy, with little distinctive flavour.

Researchers have found over 300 varieties of breadfruit in the South Pacific Islands. The main varieties in Jamaica are, the white heart, the most hardy and most plentiful, the yellow heart which is the most liked because of its superior eating qualities, the prickly walled which is less common and the St. Kitts breadfruit, characterized by the more shallow lobes of leaves. J. Leon of Costa Rica, in one of his works notes that variations in fruit characters are associated with differences in leaf shapes.

PROPAGATION

It should enhance our interest to do a study of the breadfruit in the context of world production conditions. Propagation is mainly done by suckers, root cutting, layering, or marcots, the first two methods of which are proven to be most successful and are generally utilized. Trees spread by means of root suckers, from protruding sections of the comparatively shallow-feeding lateral root system, branching from the deeper tap root. The root bark becomes scarred, a sucker arises, and develops an independent root system to develop into a grove, if the suckers are not transplanted. This vegetative means of propagation is particularly adaptable to the seedless variety.

Procedure

When a sucker arises, a section of root carrying the young shoot is carefully severed from the parent tree and transplanted. A tree can be induced to sucker by cutting a number of the smaller roots, and raising the cut end above the soil. By maintaining plenty of moisture, the severed root is forced into aerial growth, and is then transplanted.

A method, less wasteful of root than the above evolved in the Phillippines: Quoting from Queensland Agricultural Journal, 1st December, 1935, "Roots of 1.25 cm (½ inch) and up to 5 cm (2 inches) in thickness are dug, and cut into sections about 25-30 cm (10-12) inches) long." These are then planted in coarse sand or sandy loam in a slanting position with about 5 cm (2 inches) of the thick end above the soil, and treated as hardwood cuttings. Wester determined that the propagating bed or frame should be filled to a depth of 20 cm (8 inches) with clean, sharp medium-coarse river sand. Beach sand is usable if the salt is properly washed out. A possible alternative is, sandy loam. Experiments have proven that the angle of planting root cutting has a vivid effect on the results, and that they are beat when planted diagonally in trenches, that the thickest end protrudes 3-6 cm (1½ - 2½ inches) above the surface. The spacing should be at least 12 x 25 cm (5 x 10 inches) to avoid injury at the time of lifting. Despite recommendations for diagonal planting, in India, the horizontal is the general although not always very successful. Experiments in India have also shown much better results from the horizontal than the vertical planting, while others have justified the exposure of the larger end. It is recommended that the thickest protruding end of the cutting should be painted with coal tar or white lead to prevent drying or entry of fungi or insect pests.

Treatment of Cuttings:

Julien advised that cuttings should be dipped in a 2% solution of potassium permanganate before insertion to coagulate the latex. In India, a 0.2% solution is sometimes used. Care is necessary in the preparation of the roots, that they are not allowed to dry or become damaged. The propagation should be conducted during the wet season.

Time for Cuttings:

It has been stressed that cuttings should be taken at the end of the dry season and the start of the rainy one. The reason is, that growth ceases during the dry season, and much of the sap is withdrawn from the aerial parts and stored in the roots, which will therefore have a high vitality at the end of the dry season. The contact with the moist soil in the propagating bed will then stimulate the development of adventitious buds. An exception to this lies with the use of a solar propagator which uses the sun's rays for heating. In this case, the root cuttings will regenerate best during the warm months of the year.

With all these procedures, there can be various adaptations. For example, at the Hope Nursery of the Ministry of Agriculture here in Jamaica, a type of solar propagation is being successfully pursued. The ends of the root cuttings which came nearest from the trunk are dipped into root hormone then placed in a 50% mixture of coir and sand, and kept at a particular humidity, and under solar heating in a plastic-covered cement trough until suckers are sufficiently stable. Many suckers spring from a single cutting. The cover is then cracked open - for exposure- for a short time -, after which the suckers are cut from the stock (with a clean stainless steel knife), the root end is dipped into root hormone, then planted into plastic bags containing suitable soil mixture. These are then placed into a trough with greater exposure to sunlight - for hardening. It is thought that suckers are best transplanted when the leaves begin to be lobed. This is an economical method, as many suckers can be produced simultaneously, from the same cutting.

DISEASES AND SYMPTOMS

The breadfruit tree, although apparently invincible, is prone to an epidemic wilting and dieback disease, called "Pinglap," which has destroyed large portions of this important food crop in the Mariana and Marshall Islands. The disease generally attacks trees of bearing age, through two disease syndromes.

The "dieback syndrome," the most common, results in wilting of the uppermost branches, followed by dieback of defoliated branches. Later, and usually after a dry weather, lower branches suddenly die back, until the entire tree is killed. This syndrome is trecherous, in that there is often regrowth of branches from adventitious buds on the trunk, and remaining sign of life for as long as a year. This type of decline is typical of affected trees in high volcanic plains like Guam. Jamaica plants are prone to this, and it has been ascribed to one of many causes such as excessive soil moisture, soil disease, and/or deficiency of certain trace elements.

In the wilt syndrome, the entire foliage suddenly wilts, and the tree dies back to the main trunk, with little or no regrowth recurring. Apparenty healthy trees die in 2 or 3 months. This syndrome is common on atolls. It sometimes causes wilting and dieback on just one side of a double tree, or one or more limbs on a single side while the remaining portion of the diseased tree continues to appear normal.

In Southern India, premature fruit dropping is attributed to the fungus Rhizopus artocarpi, which results in a mouldy appearance, but the situation is averted by spraying. In Jamaica, the situation is attributed to an imbalance of water - as produced by drought in plants. (The few suspected diseases occurring on the plants in Jamaica have not been much investigated, owing to their comparative unimportance.).

A bulletin by the Plant Protection Division of the Ministry of Agriculture (1958-61) stated the finding of lesion nematodes (Pratylenchus sp.) but their harmfulness is questionable, as these organisms are so prevalent in almost every habitat.

The Jamaican custom of driving a rusty nail or horse-shoe into the trunk of an affected tree, or slashing the bark and painting the cut with white lime could be more than superstition. It has not been scientifically proven, but it seem possible, that the former could supply trace quantities of iron, and the latter, calcium, which can influence the uptake and utilization of many other important nutritive elements.

REAPING

In Jamaica, the reaping process for breadfruits leaves much to be desired, as, the most frequently used picking and dropping them on the ground causes battering and bruising, which magnifies the already poor keeping quality, which is just a few days, and resulting in excessive waste. A proper method is urgently desirable.

UTILIZATION

(a) Non food uses:

A viscous white gum, somewhat like rubber latex, exudes both from the fruit and the bark, the latter of which is used for caulking canoes, as it dries rapidly, and makes a good cementing material between the rough planking.

The bark produces a useful "bark cloth", quite as good as that made from the better known mulberry tree (Brousonetta papyrifera).

The breadfruit plant is one of the more useful plants of Jamaica. Practically every part is utilisable. The tree furnishes wood for good quality lumber that is light, strong, soft but durable when kept dry, elastic, very adaptable for cabinet work and furniture, also suitable for boards and internal house construction, and resists the attack of wood ants.

(b) Use as Food

In all the tropical areas in which the breadfruit has been grown, it has been used as an article of food, although to a greater extent in some, than in others, and with a diversity of characteristics. On the whole, despite its potential value as an abundant producer of a nourishing wholesome and palatable food, no other tropical fruit is as neglected today in the tropics at large including the Philippines, except the Marquesas

and Society Islands and other Polynesian Archipelagos where the breadfruit has been the staff of life. The excellent unequalled utility of the breadfruit quality of the South Sea Archipelago - the Marquesas Islands in particular - may well be due to the excellent varieties which have been grown there, and unfortunately, have not been introduced in other parts of the tropics. It is thought that excellent dishes may result from a better knowledge of the fruit and its preparation, and how to bring out gustatory qualities.

The Polynesians used breadfruit as a supplement to, or substitute for sweet potato and taro. Maybe if we adapted this procedure, we would have a wider range of starchy foods to our credit here in Jamaica, where the ripe breadfruit is inadequately utilized as a vegetable. In the smaller islands where hurricanes can cause very serious shortage, the material is ground into a paste and stored in pits for emergency use.

Stafford, in his "Useful Plants of Guam": states that in that island, a kind of biscuit is made by slicing the fruit into moderately thin sections after having cooked it, and drying the slices either in the sun or in ovens. Thus prepared, it will last from one breadfruit season to another. The dried slices might be eaten as they are, or toasted, or ground up and cooked in various ways.

Wester also suggests that, "Cut into slices of 3-4 centimeters thick, and baked in an oven, the ripe breadfruit makes an excellent dessert eaten alone or with ice cream, and still retains to some extent, the characteristic rich aroma of the ripe, fresh breadfruit.

In Jamaica, the breadfruit should be appreciated as one of the more important food crops, because: it is one of the more plentiful foods when in season - although one of the more wasted although it is liked by many Jamaicans -; it can be utilized at every stage of development, and can be preserved in various ways; most of the products can be easily enriched; the breadfruit plant is widely distributed in almost every parish of Jamaica, thus offering prospects for development of applied technology, until if needs be, supplementary crops are cultivated.

Conventionally, the fruit is roasted or boiled, and used to substitute bread, yam, or other starchy food, root, or tuber. It can, however, be used in various forms, as is portrayed in the recipe booklet - BREADFRUIT FOR ECONOMY - produced by the writer of this paper, at the Scientific Research Council, and other available sources. In BREADFRUIT FOR ECONOMY, there are recipes utilizing:
BOILED BREADFRUIT used in delicious and economical dishes such as, Breadfruit Meat Roll, with no flour added to the breadfruit pastry, Salad, Fritter mixture, Stuffed Vegetable, Soup, Fish-cake Mix and Dumplings. Economy can here be affected, not only through using a plentiful product, but fuel-wise, in that the breadfruit for other dishes can be boiled along with food for a previous meal or used as left-overs in for example, the Soup. Salad, Fish Cakes or Breadfruit slices.

FRESH UNCOOKED BREADFRUIT, in cubes for a curry - and one-pot dish - for chips, or grated for Porridge, No. 1. Special attention must be made of the Curried Breadfruit, a One-Pot Dish, hence a source of economy on fuel..

BAKED PRODUCTS, most of which have a common factor, - the grated mature breadfruit. Such dishes are, Breadfruit Muffins, Gingerbread, Puddings Nos. 1 and 2, and Buns. The ripe breadfruit is not grated, but mashed, for making the Cake.

A detailed examination of these reveal the following points:

- Some products like the Gingerbread, Buns, and Cake, have wheat flour added, in varying amounts. The cost of wheat flour is thereby minimized. Of course, special mention must be made of the ripe breadfruit, which is so often discarded and wasted.
- Other recipes like the muffins, one type of the Pudding (No. 1) and the pastry, use no flour.

The recipe for one type of Pudding - No. 1 - requires no wheat, but breadfruit flour. All this suggests that, where there are breadfruits, one can effect economy without being deprived of certain types of favourite products.

PRESERVED BREADFRUIT may be obtained by freezing or drying, the latter method having the flour as an end product. The preserved breadfruit is particularly helpful in that one can use as much as possible during the 'season", - when it is less expensive and preserve excess, which can successfully last from one season to another.

Baked or roasted breadfruit can be pared, cored, sliced, wrapped, frozen, and kept in good edible condition for months. The boiled breadfruit can also be frozen for a long while, although it is not recommended for as long as the roasted or baked. It should be of interest to note, that the frozen baked or roasted, when reheated is distinctly like the fresh product. When put into soup, for example, it can hardly be discerned as not being the fresh fruit. The frozen roasted, reheated breadfruit can be used in a salad when no fresh fruit is available. Drying is another important method of preserving breadfruit. This is particularly appreciated by those who are not privileged with access to electricity. Fresh breadfruit can be grated, or slivered for drying. Both products can be subsequently be reduced to flour, or used in their respective form in many culinary arts.

In today's Jamaica, this method of preservation, requiring only solar heating on a domestic basis, at least, is an avenue for economy.

An examination of all the recipes reveal, that the breadfruit can produce dishes suitable for all occasions - Breakfast, Lunch, Snacks, Dinner and Party Time. Without discounting the conventional methods of preparation - roasting, boiling, and frying - the dishes mentioned above offer some more exciting and unusual ways of using the breadfruit. Although not difficult to be made, they require more planning, and imagination, but hopefully, offer more satisfaction.

NUTRITIONAL VALUE OF THE BREADFRUIT

The breadfruit has about the same amount of total carbohydrate as sweet potato, but more than irish potato. In comparison with other fruits, the breadfruit is only a fair source of calcium. When eaten in large quantities, it can supply a good proportion of the day's needs. The calcium content is higher than that of irish potatoes, but about the same as that of sweet potatoes. Different varieties have been found to be fair to good sources of phosphorous, but poor in iron, although it contains more than green bananas.

CONCLUSION

The prolific fruiting habit, little needed care, and comparatively infrequent appearances of disease have contributed to the lack of scientific study and observation on this valuable food crop of Jamaica. With new considerations of the versatility of the breadfruit, efforts for its cultivation, as of other tree crops, is now imminent. Towards this end, research should be done on the varieties - which are numerous - for selection of clones in the light of superior yield quality and flavour, an extensive range of fruiting season, and good vegetative propagation possibilities. There seem no reason why Jamaica could not seek the best of the varieties of, for example, the South Seas Islands.

Prevention of waste of the present, and future supply is necessary, and, a solution of this could be, dwarfing.

In the light of dishes mentioned above, extensive agro-industrial projects could be developed from the breadfruit both for domestic and export purposes.

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NUTRITIVE VALUE OF JAMAICAN FRUITS

V.S. Campbell

Jamaica boasts a wide variety of fruits most of which are of commercial value in their fresh, frozen or canned forms. Others are available on a small scale and may well be termed 'exotic'.

For purposes of this paper the popular fruits excluding citrus will be grouped according to the energy content and major nutrients they contain. It must be borne in mind however, that moisture is the single largest component of fruits - ranging from 60-90%. Sugars, acids, pectic substances, gums, nitrogenous substances, mineral salts, sometimes starch, vitamins, pigments, tannins, cellulose and other substances comprise the rest of the fruit. The proportion of these constituents varies greatly in different fruits, in different varieties of the same fruit, and with the stage of maturity. The principal fruit acid is citric acid and the distinctive aroma comes from small amounts of volatile essential oils and esters.

The carbohydrates in fruits are for the most part easily digested but there are few sugars which are not digested because the human alimentary canal does not produce the specific enzyme. These sugars, by reason of the size of the molecule are not resorbed by the intestinal wall. They come in contact withbacteria which utilize them in the lower parts of the intestine producing flatus characterised by the presence of high amounts of CO_2.

High Carbohydrate Fruits - (Energy)

The starchy fruits (breadfruit, banana, plantain) eaten at the mature, unripe stage are staple foods providing energy primarily from starch (29% in green bananas, 20% in breadfruit and 35% in green plantain). When they ripen the starch changes to sugar resulting in slightly higher moisture content and reduced energy. (See Table 1).

Protein and fibre contribution are negligible i.e. 2%. Trace mineral content with the exception of potassium are minimal despite the widespread belief that green bananas particularly the very mature ones, are rich in iron. The origin of the belief is not clear but the darkening of the liquor after cooking the bananas or the colour of the cooked bananas may be the chief guiding factor. The darkening of the fruit and/or liquor is due to the oxidation of the tannins (stain) a reaction which is catalyzed by iron in the cooking e.g. iron pot or cutting implement - machete or poor grade steel knife. It is estimated that if an adult were to depend wholly and solely on green bananas for his daily supply he would have to consume 2.7 kg or 32 medium-sized fingers and ensure that those conditions which favour iron absorption are met. Some of the conditions are:- the absence of tannins as in tea, presence of animal protein, and presence of ascorbic acid. The first seems ironical as tannins are innate in bananas.

The vitamin contribution of these starchy fruits is negligible as only minimal quantities of the B and C vitamins are present initially and methods of preparation and cooking - soaking in water and long cooking in large quantities of water are non-conservative of the water-soluble vitamins. In ripe bananas the vitamin C content although only $1/5$ that of a mango or citrus fruit is significant as the fruit is not cooked.

Refuse of waste (skin, core, stem) in these categories of fruits is approximately one-third of the initial weight of the mature fruits.

Tamarind

Tamarind finds a place in the high energy fruits as theediblepulp contains 41% sugar. Its high acid content is due to the presence of tartaric acid (14%) and not to ascorbic acid (Vitamin C).

The calcium content (.11%) of tamarinds is the highest for any fruit and is comparable to some vegetables e.g. the B vitamins Thiamine, Niacin and Riboflavin are also present in appreciable quantities. The iron content is enhanced by the traditional methods of preservation in molasses and crude sugar.

Fatty fruits (fats, oils – energy)

The avocado, ackee, coconut and cashew by their pattern of usage are contributors of significant quantities of oils in the diet.

The oil content of avocados (alligator pear) may range from 7-26% edible portions, digestibility is comparatively high and there is a greater proportion of unsaturated than saturated fatty acids. Other nutrients present in avocados in reasonable quantities include phosphorus, vitamin B_1B_2, B_3 and carotene (pro-vitamin A) in the deep yellow-fleshed ones.

The cleaned arilli of the ackees contain 17% fat, 4% protein, twice as much iron as green bananas and fair quantities of the B vitamins, carotene and significant amounts of Vitamin C when cooked. The presence of a toxic principle hypo-glycin in the ackee dictates precautionary measures in preparation, that is remove raphe (red membrane) in arilli, cook separately from other foods, discard cooking water and combine with animal protein food e.g. meat, or fish. The tradition of combining ackee with saltfish must only be viewed therefore from the palatability standpoint but from one of safety also.

Coconut

The mature endosperm ("meat") supplies 27% fat, 3.5% protein (same as in Milk) and 3.5% fibre. The high fibre content does not permit good utilization of the protein; However the practice of throwing away the 'trash' after extracting the 'milk' is wasteful of much of the protein. This mature flesh also contains twice as much iron as green bananas and a fair quantity of phosphorus. Depending on the thoroughness of extraction from the mature coconuts, the protein and fat content of the milk could be significant (30% and 25% respectively). In the traditional manner of grating and extracting with warm water the percentage extraction for protein and fat are 3.2% and 24.9% respectively.

Water from mature or immature coconuts contains fair amounts of calcium and potassium and small amounts of Vitamin C.

Cashew

The nut is the true fruit. However the pear-shaped, yellow to red fleshy portion which bears the nut is called 'Cashew banana', 'cashew apple' or 'cashew fruit'.

The dried hulled seeds contain 3% moisture, 15% protein, 37% fat, 42% carbohydrate and 533 calories/gram.

'Cashew banana' contains 219 mg vitamin C/100 g and is thus comparable to guava (see below) in this nutrient. The other nutrients are present in trace quantities.

Acid Fruits (Ascorbic Acid - Vitamin C)

(a) Citrus 30.50 mg Vitamin C/100 g edible portion

(b) Garden Cherry (West Indian Cherry, Acerola) is the most potent source of Vitamin C in the region containing 2,000 mg/100 gm. With 90% moisture, macro and micro nutrients except ascorbic acid are minimal. Vitamin C is readily oxidised therefore bruising or fermentation of cherries leads to loss of Vitamin C. One part of cherry juice may be used to fortify 10 parts of other fruit juices e.g. Otaheite apple, less potent in Vitamin C (c) Guava - 81% moisture, 218 mg/100 g vitamin C and minimal quantities of other nutrients. Its distinctive, characteristic flavour and high pectin content make it particularly suited to the making of jelly, jam and confection - cheese. Unfortunately, much of the Vitamin C is destroyed in the products noted above but the juice and nectar retain high Vitamin C levels.

There is a belief that pink guavas like tomatoes "give blood" by reason of the similarity of their colour to blood. In reality it is not a matter of colour but the Vitamin C contained in them which aids the absorption of iron, a mineral which is required for

contained in them which aids the absorption of iron, a mineral which is required for healthy blood.

(d) Lychee/Carambola. Lychee contains 60 Kcal and 72 mg Vitamin C/100g. It is also a fair source of phosphorus. Like ackees the lychee contains appreciable quantities of hypoglycin. The supply never meets the demand of Orientals in particular hence lychees fetch an attractive price.

Carambola contains approximately 10% of Sugar, a small quantity of pectin and an appreciable amount of ascorbic acid. The watery pulp of the fruit has a pleasant taste and is refreshing when eaten ripe or used in an iced beverage. When the fruit or juice is cooked or canned an unpleasant bitter flavour develops. The diced dried fruit are not unlike seedless dried green grapes and find application in baked products or as a confection.

(e) Annona Species -

Custard apple (Annona reticulata). 30 mg/Vit. C/100 g

Sweetsop (Annona squamosa) 35 mg Vit. C/100 g

Soursop (Annona muricata) 26 mg Vit. C/100 g and minimal quantities of all other nutrients and energy.

There are a number of folk uses for the leaves, fruits and other parts of these plants. Studies have shown that there is a medicinal factor in the soursop which relaxes the nerves - in other words has a sedating effect, thus the linkage to the popular belief "soursop is good for the nerves".

(f) Plums -

Coolie Plum. Dunks (Ziziphus jujuba) - 66 mg Vit. C/100 g .

Hog Plum (Spondias mombin) - 28 mg Vit. C/100 g and minimal quantities of energy and other nutrients.

Yellow Fruits (C arotene pro-Vitamin A)

Mango when ripe contains appreciable quantities of carotene comparable to 210 units of retinol (Vitamin A), appreciable quantities of Vitamin C (53 mg/100 g) and small amounts of other nutrients and energy.

Green mangoes have twice as much Vitamin C as ripe ones but carotene values are reduced to mere traces.

Pawpaw, papaya (C arica papaya) when ripe, contains 56 mg Vitamin C and 175 retinol equivalents of carotene / 100 g.

Pawpaws, especially the green ones, are potent suppliers of the proteolytic enzyme papain which is the major ingredient in commercial meat tenderizers. In the home, the young fruit and leaves are added at the seasoning of marinating stage to tenderize tough meats and poultry. Heat destroys the enzyme.

There is a belief that if adults include cooked green pawpaw in their diet, their flesh will be softened and youthful appearance will be prolonged.

Other Fruits

Figs - Fair amounts of calcium 50 mg/100 g, poor source of iron. Granadilla/passion fruit - 21% sugar and minimal quantities of other nutrients.

Guinep - 20% sugar.

Jackfruit - 25% sugar and small quantities of minerals and B Vitamin is in edible portion.

Mammee Apple - 12% sugar with minimal quantities of other nutrients.

Naseberry - 23% sugar and minimal quantities of other nutrients.

Otaheiti apple 10% sugar with minimal quantities of other nutrients.
Malacca apple 10% " " " " " "
Pomegranate 16% with fair supplies of Vitamin C and calcium.
Starapple 15-16% with small quantities of minerals and B vitamins.

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FORESTRY FOR LOCAL COMMUNITY DEVELOPMENT

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Forestry for Local Community Development is a people oriented concept, the main object of which is to raise the standard of living of the rural population whilst involving them in the decision making process and in contributing to a wider range of activities than they are used to, and of which they will be the direct beneficiary. Its ultimate objective is not physical but human. The physical goals set, have as a primary objective the enhancing of the level of the local people. In this context, forestry has always been for people but we are taking a fresh look at forestry within the scope of rural development.

The problems of rural poverty are generally related to population growth and rising expectations. As long as populations remain stable over long periods, the way of life that has evolved ensures adequate levels of production to satisfy established demands. However, in comparatively recent times, most countries have experienced periods of rapid population growth, making it impossible to maintain sufficient production by traditional methods from the available land area. At the same time, the spread of information has led rural dwellers to increase their demands, to receive some of the benefits enjoyed by town dwellers. A factor underlying the steady drift from rural to urban areas.

In heavily populated regions, many rural peoples have sacrificed their forests, since wood is more dispensable than food. (although in the longer term the absence of woodland can depress farm outputs.) This has often led to erosion where agricultural cultivation has been pushed onto unsuitable land. As a consequence, temporary relief from food shortages has been gained at the cost of consuming capital in the form of trees and soil, leaving a smaller capital base for future production of all kinds.

The main aim of rural development is to assist the rural poor towards self reliance in alleviating their situation. This cannot succeed unless due cognisance is taken of their (the people's) interpretation of needs, problems and aspirations. Forestry for community development must reach the grass roots, in the form of forestry for and involving people. In further studying the concept we have to consider:

i) the outputs and benefits from forestry;
ii) forestry systems suitable for community development; and
iii) main factors related to community forestry development.

Forestry Outputs or Benefits

The importance of forests to rural communities in the developing countries is mainly threefold. Forest trees provide fuel and other goods essential to meeting basic needs at the rural household and community level. Forests and forest land provide food and environmental stability necessary for continued food production. Forest and forest products can generate income and employment in the rural areas.

Wood is the dominant domestic fuel for rural people in developing countries and for many of the urban poor as well. Wood is also often the main structural material for shelter and housing.

Wood is the preferred fuel because it can be used without complex equipment, both for use and distribution and can often be acquired at little cost. For the poor there is often no alternative to wood fuel or other organic materials. Commercial fuels require cash outlays not only on the fuel itself but also on stoves or related equipment, which can represent excessive expenditure to the rural poor. This situation is further intensified by recent accelerated increases in the prices of fossil fuels. One adverse consequence of a growing population is an exorable increase in

the pressure on locally available resources and other sources of the fuel matter. The source of wood fuel can extend rapidly and progressively from collecting dead wood, to the lopping of live trees, the felling and destruction of tree cover, the loss of organic matter to the soil and eventually to the uprooting and removal of stumps and shrubs. The next retrogressive step is the diversion of agricultural residues and animal dung to fuel use, to the detriment of soil structure and fertility.

However, where the forest resource is properly managed it represents a perpetually renewable resource.

The main forestry benefits are;

i) the production of low cost fuel and building materials, which substitute for costly commercial fuels or materials. Fuelwood substitutes for agricultural residues and provides the heat for cooking.

ii) The conservation of a protective ground cover.

iii) The complementary production of food, fodder and grazing. In addition, tree barriers protect the land against wind and water erosion and increase yields on marginal land. Trees are also an environment for supplementary food production.

iv) Increasing income by marketing saleable produce from the forest.

v) Creating income by employment,

Unfortunately and understandably, not all of these benefits are readily recognised by farmers who are engaged in the daily struggle of subsistence agriculture. Often the benefits are only appreciated when their source, the forest resource has been severely damaged or destroyed.

Forestry Systems for Community Development

Any forestry system established to involve and to satisfy the needs of the people, requires that these needs and

aspirations have been determined and either that suitable forests exist or can readily be created to satisfy these needs.

The main systems are:

- multiple product forestry
- small scale forestry (village woodlots)
- arboricultural (tree farming)
- agrisilviculture
- silvipasture.

All of these systems have in common, the yielding of products that can either be directly consumed or easily harvested and marketed by the local community.

Let us consider these systems further.

Multiple Product Forestry

This term covers the production from a forest ecosystem of material products other than wood. (e.g. honey, fungi, lianes, etc.) Multiple product systems are particularly associated with forest communities having a tradition of collecting a variety of products from a forest of which the main function may be wood production or protection.

Village Woodlots

This system is related to specific local needs for forest produce and the availability of suitable local land.

There is a single main product, generally firewood which usually requires a fast growing easily cultivated tree species.

The system often involves plantations, but may also constitute line or group plantings. With the latter approach the object may be to produce wood or shelter or both.

The system may also include individual private owners growing fast growing species as a cash crop.

Arboriculture

Arboriculture employs the intensive cultivation of trees individually or in groups or orchards for the production

of such items as fruits, latex or barks. In this context there is usually an arbitrary dividing line between forest and agricultural tree crops - but in community type undertakings what is required is greater integration rather than division on institutional lines.

Arboriculture tends to require skills and can only be successful where there is a community tradition of planting and tending special tree crops.

Agrisilviculture

This term covers all systems where land is used to produce both forest trees and agricultural crops, either simultaneously or alternately. With food trees this system merges with multiple product forestry or arboriculture.

One system is agriculture with tree fallow. This is basically shifting cultivation, but with the distinct proviso that the tree fallow period produces a tree of value to the farmer.

Agricultural afforestation (taungya*) consists of intercropping a forest plantation with agricultural crops including fodder during the establishment phase.(i.e.when the tree crop does not utilise the full site.) This is a long established method of afforestation employing land hungry farmers who are paid partially or wholly on the basis of use of the land. In this system forestry is the dominant and required land use and in steep lands the system can only be used with most careful management. For the system to be effective requires a proper knowledge of the interaction between the crops. It is also necessary to be aware that when there is an agricultural system with trees, when agricultural production predominates then this does not really come within the community forestry concept, although the lines of demarcation are not too clearly defined.

*Taungya is a Burmese word meaning hill cultivation and in relation to forestry was first used in 1856.

The agricultural crops grown in agricultural afforestation are generally annuals. A number of perennials are grown, such as coffee, cocoa, oil palm, rubber and tea but in most such mixtures the perennial crop production is of much greater consequences than wood production.

Silvipasture

Silvipasture combines cattle with forestry, in which controlled grazing of forest vegetation occurs during part of the rotation. The emphasis is on controlled grazing and the transaction from unmanaged grazing to silvipasture represents a most difficult task, but in many countries is the alternative to destruction of the environment.
This system requires that certain areas of forest should be closed to grazing when the tree crop is vulnerable to animal damage, it also demands a careful balance between silviculture and sound livestock husbandry.

Integrated Watershed Management

Integrated Watershed Management is not a system, it is much more a complex of systems embracing all of the community forestry techniques in different social and ecological zones. Much of the work in developing community forestry systems has been initiated in watersheds many of which were managed by forestry institutions. Watershed management is geared towards:

i) the rationalization of land use patterns;

ii) the optimisation of the use of natural renewable resources;

iii) the protection of water resources;

iv) the conservation of soil productivity;

v) the improvement of quality of life, both for local communities and for other human settlements dependent on the watershed's resources.

Community forestry can contribute to all of these objectives, but item v) includes the exceptional factor of protection forestry with benefits being enjoyed outside of the local community.

Main Factors Related to Community Forestry Development

The main factors affecting community forestry undertakings are

i) a sound technical base;

ii) competition for land
   a) forest land
   b) land for forestry

iii) the people or community
   a) forestry time scale
   b) risk factor
   c) labour availability
   d) lack of tradition

There are other factors, and even those above are not set out in order of priority, people being the main consideration, but these factors are interrelated and without information on these and areas of possible constraints projects or systems cannot be successfully developed.

Technical Base

Fundamental to any community forestry is a sound technical base. The tree species used must be wellknown and well used, and simple tolerant establishment and management techniques should have been evolved. The wood or other yields under different ecological and management systems have to be known if realistic estimates of benefits are to be made keeping in mind that benefits are critical to the community activity. This need for knowledge applies equally to mixtures, where the yields of each component have to be reasonably quantified. Mixtures are, of course, more difficult to manage, and management variations can produce adverse results and imbalance in the system.
A sound technical base requirement sounds almost too obvious to require stressing, but unfortunately many

community systems have been introduced and failed because just this factor had not been sufficiently determined before involving impoverished rural communities who do not have any capacity for undue risk. There are ecological zones where the inputs required far exceed the benefits and community forestry as such is not possible.

Competition for Land

Suitable land is a key factor. An established forest estate and a land hungry population require systems that will provide land or use of land for people.

On the other hand, in deforested areas, with a need for forestry benefit, the problem area and land use need is reallocation of land for community forest systems.

With a shortage of land, and large forest areas our reserves are under pressure from harmful shifting cultivation, the need is to stabilise the situation and introduce less harmful cultivation practices. The introduction of soil conservation systems can increase agricultural production, whilst reducing harmful erosion. Agrisilviculture involving intercropping can help to alleviate the situation. Another approach is the alienation of a small percentage of forest land to improved permanent agriculture (soil conservation) and supplementary agrisilviculture. The balancing of national needs such as watershed conservation and community needs in this situation is never easy. However, where a forestry system is introduced into such a situation, it requires measures to give the community alternative ways of generating the crop,or livestock production or income foregone by becoming involved in such a system.

In areas where agriculture has predominated for many years, where there is little or no forest, where there is a shortage of land and a recognised need for trees, the situation requires the transfer of some land from agriculture to forestry. This is a situation where nothing can

be accomplished without community participation and their acknowledged desire for afforestation. The first approach would be to site community forests on marginal land. Other planning includes roadside planting, windbreaks, use of multipurpose species and agrisilvicultural systems. Again, the community has to be compensated for the benefits foregone by allocating land to trees.

The People or Community

As already noted, the entire concept is about benefits for people or communities. It is fundamental that the community has to be aware that there is a present or potential problem and that there is a need and place for forestry. The benefits from a forestry system must be real and measurable, and must exceed the inputs required of the participants. The community should be seeking some degree of self reliance. As a forestry development system has to do with solving problems, there has to be some form of community organisation and discipline, without which there is no foundation for community progress. Forest development requires the backing and support of a strong technical institution, the more complex the system the greater is the input required of this source. The community has to be motivated and this can to some degree be attained by the provision of benefits, but requires and is certainly helped if the State is committed to these facets of rural development.

Forests take a considerable time to mature and the timescale of forestry is bound to conflict with the priorities of the rural poor, which are sighted on basic present needs. Land, labour and other resources required for present food, fuel and income cannot readily be diverted to the production of wood which will be available only several or many years in the future. The approaches to this problem where forests exist are to provide produce from present forests whilst building up the resources. In plantation forestry the lag

between establishment and harvest can be a major constraint and it may be necessary to provide low interest loans, or subsidies for the period without income and use species that reduce the non- productive period to as short a time as possible. In some systems the forestry input is related to other activities producing immediate income, with forestry representing savings and increased future income.

The implementation of forestry systems introduces change, and in the rural environment has has been well documented, there is marked resistance to change, and change is related to risk. Connected with the timescale, is an anxiety as to whether the participant will enjoy the eventual benefits of the forestry inputs. In relation to community activities there is often a lack of security relating to ownership and the value of benefits. It requires some considerable effort to reassure the members of the community in such ways as:

- giving individuals or communities security of tenure on the land they are cultivating or growing trees;
- where forest produce is grown for sale it is beneficial to have assured markets and assured price structures;
- where the forest benefits are disposed or on extended time scale it is necessary to determine methods to compensate the producers for periods without cash flow.

One of the main facets of community forestry is that the community should be involved in and contribute to the forestry programme. Such a contribution can take many forms, but the most common input is labour. Very often, the agricultural and forestry season of activity coincide, and as a consequence there is a shortage of forest labour. Forestry systems then have to be devised which allow the forestry activities to fit into the agricultural system or calendar.

In the rural communities understandably the main preoccupation is production of food and income. Historically, there seldom is any forest tradition and forest produce is looked upon as a free resource. Indeed forests are often viewed with hostility as a source of woody regrowth hampering cultivation.

There is a lack of understanding of the role of forest trees in maintaining soil fertility and a reluctance to recognise the consequence of soil loss, fuel and other shortages which inevitably follow the destruction of forest cover. The people involved have little recognition of the damages until they occur, and equally they have no bases on which to readily perceive the beneficial effects of forestry. The introduction of forestry systems, or the conversion of destructive use of forest to one of managed use, will often require a profound change in attitudes and behaviour by both foresters and communities).

The problem is to reconcile technically desirable change with the value system it appears to threaten.

Any voluntary solution requires confidence on the part of the population and empathy for the local way of life on the part of the implementers of development.

The involvement of people in forestry requires soundly based systems, relevant institutional and state backing, the development of community spirit, the building of relevant infrastructures and the foundation of an adequate legislation.

(Author's footnote - During the seminar it is hoped that that there will be opportunity to discuss selected case studies and to relate the concepts of community forestry to Jamaica.)

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THE EFFECT OF SOIL AND ENVIRONMENTAL FACTORS ON THE PRODUCTION OF TREE CROPS

A.H. Parke/R.J. Baker

(Special reference to Avocado, mango, soursop, naseberry, litchi, ackee, guava, breadfruit, acerola-Cherry, cashew.)

The successful production of Tree Crops and in general all crops, depend on a favourable interaction between the soil and environmental factors such as rainfall, light intensity, temperature, humidity and wind.

Within the soil itself, a number of environmental factors inter-play to influence the development of the root systems of plants.

(a) the space that can be penetrated readily by the roots; it is limited by depth of the soil, existence of a hard pan or heavy clay layer, water logging;

(b) availability of moisture;

(c) soil fertility level;

(d) soil temperature;

(e) competition;

(f) soil reaction;

(g) aeration

These soil environmental factors together with the genetic constitution of each species will bear an important influence on the type of root development which occurs, which in turn will determine practices, such as the spacing of trees in the plantation, the possibilities of inter-planting with other plants for crop diversification, irrigation practices, erosion control, application of fertilizers etc.

As far as the climatic factors i.e. rainfall, temperature, light intensity, wind are concerned, these combined, effect a wide range of influence on plant growth and development. These climatic factors will determine overall the type of crop that can be grown in a particular locality.

Temperature

Temperature will affect the growth and development of both plant and fruits of many tree crops. Temperature influence may extend also to fruit quality e.g. the degree of acidity of citrus fruits. Temperature many influence flower initiation and subsequent fruit set, thus a number of fruit trees e.g. mango, citrus, litchi (lychee) need a dry hot period for flowering and fruit set. In avocado, the time between the blossom and the mature fruit, tends to be shorter, the higher the mean temperature during that period. Another limiting effect of temperature on tree crop production is the influence it has on the activity of certain parasites e.g. certain fungal disease are associated with cool moist conditions, while others are favoured by high temperatures in conjunction with humidity. In essence therefore, functional activity and growth of any kind in a plant have definite temperature requirements.

Rainfall

The successful establishment of Tree Crops depends heavily on the availability of adequate moisture. Under our conditions, irrigation is a limiting factor so that the farmer should plant against these odds, by establishing his trees in the major rainy season. An adequate moisture supply has positive influence on the nutrition of the crop, the regularity of bearing, fruit size and fruit quality. Disease susceptibility is often modified materially by the rate of growth as influenced by soil moisture conditions.

A number of tree crops require a dry period for flowering and fruiting. In other instances severe water deficiencies at the time of fruit-setting are likely to result in an undue amount of fruit drop. An excess or a deficiency in soil moisture, is likely to be accompanied by a disturbed condition within the plant and often by the appearance of

pathological symptoms. Fruit splitting, fasciation and chlorosis are example of those brought in by excess of moisture supply, while fruit pit, cork, dieback, are examples of those brought on inadequate moisture. Preventive measures against such problems include proper drainage, proper site selection, controlled irrigation. Premature defoliation is one of the more serious results of moisture deficiency. It is likely to be followed by decreased vegetative growth, lessened yields and in extreme cases, dieback. The effect of a drought may be more pronounced in the next season's crop.

Wind

Wind, atmospheric humidity, temperature and light intensity all combine to determine the evaporative power of the air and ultimately the rate of transpiration in plants. The importance of wind in Tree Crop Production extends to other phenomena such as fruit-drop in high wind conditions and pollination of flowers in some species. The effectiveness of wind-breaks upon wind velocity in reducing evaporation varies with their height and density and also on topography.

Humidity

Atmospheric humidity has an influence on plant development independent and distinct from that of rainfall and soil moisture, though it often happens that both influences tend in the same general direction. Under average outdoor growing conditions abundant soil moisture is likely to be accompanied by relatively high humidity and low moisture by a dry atmosphere. In practice therefore, these two factors of environment are interdependent. Atmospheric humidity is of importance in fruit setting. Hot drying winds at blossoming time may evaporate the moisture from the stigmatic secretions and thus prevent germination of pollen in some species. Extreme atmospheric humidity may interfere with the work of insects carrying pollen, or it may encourage the development of certain fungi that affect flower and young fruits in some species.

FEATURES OF THE LOCAL ENVIRONMENT

Ideally, Tree Crops are considered to need deep, fertile, free draining and non-stony soils for their production. Although it is generally agreed that the rapid expansion of tree crop production in Jamaica is vital to our economic recovery, this fact must be viewed against the background that most of our good or ideal agricultural soils are already devoted to the cultivation of traditional export crops such as sugar cane, banana, citrus, coconuts, cacao etc. It therefore means that the soils generally regarded as marginal, and which exhibit one or more of a number of adverse soil factors must be utilized for this needed production.

Baker and Weir 1975, identified some of the limitations of these marginal soils as:

(a) poor drainage
(b) high scale alkalinity (calcareous soils)
(c) saline and alkaline soils
(d) high soil acidity
(e) poor water supply
(f) rocky, stony and thin shallow soils

Locally, one of the predominantly limiting soil factor is that of stoniness and shallowness. In this condition root room is severely limited and the successful use of these soils will involve the use of appropriate technology in trying to create root room for suitable tree crops.

Baker, 1970 - Soil Survey of the Cayman Islands, mentioned the possible use of small explosives to make "holes" in these stony areas. These holes when filled with organic matter and debris etc. could be used to establish tree crops suitable to these conditions. The important result is that the roots of plants once established can penetrate these rocks and find enough nutrients and water for their growth. Overall there exist locally a very large potential for growing tree crops in areas of this nature. Some species have become naturally adopted to certain conditions otherwise unsuitable to others eg cashew

thrive well on very acid soils, but do not produce at the same level on the calcareous soils of drier areas in Jamaica.

The overall success of any tree crop production programme however will depend on the application of the management practices recommended for particular soil conditions, and on identifying the crop most suitable to those conditions.

In consideration of the other environmental factors which affect Tree Crop production in Jamaica, it should be noted that there are no real marked difference in climate islandwide, rainfall is the dominant meterological variable which influences fluctuation in temperature, humidity, sunshine and evaporation, but the local climate is also influenced by numerous slopes, valleys and plateaux formed by the system of mountains. Islandwide rainfall shows a bimodal pattern with primary maximum in October and secondary in May. Relative humidity values are usually higher in the inland areas, although the islandwide variation is very little. The annual range of temperature is only 5°F in coastal areas and 6°F inland. Locally the climatic factors with the exception of rainfall, therefore, do not pose to any great extent any serious limitations to the production of the tree crops being considered.

OBSERVATION ON THE EFFECT OF SOIL AND ENVIRONMENTAL FACTORS ON SOME LOCAL TREE CROPS

The soil types and environmental conditions mentioned for the different crops may be indicative of the conditions to look for in selecting new sites for the future expansion of tree crops.

Cashew (Anacardium occidentale L.)

It is generally observed that cashew is not very tolerant of saline conditions, is highly resistant to strong winds, and needs a long dry period for blossoming and fruit development.

Cashew thrives well in areas like Linstead - St. Catherine, Brompton - St. Elizabeth and Cross Pen in Clarendon. The soil types typical of these areas are in order - Map No. 61 - Linstead Clay Loam, Map No. 204 - Four Paths Clay Loam, Map No. 207 - Bryssons Clay Loam. These are all regarded as old alluvial soils, with a characteristic strongly acid soil reaction, with a pH range of 5.1 - 5.6. Moisture retention in these soils is high and internal drainage is slow. Rainfall in the Linstead and Brompton areas is about 66 inches per annum respectively, and at May Pen between 50 - 75 inches per annum. Relative humidity values for the more inland areas of Linstead and May Pen will show a slightly higher value than at Brompton. In general, humidity is very high during the nights but drops rapidly during the day and reaches a minimum at about 3:00 p.m. The pattern may be changed by rain. The coolest months in all three areas are January and February and hottest months are July - August.

Litchi - (L. chinensis)

Areas of best production so far are Castleton in St. Andrew, Blue Mountain areas (Top Hill) and the Paddington Terrace/Liguanea area. Soil types of these areas in order are: Map No. 46 - Halls Delight Channery Clay Loam, Map No. 22 - Maverley Loam. Map No. 38 - Cuffy Gully Gravelly Sandy Loam. These soils are especially free drained, and are mildly alkaline to slightly acid in reaction. Rainfall distribution is good, the Blue Mountain areas and Castleton having a range of about 45-90 inches per annum, the higher values generally applicable to the hilly regions. In the case of the Paddington Terrace area, the fact that home owners with litchi trees do water these trees regularly, suggests that a regular moisture supply may be necessary for good litchi crops. The relative humidity in the Castleton, Top Mountain areas is quite high. Hottest months are July - August, maximum and minimum temperatures being 89°F and 68°F. Coolest months are January and February with temperature range 79°C - 62°F. Chandler - In "Evergreen Orchards", suggested that the Litchi tree needs for good growth and bearing a long hot summer with high temperatures and humid atmosphere. These conditions are more apt to occur at higher elevations. It is also suggested that the Litchi does better on non-limestone soils, and an acid soil reaction is more favourable for its growth.

The authors have observed a Litchi Tree, having good vegetative growth on soil type No. 78 at Claremont - St. Ann a somewhat protected area, where humidity can be quite high at times. However, after a single good crop in 1975, the tree has not borne since. It therefore seems that the litchi shows positive response to climatic factors such as relative humidity, rainfall and temperature.

Mango - (Mangifera indica)

Mangoes show generally good growth and production throughout Jamaica. The problem areas include Manchester, and the North coastal areas including some areas of St. Ann. In some of these areas , the mango achieves good vegetative growth, but fruiting is poor and at best biennal or less regular. (Mathias - personal communication), pointed out that the variety Ann, grows well on the marl soils of St. Ann's Bay, with good fruiting and fruit characteristics. The variety when transferred to Lima in St. James, however, did not reproduce those same fruit qualities etc. The mango can grow well on a wide range of soil types and needs a long dry period for flowering and fruit set. The occurrence of heavy rainfall and strong winds during this period will reduce mango yields drastically. Mathias also pointed out that the varieties Ann and Tommy Atkins provide the best rootstocks for marly soils, which suggests that different varieties may be adaptable to different conditions. In St. Elizabeth mangoes do well on soil type No. 78, yet in Manchester and St. Ann the opposite is true. The suggestion here is that elevation seems to be very important for economic production of mangoes, especially since problems of fruit fly and anthracnose may become more severe at these elevations. This is in contrast to that obtaining at Yallahs - St. Thomas where Julie and East Indian yield well and are unaffected by such maladies.

Avocado - (Persea americana) and
Ackee - (Blighia sapida)

These two tree crops show generally good growth and production throughout Jamaica. With the exception of high winds, there seems to be no limiting factors imposed by the environment, but in the case of avocado, there is definitely a soil problem, in which poor drainage conditions appear to be the most important factor. The avocado is extremely susceptible to water logged conditions, where damage and eventual death of the tree is attributed to the root rot fungus (Phytophtora cinnamoni). Even where avocados are planted on raised beds in poorly drained soil, the trees die after a few years. The avocado needs proper rainfall distribution and is intolerant of severe drought conditions.

Soursop – (Annona muricata)

The soursop did not bear well at Orange River - St. Mary, mainly because of poor fruit set. At Orange River the main soil types are Map No. 41 - Belfield Clay with a slightly acid topsoil, and alkaline below, high moisture retention and moderate internal drainage, and map No. 43 - Highgate Clay which is strongly acid, and slow drainage. Annual rainfall in this area is about 90 inches. Relative humidity is high. It is felt that the incidence of high rainfall and humidity coupled with a high level of pathogenic problems associated with such conditions help to reduce the yield of soursop at this location. On the other hand the soursop semm to do well at Lyssons where the elevation is 50 feet. At this location rainfall is high and fairly well distributed, but the humidity values are less as is typical of coastal areas, where the "Sea Breeze" exerts its influence on the air conditions. At Lyssons also the soil types are in the alkaline range.

Naseberry - Sapodilla - (Sapota achras)

Sweetsop - Sugarapple - (Annona squamosa)

Starapple - (Chrysophyllum cainito)

These tree crops seem to favour generally dry areas of the country. In the case of the starapple, it is usually seen growing in areas of deep soil eg. on St. Ann Clay Loam Map 78. The Sweetsop and Naseberry are seen to do well on very shallow stony soils of dry areas. In these areas also the vegetation tends to suggests that these crops are very tole-

rant to competition as they tend also to be very slow growing.

Naseberry has been observed to be bearing well in areas of Paul Mountain and Gibralter in St. Catherine, Porus, Pratville and Grove Town areas of Manchester and in areas in St. Thomas to name a few. The predominant soil types in some of these areas are St. Ann Clay Loam, and Bonnygate Stony Loam. These are typically free draining soils which are also poor in nutrients. It therefore seems that these crops show definite responses to soil and climatic factors, and are definitely intolerant of soils with impeded drainage. Good distribution of rainfall will enhance yields considerably.

Guava - (Psidium guajava)

This crop is observed to be doing well on soils that show acid reaction, and on usually wet stiff clays, although they grown well on other soil types.

Guava has done well at Orange River, where the soil types as already mentioned tend to be acid, rainfall high and humidity also high. Guavas have also been observed growing and fruiting well on some drier areas, eg. areas of St. Ann and Smithville in Clarendon. This suggests that this crop can be grown over a wide range of locations, with probably the only limiting factor being an adequate distribution of rainfall. At higher elevations the incidence of fruit fly damage may be quite important.

Breadfruit - (Artocarpus communis)

In Jamaica, breadfruit seems to thrive well on free draining soils. It is questionable whether breadfruit could not be grown on all soil types, since the trees have produced well over a wide range of soil types and locations, eg. concentrated areas of production include Bog Walk, St. Catherine, Lime Hall - St. Ann, Irwin, Flamsted, Lethe in St. James and Blackwoods in Clarendon. In addition large yields are obtained in parts of Portland and St. Thomas. The soils in these areas range from shallow marl soils to clays. The chief limiting factor to production seem to be an adequate distribution of rainfall and the selection of heavy fruiting cultivars.

Conclusion

From the foregoing discussion, it should be seen that the many soils regarded as marginal for agricultural production in Jamaica, and which exhibit a number of adverse soil factors, can and must be fully exploited for the production of tree crops.

There are also a number of tree crops which are naturally selected for some of these conditions. Notwithstanding, the successful exploitation of these soils for tree crop production will necessitate the use of proper management practices aimed at ameliorating these conditions. The main objective in so doing, is to render soils otherwise suitable to only certain crops, capable of growing a wide range of crops, as long as other environmental problems do not pose limitations. In the case of mangoes the evidence seems to suggest that different root-stocks will show a difference in their response to varying soil and environmental conditions, and thus indicate the need of a study of a way of over-coming this problem of a lack of production of mangoes in some areas may be the use of rootstocks of varieties which grow in these areas.

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DISEASES AND PESTS IN FRUIT TREE NURSERIES

J.R.R. Suah, CARDI

It is common practice in modern agriculture to establish nurseries of selected fruit trees, for orchard establishment or for distribution to farmers and householders. This ensures the availability of approved high producing varieties, facilitate mass production and ease in distribution, and simplify the task of monitoring the species and numbers of plants ready for planting at any given time. In Jamaica, the nurseries are operated by the government, primary producers association, private nurserymen and farmers.

Although the benefits derived from nurseries are many, unless great care is taken to control the diseases and pests that can spread from them, they can be of more harm than good. Examples of some diseases and pests that can be so spread are:

DISEASES

Scab	Elsinoe fawcetti on citrus
	Sphaceloma perseae on avocado
Stem knot	Sphaeropsis tumefaciens on citrus
Wither tip	Gloeosporium limetricolum on lime
Psoroeis	virus on citrus
Tristeza	virus on citurs
Root rot	Phytophthora cinnamoni on avocado
Black rot	Rosellinia sp. on avocado
Anthracnose	Colletotrichum gloeosporiodes on mango

PESTS

Galls	Asterolecanium pustulans on ackee
Thrips	Selenothrips rubrocinctus on avocado, guava and mango
Scale insects	various species on all fruit trees
Red mite	Tetranychus spp on all fruit trees

NEMATODES

Citrus nematode	Tylenchulus semipenetrans on citrus

This unintentional spread of diseases and pests should not be allowed to continue. Most plants produced in nurseries are used to establish new orchards away from the nursery area, and usually the natural enemies (parasites or predators) or the natural environmental control conditions are left behind. Thus the pests or diseases are often allowed to build up and spread sometimes to epidemic proportions before they are noticed and control measures attempted.

The following guidelines are intended to assist nursery operators in reducing or avoiding the spread of common diseases and pests on young plants.

Location

It is essential that a nursery should be located at a spot that is convenient for every purpose. Considerations should be given to the ease of obtaining materials and labour, and for plant distribution, water availability, soil type, climate etc. From the plant health point of view, care should be taken not to locate a nursery in an area where there has been previous incidences of diseases or pests of the plants to be grown, or near to places where they are

active. In the case of soil-borne pathogens and nematodes, a nursery should not be placed where run-off water from an infected area can flow through it.

Production Limits

It is a bad practice to over-produce plants in a nursery, as it soon becomes very costly an uneconomical to care for the superfluous ones. These are usually left in the nursery to become 'old boys', which if not well cared, will provide host materials for pests and diseases.

Spacing

Plants should never be set too close in nursery beds or nursery rows. Crowded plants cannot be easily observed for diseases or pests, and where an attack occurs, over-crowding hampers proper artificial control methods.

Nursery Rotation.

Just as rotation of crops is a wise and profitable practice, so is it just as valuable for fruit tree nurseries. A nursery should be rotated before disease pathogens, nematodes, insects or weeds multiply to become problems. This practice is applicable to plants grown from seedlings in nursery rows.

Shade

Many nursery plants are best produced under shade. Where this is provided by non-living shade materials such as wooden slots, plastic or cloth mesh, disease and pest incidence is minimized as these materials do not act as alternate hosts. Great care should be exercised when using living plants as shade. Pests like the scale insect complex, mealy bug, leaf hopper and mite and diseases such as Cercospora leaf spot and sooty mould usually multiply on the shade plants and transfer to the nursery plants. A prime example of this was where coffee and cocoa seedlings were being produced under Gliricidia spp. However natural shade properly managed (light, disease and pest controlled and risk of falling and damaging the plants reduced) can be very effective and cheap.

Unwanted plants

Left over plants that are allowed to remain in the nursery and grow, and large plants of the nursery species growing in the nursery, or nearby, usually provide ready sources of pests and disease pathogens to reinfest and reinfect a healthy nursery. For this reason, these plants should be removed or destroyed.

Nursery Sanitation

As in other production practice, proper site sanitation will aid greatly in disease and pest control. Weeds and discarded plants parts can serve as feeding and multiplication sites. Debris, rocks and logs can provide hiding places for pests. An untidy nursery can reduce the enthusiasm of the workers to result in various problems.

Chemical Control

If after practising the various cultural methods discussed before, there are still diseases and/or pests existing in a nursery, it is recommended to use chemical control methods. These can be as sprays, drenches, dusts, fumes or injections. A good nurseryman should be able to properly monitor the pest and disease incidence and apply the appropriate control methods early, thus not allowing spread in the nursery.

Since nearly all fruit tree plants produced in nurseries will live and produce for many years, it is essential to start out with healthy vigorous disease and pest free materials. The time and effort spent to do this will ensure good profits in later years.

THE LATEST DEVELOPMENTS IN PRESERVATION OF FRUIT CROPS

L.H. Kerr (J.I.D.C.)

The major tropical fruit crops (excluding citrus) are pawpaw (papaya) mango, banana, coconut, and avocado. Several less popular fruits have great commercial potential, viz: ackee, soursop, guava, garden cherry, naseberry, otaheiti apple, jew plum, tamarind, breadfruit, nutmeg, guinep and jackfruit. Some of these beeen processed commercially either as canned fruit in brine, syrup or as nectars, juices or candied products. Much of the development work was done at the J.I.D.C.'s. Food Technology Institute.

The main objective in processing fruits is to extend the usable life while retaining as much as possible the natural qualities of the product. The effectiveness of the process is dependent on the extent to which the agents responsible for spoilage are inhibited and or destroyed. Spoilage genera lly results from the activites of micro-organisms and enzymes within the plant tissue.

The principal methods of fruit preservation include freezing, dehydration, heat processing, concentration, and pickling. Freezing employs the use of low temperatures to suspend the harmful effects of microbes and enzymes. Heat processing on the other hand, utilizes high temperatures which effectively destroy pathogenic and spoilage-causing organisms. Concentration, dehydration and pickling all involve the reduction of water within the product, making conditions unfavourable for microbial growth. Fruit juice concentrates as well as jams, jellies and candied fruits are products of the concentration process.

New developments in fruit-crop preservation are based mainly on expansion of existing product lines. This is done with a view to maximise the use of the commodity at all stages of maturity. For instance, the mango may be used for making chutney or pickles, when green or half-ripe and for canned slices and nectar when ripe. Later development may well involve changes in packaging as a few problems are now affecting traditional supplies.

Jamaica should adopt the pattern of growing crops specifically for processing. This is extremely important as it is folly to base any processed-food industry on agricultural surplus, as has largely been the case in Jamaica. It is therefore, vital that the farmer and the processor work together to ensure that the most suitable raw material is used for processing. Careful selection of proper species and varieties will allow for year-round supplies of most fruits, having the desired attributes.

ACHIEVEMENTS IN PROCESSING

In Jamaica today, the most popular methods of fruit preservation include heat processing (canning) and concentration. Evaporation under vacuum proves most effective in producing fruit-juice concentrates. This process employs the use of lower temperatures and therefore retains more of the delicate flavour components and nutrients present in the fresh fruits. Freezing generally finds wider application in our meat and dairy industries but is sometimes used in combination with concentration as a method of preserving fruit juices. Dehydration is not practised to any great extent with fruits although breadfruit and banana have been dehydrated to produce flour and banana "raisins" locally. Spray drying of coffee is one of the better known examples of dehydration.

The Food Technology Institute started out as the Processed Food Division of the Ministry of Trade and Industry in 1959. The emphasis then was on monitoring food processing operations. Research commenced in 1966 on the processing of frozen foods. Jamaica Frozen Foods was established in 1968 to manufacture these products, which were marketed under the Jamaica Way label. The following products are but a few of those developed between the late 1960's and mid 1970's, using local fruits:

BY CANNING	BY FREEZING
Coconut Cream	Limeade Concentrates
Coconut run-down Sauce	Sorrel Concentrate
Ackee Paste	Coconut Cream

BY CANNING	BY FREEZING
Lime and Pineapple Pie Filling	Breadfruit
Banana/Pine/Citrus Drink	Banana (Green)

Other banana products developed include puree, 'figs', sauces and baby food mixes (banana/legume combinations) the banana figs being the only one in commercial production at present. This product is manufactured chiefly for bakery operations where it is used as a substitute for imported raisins.

Candied fruit-peel (mixed peel) and chocho "cherries" both developed at the Food Technology Institute are now being produced by the North Clarendon Processing Company. Jamaica's fleshy fruits are particularly suited to candying. For instance, the unripe pawpaw makes as good a "cherry" as the chocho.. There is significant export potential for this type of product.

Several of our local fruits have been marketed in the past as canned products in syrup, puree and fruit juice concentrates. Pawpaw chunks, Otaheiti apple slices, mango and june plums were among the more popular items in syrup. Purees and fruit juice concentrates prepared at the Institute include mango, guava, tamarind and soursop, to name a few. These find ready use in the ice cream, jam/jelly, fruit syrup and fruit drink industries.

Currently the Food Technology Institute has placed more emphasis on expanding existing product lines so as to maximise utilization of the fruits. To this end, developmental work on several new pawpaw products (viz nectar, pie fillings, jam and sauce) utilizing the fruit at all stages of maturity, is near completion. There is great potential for this line, and particularly the nectar on the export market. Other developmental work on a coconut pie filling and tropical fruit salad using various combinations of 3-5 fruits, is also nearing completion. On completion of developmental work, the institute is prepared to sell formulations to processors. In some cases the research project may have resulted from a particular request and in such cases the processor may obtain exclusive rights to the formulation.

EXISTING PROBLEMS AND OUTLOOK FOR THE FUTURE

There are several problems presently affecting both research and general processing operations in Jamaica. These include identifying and obtaining proper raw materials and foreign exchange restrictions which affect the procurement of machinery as well as packaging and processing aids.

The inconsistent and inadequate supply of good quality raw materials is a constant problem. Farmers are unaware of the processor's needs because of a general lack of communication. This possibly relates to a weakness in our educational system whereby the farmers sees no connection between his growing of specific crops and the earning of foreign exchange through the export of products manufactured from these crops.

Apart from the traditional fruit crops grown for industry (i.e. banana, coconut and citrus), other fruit cultivation is done on a very small scale. Otaheiti apples for instance, are grown mainly for wind protection of primary crops. Jamaica's pawpaw production for 1978 was forecasted as 142 short tons. This was the only reference made to any tree-crop fruit. It could therefore be assumed that this fruit is the only one (of the non-traditional group) which is cultivated to this extent.

Recently more farmers have undertaken the cultivation of many varieties of mangoes. These however, are mainly for the fresh fruit export market. Before starting operations it is necessary for the processor to predetermine what variety best suits the particular process and then to arrange for supplies with the farmer. For instance, problems of varietal identification exist with respect to the naseberry. Two basic varieties of this fruit are commonly found. To the laymen these can only be identified after tasting and to this end the farmers assistance would be invaluable to the processor. One variety has a coarse, granular texture when compared with the other which is smooth. This feature is of significance to the processing industry as the resulting products would be grossly different. The smooth textured variety gives a much more palatable product.

The recent shortage of tin plate at Metal Box Jamaica Limited resulted in reduced quotas of tin cans for the processing industry. This shortage stems from foreign exchange restrictions which affect payments for imported goods and materials. In an attempt to side step the problems of obtaining tin cans, the processors may look at alternative methods of packaging. Packaging in plastic pouches might be an answer but this in turn will alter the the process method. It is not likely that freezing will regain popularity as a general method of processing as excessive fuel costs would make it uneconomical.

Most of the problems mentioned above can be solved through better planning for the future. The processor need not be faced with raw material problems if he first sets his specifications with the farmer. The setting up of a factory should incorporate considerations of raw material availability, the proximity of the source, methods of harvesting and transportation. Furthermore, with particular reference to our fruit crops, special planning is required in order to have production geared towards the particular fruits in season. Training in special areas of fruit technology would definitely improve the present situation.

In considering the shortage of cans, our local juice industry in particular could overcome this problem in introducing bulk packaging, when necessary. This type of packaging would be most suitable for local hotel and restaurant business and would also be appropriate for export. Our local engineers should be capable of making the necessary changes this would require to the filling machines.

The Institute at present is the only food research unit with the equipment, pilot plant and personnel capable of developmental work for the processing industry. The need for greater involvement of the private sector with the Institute has been recognised. Co-operation of the two will undoubtably ensure the "implementation" aspects which are so vital to making research work relevant to the society.

Harvesting, Handling & Storage of Fruit Tree Crops

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Most tropical and sub-tropical fruits are usually harvested at high temperatures which if maintained drastically shortens the storage life of the produce. As these regions are usually great distances from their export markets it is of importance to get the maximum storage life from this produce.

The purpose for storing fruits and vegetables is to extend their availability to the consumer and provide for more orderly marketing. Successful storage is attained by providing environmental conditions which reduces the respiratory activity of these living agricultural produce and inhibit the growth of decay-causing organisms while maintaining good quality.

Maximum storage life can be obtained only by storage of high quality commodities soon after harvest. Storage properties may be influenced by variety, climate, soil and cultural practices, maturity and handling practices before storage.

All fresh fruits and vegetables remain alive and metabolically active throughout their period of saleability and during this period continue to respire and to utilize the reserved food stored during growth. Respiration is accompanied by changes in the composition of the fruit resulting in changes in quality and eventually in spoilage. Although the metabolism cannot be stopped completely, it should be slowed down if the quality is to be retained and the aim of good storage practices is to provide the most suitable environment which will reduce the metabolic activity to a minimum yet keeping the food alive.

It is well known that the market quality of all fruits is controlled by a time temperature relationship and that the rate of deterioration for most fruits is as much as four times for every ten degrees rise in the temperature. It is therefore obvious that rapid deterioration can occur if the produce is left standing in tropical temperatures of 30°C or more for even a short period e.g. in the field.

Not only do high temperatures accelerate ripening and deterioration but it also favours the development of decay. Because the activities of decay causing organisms is accelerated by high temperatures the reduction of temperature as soon as possible after the fruit is harvested is of utmost importance in order to maintain the quality of the fruit.

Production

The successful storage and also the development of an export trade begins with the grower. In order to produce first class fruits free from all blemishes, disease and insect infestation the grower must be able to organize his production on scientific lines, using modern techniques to control insect pest and diseases.

When possible varieties with potentially long storage life should be favoured over those which even best conditions available will store only for a short time.

Harvesting

This must be carefully controlled so that fruits are picked at the correct stage of maturity to enable them to go through the storage period, arrive at their destination in the optimum condition for eating, and yet have an economic shelf life for retail distribution. If immature or over-mature the storage life may be impaired. Whenever possible the fruits or vegetables should be harvested under dry conditions and in the coolest part of the day.

Handling

Careless handling during harvesting, putting in and removal from storage and subsequent grading and packing is one of the primary causes of spoilage.

Fruits, root crops and vegetables intended for storage should be as free as possible from skin breaks, bruises, decay and other deterioration. Bruises and other mechanical damage not only detract from the appearance of the product but are usually the principal avenues

of entrance for decay causing organisms. Whenever the skin of a fruit etc. is damaged, spoilage will start immediately.

The use of clippers rather than pulling is recommended for e.g. mangoes and avocadoes and the fingernails of packers should be kept as low as possible . The labour force should be trained to handle fruits carefully so as to minimize bruising. Two common causes of bruising are, the workers dumping the produce carelessly in the picking container or applying too much pressure when handling the fruit. Sometimes finger marks can be seen on mangoes, avocadoes, pawpaws etc. on the shelf.

Storage Methods

Methods commonly used for the prolongation of storage life are reduction in temperature, curing, controlled atmosphere storage, waxing and chemical treatment, the last four named being supplements to reduction in temperature.

Reduction in Temperature

Refrigerated storage is recommended for many perishable commodities because it retards (1) respiration and other metabolic activity, (2) aging due to ripening, softening and textural and colour changes, (3) moisture loss and the wilting that results, (4) and spoilage due to invasion by bacteria, fungi and yeasts,.

If the best results are to be obtained it is important that the temperature in the storage rooms be held fairly constant. Variation of 2 or 3° are too large in most cases. The danger is greater the longer than the period during which the temperature is above the optimum. On the other hand if the temperature goes to 1° or 2° below there is a chance that freezing will occur. In addition fluctuations in temperature often cause condensation of moisture on stored products which may favour the growth of moulds and the development of decay.

Temperature variation can be prevented if the store rooms are well ventilated throughout and have adequate refrigeration. Proper stacking and adequate air circulation also help to minimize temperature variation. Storage rooms should be equipped with reliable accurate thermometers or with manual controls. It is important to keep a watch on the temperature at various places in the storage room.

The temperature of the produce stored in packages or within bulk should be taken at various locations. A good quality thermometer is essential. Temperatures in inaccessible locations e.g. the centre of stacks, can be obtained conveniently by distant reading thermometer equipment e.g. thermocouples.

Precooling

This refers to rapid removal of field heat before shipment or storage and is essential for the more perishable horticultural crops e.g. breadfruits. Since deterioration occurs much more rapidly at warm temperatures than at low temperatures, the more quickly field he heat is removed after harvest, the longer produce can be maintained in good marketable conditions in storage. Usually storage rooms desired for holding produce under refrigeration do not have the refrigeration capacity or air movement for rapid precooling. So precooling for storage usually is a separate operation. Precooling is done commercially by several methods. All involve the rapid transfer of heat from the commodity to a cooling medium e.g. air, water or ice. Thirty minutes for adequate precooling.

(1) Rapidly moving air

Cooling with rapidly moving air is one widely used methods of precooling produce. It can be adapted to refrigerated rooms, rail, cars, trucks or the forced air method.

(2) Ice-cooling

This involves the use of crushed ice either placed within containers in direct contact with the produce or on top of packed containers.

(3) Hydrocooling

This is a popular precooling method wherein produce is flooded or immersed in cold water near 0°C. Properly used it is one of the most rapid and effective means of removing field heat. Carrots, cucumbers, breadfruits, are commodities which should be precooled. Once the product is precooled, it should be promptly refrigerated.

For many tropical fruits precooling to temperatures between 0°C and 5°C is not practicable because of the risk of chilling injury.

Chilling Injury

Certain fruits and vegetables are injured by low (0° - 10°C) but non-freezing temperatures. At these temperatures they are unable to carry on normal metabolic processes. Products which are chilled often look sound when removed from the low temperatures. However symptoms of chilling become evident in a few days at warmer temperatures. Fruits which have been chilled may be particularly susceptible to decay e.g. of susceptible fruits are: bananas, grapefruits, mangoes, limes and pawpaw.

Chilling injury results in shortened shelf life and usually the chilled fruit suffers from blemishes, internal discolouration, increased susceptibility to decay and a failure to ripen. Cold intolerant fruits e.g. breadfruits, avocadoes, pawpaws and mangoes should be precooled at around 13°C and if possible maintained at this temperature during storage.

Relative Humidity

The relative humidity of the air in the storage room affects the keeping quality of the products held in them. If it is too high it favours the development of decay especially in rooms where there is considerable variation. If it is too low wilting or shrivelling occurs in most fruits and vegetables. The control of molds become difficult as the relative humidity approaches 100%, which results in condensation. Surface moulds may grow on walls, ceilings and containers as well as on stored products.

A high relative humidity of 85 - 95% is recommended for most perishable horticultural products, to retard softening and wilting from moisture loss except onions and other bulbs.

Relative humidity can be measured by a sling psychrometer or a hair hygrometer.

Air Circulation

Air must be circulated to keep a cold storage room at an even temperature and provide faster cooling of stored commodities throughout. Modern storage rooms are equipped with some means of air circulation e.g. a fan or blower.

Weight loss in storage

All fruits and vegetables lose water by evaporation after harvest which can result in serious wilting and a loss of their fresh appearance. Some water loss can be tolerated but losses great enough to cause wilting must be avoided. Most fruits and vegetables contain 80 - 95% water by weight, some of which can be lost by evaporation.

Wilting can be prevented by raising the relative humidity, by lowering the air temperature, reducing air movement and by protective packaging. The nature of the fruit itself is also important but most wilting can be minimized by maintaining the fruit in an atmosphere with 85 - 95% relative humidity. General moisture loss should be minimized as it represents a loss in saleable weight.

Sanitation

Maintenance of sanitary conditions within storage rooms is essential. Storage rooms should have a thorough cleaning at least once per year to remove unsightly surface moulds, with a cleaner containing sodium hypochlorite.

Rotting fruits and vegetables should be handled carefully to avoid spreading of spores and once removed should be disposed of promptly.

Supplements to low temperature storage

Although refrigeration is the most effective method of extending the storage life of most fruits and vegetables, supplemental treatments are often beneficial to many produce. Supplements can be used to control decay, retard respiration to control physiological disorders or to control moisture loss.

Hot water treatment

It has been found beneficial to dip certain fruits like mangoes and pawpaws immediately after harvest in hot water for a short period. This treatment greatly reduces fungal infection during storage. After this the fruits must be stored under conditions of low temperatures and relatively high humidities.

Controlled Atmosphere

This method is used in developed countries to supplement cold storage: example, in the storage of apples. Respiration, aging, ripening and certain physiological disorders can be further reduced by increasing the carbon dioxide level and/or reducing the oxygen level. The use of polyethylene bags in the storage of fresh breadfruits is an example of controlled storage.

Waxing

The application of wax emulsion commercially to citrus, turnips, cucumbers, tomatoes and sweet potatoes has been in use for many years. It reduces moisture loss, gives an improved glossy appearance to some produce and acts as a carrier for sprout suppressants, fungicides and other chemicals.

The thickness of the cost is critical as too thin a coat gives no protection and too thick a coat causes physiological breakdown and increased decay.

Mixed Commodities

At times it may be necessary to store different products together. Most fruits can generally be stored together if they have the same temperature requirements. With some products there is a cross-transfer of odours. Most fruits also give off ethylene which may produce adverse effects on e.g. lettuce and carrots. Ethylene stimulates ripening of many fruits. For this reason products such as cucumbers and green peppers in which retention of the green colour is desirable should not be stored with ethylene producing crops.

As some of the potential life is used up during storage, when fruits and vegetables are removed they will not keep as long as freshly harvested produce. However if the storage period is not exceeded there will be sufficient times to get them on to the market and to consumers.

Proper storage methods for a few local produce are given below:-

Breadfruits

Fruits for export should be carefully picked at the mature green stage making sure they do not fall to the ground. Then they should be precooled, placed individually in polyethylene bags (100 -- 125 gauge), carefully packed in cartons and as quickly as possible placed at 12 - 15°C.

Mangoes

Example St. Julian variety. For export purposes fruits should be picked at a mature green stage with about 1 cm. of stalk attached to reduce latex exudation. Bruising should be carefully avoided during harvesting and subsequent handling. Prior to storage fruits should be dipped for five minutes in hot 55°C water as this delays the anthracnose development during subsequent storage.

For optimum storage a temperature of 12.5°C, 90% relative humidity is recommended. Under these conditions fruits keep well for about three weeks. At lower temperatures chilling might occur but sea shipment have successfully been made to the United Kingdom. At 7°C and fruits ripened normally with good flavour. The temperature is not recommended for commercial shipment. Preferable ripening temperatures range from 18 - 21° C as at these temperatures fruits develop a more attractive skin colouration than at higher temperatures.

DISEASES OF MISCELLANEOUS FRUIT TREES

F.L. Edman - Ministry of Agriculture.

Pests and diseases are serious constraints which limit the production of high quality and yield of fruits grown both for domestic and export markets. Fruit trees whether started as seeds or rooted cuttings are subjected to attack of pests and diseases from the nursery stages. Hence proper crop care methods must be practised from seedling stage until the fruits are delivered to the consumer.

MANGO

There are several diseases which affect the production of mangoes in Jamaica. Of these the more important ones are powdery mildew, anthracnose and sooty mould.

Powdery Mildew

This disease is caused by the fungus Oidium sp. and occurs during dry weather. It attacks young leaves producing irregular greyish blotches and pre-mature leaf fall. On the blossoms the disease appear as a white powdery growth which causes the whole inflorescence to become brown and finally abscise. It also causes abortion of young fruits.

Control

Spraying with a fungicide such as Benlate, Daconil (Bravo), Karathane or a ½ mixture of Benlate and Daconil when the symptoms first appear and 8-14 days after the first application should give adequate control.

Anthracnose

This disease caused by the fungus Colletotrichum gloeosporioides affects blossoms, leaves and fruits. On young leaves it appears as small dark irregular spots, while on the blossoms small black spots occur on the open flower clusters. On fruits, black sunken spots of varying sizes may occur which often coalesce to envelope the entire fruit reducing it to a black mass. Fruits become infected when very young but symptoms are only expressed when fruits are almost mature.

Control

Spraying with a fungicide such as Benlate, ½ Benlate, + Daconil (Bravo), Cupravit or Difolatan, should commence at flowering and continue at monthly intervals until the fruits are developed.

Sooty Mould

This condition is caused by fungi which grow in the exudate (honey dew) of sucking insects. It is seen as a black velvety coating on the leaves. It is superficial, but if it occurs extensively will reduce photosynthesis and weaken the plant.

Control

Spraying with an insecticide such as Malathion and White Oil to control the insects scales, and aphids will reduce the incidence.

AVOCADO

AVOCADO

The major diseases which are important in the growing of avocado are Root Rot, Scale, Anthracnose, Leaf Spot and to a lesser extent Algal Rust.

Root rot is caused by the fungus Phytophthora cinnamoni, and is most severe on poorly drained or clay soils. Young plants appear stunted and unthrifty, have pale green to yellow leaves which fall prematurely and may show signs of tip dieback. Mature trees exhibit excessive leaf fall, accompanied by heavy flowering and production of many small fruits.

Control

Seedlings should be started in free draining soil, however, treatment should be carried out with a fungicide such as Dexon, Ridomie or Terrazole at monthly interval until improvement is observed.

Scab

This disease is caused by the fungus Sphaceloma perseae and appears as raised brown corky lesions on leaves and fruit.

Control

To protect the young leaves and fruits an application of a fungicide such as Benlate, Difolatan or Cupravit should be made in the early spring while the buds are still dormant. Depending on weather conditions, four (4) two-weekly applications should be made as the flower bud clusters open, thereafter at monthly intervals.

Anthracnose

This condition produces a fruit rot and is caused by the fungal Colletotrichum gloeosporioides. It is not very serious on fruits consumed locally, but causes a rot of fruits during shipping.

Control

Fruits for export should be handled carefully to avoid injuries. A pre-package dip in Benlate solution will prevent this condition.

SOURSOP

Anthracnose is the major disease which affects this crop,and is caused by the fungus Colletotrichum sp. The disease attacks the leaves inflorescences and fruits. The condition appears as sunken brown spots which on leaves and flowers causes premature leaves and flower to fall. On fruits, it produces a rot.

Control

Spraying with a fungicide such as Benlate, ½ Benlate + Daconil (Bravo), Cupravit or Difolatan, should commence at flowering and be continued at monthly intervals until the fruits are developed.

CASHEW

This crop has been affected in recent years by diseases which attack the inflorescences, leaves, nuts and apples. This disease is caused by the fungi Botryosphaeria ribis, Glomerella cingulata, Phomopsis anacardi and Pestalotiopsis.B. ribis is the primary agent. The symptoms are withering of the petals and other floral parts. This is followed by a progressive dieback of the peduncles and floral shoots. When however the immature apples and nuts become infected, they become black and puffy, then wither and remain mummified on the trees.

Control

Spraying ½ (Benlate + Daconil) or Difolatan or Daconil at flowering will reduce the disease incidence.

PAWPAW

The diseases of any importance which affect pawpaw are Anthracnose and Bunchy Top. The former is caused by a fungus Colletotrichum sp. and the latter a mycoplasma..

Control

Anthracnose. Spraying with a fungicide such as Benlate, ½ Benlate + Daconil (Bravo), Cupravit or Difolatan should commence at flowering and be continued at monthly intervals until the fruits are developed.

Bunchy Tops. This condition can be minimized by controlling the insect which transmits it by spraying with an insecticide - Rogor, Perfekthion or Sevin at two weekly intervals. Cutting back of affected plants at a point below the sap flow will encourage healthy side shoots.

ACKEE

No serious disease affects this crop.

GUAVA

Sooty mould and fruit rot occasionally affect this crop but do not warrant any control measure.

PESTS OF MISCELLANEOUS FRUIT TREES IN JAMAICA

T.M. Williamson - Entomologist, MINAG.

MANGO

The most important pests attacking mangoes in Jamaica are the fruit flies; other less important pests include Thrips, scale insects and mealy bug.

Fruit Fly (*Anastrepha* spp) –

This pest is the main limiting factor to mango production in Jamaica. There are several species attacking a wide range of fruit trees including mango, guava, plums, otaheiti apple, star apple, naseberry and others. Mango is the primary host of the species Anastrepha mombinpraeoptans. Of the exo tic varieties of mangoes (the Bombay, the St. Julian and the East Indian) the Bombay is the most susceptible to fruit fly infestation during the main crop. It was found that infestation of fruits may occur in the young or maturing fruit and sometimes even at a later stage. The St. Julian variety has been found to possess a fairly high degree of resistance to the fruit fly.

Control - It has been stated by an expert in the field that "the fruit flies in Jamaica cannot be economically controlled, unless an ingenious and creative non-conventional method of control is found or discovered." Nevertheless, some amount of control in orchards may be obtained by planting varieties that have some degree of resistance to the pest. Chemical control may also be employed by spraying mangoes with an insecticide such as Lebaycid or Rogor from fruits that are about 30% mature at 10 day intervals and up to 14 days before harvesting.

Thrips - *(Selenothrips rubrocinctus)* - Thrips are tiny insects about 1 mm long, dark brown in colour in the adult stage. In the immature stage they are yellow with a bright red band around the body. They have a fairly wide host range which includes mango, cashew, avocado, guava and cocoa. The thrips feed on both foliage and fruit usually in the young stages. On the foliage they feed on the lower surface of leaves giving them a darkly stained, rusty appearance, with numerous small shiny black spots. Badly damaged leaves become curled, turn brown and abscis prematurely. Young leaves are most severely affected. Thrips are favoured by hot dry conditions. The Bombay and the East Indian varieties seem particularly prone to thrip attack.

Control - Thrips may be controlled by spraying trees with contact or systemic insecticides such as Malathion or Rogor. On small trees a high volume sprayer may be used but on larger trees it is necessary to use an air blast sprayer (Mistblower) for adequate spray coverage. Care should be taken to direct spray at the under side of leaves.

Scales and Mealy bugs - Several species of scales may infest mango trees but their damage is not usually of economic significance. Among them are the Soft Green scale *(Coccus* sp.), the Coconut scale *(Aspidiotus destructor)* and the Thread Scale . These scales may be found on both foliage and fruit.

Mealy bugs are not of economic importance but they do occur mainly on fruits at the stem end and between clusters of fruits.

Control - Control measures applied for the fruit fly for thrips will also control scales and mealy bugs.

AVOCADO

The pests attacking avocado in Jamaica include thrips, scales, mites.

Thrips – The damage done by thrips on avocado is similar to that done on mango. The same control measures recommended on mango are effective.

Scales – Avocado is affected by the coconut scale insect (Aspidiotus destructor) but this is not a serious pest.

Mites – Spider mites may infest avocado trees under dry conditions. This is not normally a serious pest on avocado but where control is necessary it may be obtained by spraying

with Kelthane, Dimethoate or Malathion.

GUAVA

The insects attacking guava in Jamaica include the fruit fly, scale insects, thrips and mealy bugs.

Fruit fly – The fruit fly is the most important pest of guava in Jamaica. Two species of *Anastrepha* have been incriminated. Both the Wild and Spanish guavas have been found to be susceptible to infestation by the fruit fly. Up to 100 per cent infestation may be obtained in fruit samples.

Control – Trees may be sprayed when fruits are one third mature and up to 10 days before harvest with Rogor or Lebaycid or other suitable chemicals applied at 10 day intervals. Removing fallen fruits from the field and destroying them or treating them with insecticide will also aid in reducing fruit fly population.

Scale insects – Several species of scale insects may infest guava trees. The most important of these is the soft green scale *(Coccus viridis)*. This scale has a very wide host range, with guava being one of the preferred hosts. Infestation is expressed as rows of flat, oval, immobile green scales, especially along the main leaf veins and near the tips of green shoots. Upper surfaces of leaves may have spots of sticky transparent honey-dew or covered with sooty mould growing on the honey-dew.

Control – Control of scale insects can be effected by spraying the trunk of trees with a persistent contact insecticide such as Chlordane, Heptachlor or Azodrin to keep off the attendant ants and allow the natural enemies of the scales to clean up the infestation. Severe infestation can be controlled by spraying the foliage with an insecticide such as Diazinon, Malathion or Dimethoate.

Thrips – The thrips *(Selenothrips rubrocinctus)* will infest guava trees doing damage both to the leaf and the young fruit. Damage results in the characteristic dark brown spotting of the lower surface of affected leaves and a rusty appearance of fruits.

Control – the chemicals recommended for the control of the fruit-fly and scale insects will also effectively control thrips.

Mealy bug – The mealy bug, though not a primary pest, may infest guava trees feeding on young shoots, berries and leaves, sometimes in large numbers. In dry weather it may move down below ground and inhabit roots. The mealy bug is generally favoured by dry weather and heavy attacks may follow periods of prolonged drought.

Control – Control measures recommended for scale insects should be adequate for mealy bug control

PAWPAW

Not many pests are known to affect pawpaw in Jamaica. The more important ones are leaf hopper, mites, and hornworm.

Leaf hopper – By far the most important pests is the leaf hopper *(Empoasca papaya)*. This pest causes direct injury to the foliage but it is of greater renown for the role it plays as the vector of the Pawpaw Bunchy Top Disease. This disease, (believed to be caused by a Mycoplasm) is very efficiently transmitted by the leaf hopper. Plants at all stages are affected and it is believed that bearing trees are most susceptible.

Control – The leaf hopper may be controlled by spraying pawpaw trees at 14 day intervals with an insecticide such as Rogor, Diazinon or Sevin.

Mites – Mites will infest pawpaw leaves especially under dry conditions. Initial damage is expressed as clusters of yellow spots which later merge and become brown as the tissue dries out. Damage is especially severe between the veins towards the leaf stalk. If damaged leaves are closely examined mites will be detected in large numbers on the lower leaf surface. A slight webbing made of fine strands of silk will also be noticed over the area of infestation.

Control – Insecticides such as Malathion and Rogor are effective in controlling mites; a miticide such as Kelthane may also be used.

Hornworm – A large hornworm caterpillar may sometimes be seen on pawpaw trees. This pests feeds on the leaves and can cause much defoliation if unchecked. It is however, hardly a problem since it is adequately kept under control by natural enemies. The most important of these is a wasp parasite, the larvae of which destroys the caterpillar by feeding on its inside and killing it. The wasp larvae form a mass of white cocoons on the back of the hornworm from which the adult wasp parasites emerge.

If additional control is necessary, caterpillars may be hand-picked and destroyed. Spraying with an insecticide such as Sevin, Basudin, Dipterex or Diazinon will give control where necessary.

ACKEE

The Ackee generally has no serious pest problem but trees may be infested on a localized level by scale insects and mealy bugs. Where control is considered necessary the trunks of trees may be sprayed with a residual contact insecticide such as Chlordane to control attendant ants. Direct control may be employed by spraying with Rogor, Malathion or other suitable insecticides.

SOURSOP

Several pests including scales, mealy bugs, aphids and a 'fruit wasp' affect the soursop. These are not generally considered as serious pests but localized infestation may occur under favourable conditions.

Scales and Mealy bug may be found on both foliage and fruit and are usually attended by ants. Aphids may be found infesting flowers and young fruit. Where this occurs the fruit fails to develop. This is not a widespread problem but may be found affecting some flowers on a tree.

The Fruit-wasp – Perhaps the pest of greatest importance to soursop production is the 'fruit-wasp'. This wasp is often found in fruits feeding inside seeds. Fruits that are infested are hard in the affected areas and fail to ripen evenly. Not much is known about this pest but it is believed that infestation takes place quite early in fruit development.

Control – Scales, mealy bugs, and aphids may be easily controlled by spraying with Malathion, Rogor, Diazinon or other suitable insecticide. It should be possible to obtain control of the 'fruit-wasp' by spraying at regular intervals with a suitable insecticide that has residual contact activity.

TOP WORKING OF FRUIT TREES

Texton Groves - (Production MINAG)

Top working is the renovation of established trees by the application of the techniques of budding or grafting.

Top working should only be carried out on a healthy vigorous trees since the growth and development of the scion will be determined by such trees.

Top working of fruit trees care carried out because of the following rasons:

1. When a variety or varieties of established fruit trees are of little or no commercial value.
2. When such variety or varieties are of commercial value but are not sufficiently resistant to diseases and pests such as anthracnose, scab, fruitfly and thrips so that commercial control is practicable, top working with an improved resistant variety is best recommended.
3. When improved or superior varieties are bred or selected, top working of such varieties is usually done on trees of inferior varieties.
4. When a grower wishes to change his varieties because of special reasons e.g. market demands. In the top woking of fruit trees, the following tools are required:

Power Saw – which is used for the cuttin back of large branches.

Pruning Saw – which is used for the cutting back of smaller branches, making cuts on rootstock as in the grafting of avocado and also for cutting back the rootstock during the process of 'Union Cleaning'.

Secateur – which is used for the cut back of branches too small for the pruning saw and also in the preparation and collection of scion material.

Budding Knife which is used to make cuts during the process of budding and grafting and also for cutting back the rootstock during the process of union cleaning.

TOP WORKING OF MANGO TREES

Mango trees can be top worked any time but a greater degree of success will be achieved if this is done in spring or early summer. In cases where trees are to be cut back, this operation is done in the fall so that shoots arising from the stumps will be ready for grafting in this period.

Preparation of Mango Trees (Rootstock) and Scions for Topworking

In the case of small trees about six (6) years old with trunks less than six (6) inches in diameter, preparation entails the removal of dead branches and epicormic growth. Small branches are also removed from the trunk at the points where top working (grafting) will be done.

In the top working (grafting) of a small or medium tree, a type of cut called veneer is made on the prepared trunk at a chosen point. In forming the veneer, a section of the bark of the trunk is removed by two (2) cuts made with the budding knife.

The first cut is a lower, shorter and angular cut, while the second is a higher, longer and more upright cut which peels off about 1½" of the bark and meets the first cut at a point. By the use of a budding knife, the section of the bark between these two (2) cuts may be easily severed and displaced from the trunk.

The prepared scion is dressed with two (2) cuts or veneer corresponding in dimensions and made in the same manner as those made on the rootstock. The first or lower cut is made on one side of the scion, and the second or longer cut on the opposite. Both cuts will meet at a point corresponding with those made on the stock plant.

The dressed scion with the veneer (cuts) is fitted neatly in the veneer made on the branch of the stock. Both scion and stock are completely wrapped and tied in order to keep them in full contact until the graft union takes and is strongly developed.

About three (3) weeks after grafting, ringing or notching of the stock plant directly above and close to the graft union is done. Ringing stimulates the buds of the scion to grow, as a result of the influx of nutrients that is cut off from the region above the graft union. The budding tape is also untied to release the buds of the scion, and re-tied afterwards.

When the scion puts on two (2) or three (3) growth flushes about four (4) months after grafting, the budding tape is finally removed, and the branch of the stock is cut back (as close as possible) to the graft union.

The surface of the cut is then treated with tar, Bordeaux paste or oil paint in order to enhance healing of the wound and also to prevent infection. These operations are referred to as "Union Cleaning".

After-care of new growth arising from the scion is of utmost importance. Disease and pest control measures should be carried out at least once per fortnight especially during the fall or under conditions resulting in high relative humidity. In windy areas, trees top-worked must be staked and scions with new growth tied to them in order to prevent breakage at the graft union or elsewhere on the new growth of the scion. The following diagrams will illustrate the preparation and fitting of both scion and stock.

In the case of medium sized trees with trunk diameters greater than six (6) inches, preparation entails the selection of the lowermost branches especially those forming the main branching system of the tree, and the removal of other unwanted branches, dead wood and epicormic growths. As in the preparation of the small tree, the branches chosen for topworking are cleared of leaves and stems at the points where grafting will be done.

Grafting of medium sized trees and the subsequent after care procedures are carried out in a similar manner to those of small trees previously described.

In the case of very large trees over fifteen (15) years old, the lowermost branches forming the main branching system of the tree are cut back to uniform heights with the use of a power saw while other branches are removed at the junctions formed with the main trunk. Selected shoots arising from the stumps of these branches, can be budded or grafted in about six (6) months time or less depending on the rate of regeneration of the trees.

After care of large or very large top worked trees are also carried out as previously described.

TOP WORKING OF AVOCADO TREES

Avocado trees can be top worked at any time, but late winter or spring is best suited for this practice. Grafts made at this time have a full growing season in which to develop before the advent of the dormant winter period.

There are two methods of top working avocado trees most widely used is the Bark Graft and the Saw Kerf or Notch Graft. Some growers and nurserymen prefer to cut back the trees and bud or graft the vigorous shoots that develops from the stump. This method although widely used in Jamaica is more time consuming and is not recommended in other countries producing this crop.

Trees can be top worked are cut off at convenient working heights where the bark is smooth. If there is a poor bud union, or if for any reason the trunk is damaged the cut can be made below the bud unions. The trees are usually cut when the grafts are placed but can be cut ahead of time. Within a day or two after the cut is made, the bark begins to tighten and will not slip again for several weeks. For this reason, if a bark graft is used the cut is madeat the time of grafting or four to six weeks in advance. If trees are cut back sometime before grafting a fresh cut must be made when grafting is to be done.

After the tree top is removed, the bark becomes susceptible to sunburn in which case the stumps are white-washed as a preventive measure.

Scions for topworking should be selected from mature growth. Thick wood with plump buds should be chosen. Avoid immature wood near the terminal bud. Always protect scion material from drying. Store in moist coir in a cool place or in polythene bags at a temperature of 40 to 45°F.

The Bark Graft

This graft is easy to make and can be usedat any time when the bark will slip. To prepare the stump, make a single 2½ inch vertical slit in the bark (to accommodate the scions). On small stumps, there should usually be two scions while on larger ones, the scions should be placed at 1" to 2" on the perimeter. These may not be all needed, but will prevent the bark from dying back until the scions selected to form the new tree are ready to take over. To prepare the scions, a diagonal cut 2½ to 3 inches long is made on one side of the scion - Fig. 1. A second cut about ½ inch long is also made on the opposite side of the scion - Fig. 2. This cut removes the flexible bark at the base of the scion and makes it easier to insert without damaging the bark. The scion should contain at least two buds but should not be unnecessarily long. The scions are pushed down under the bark leaving only a little of the cut surface exposed.

The scions are held in place by several turns of stout tape or by driving one or two flat headed nails through them into the stump.

Figures 1, 2 and 3 illustrates the preparation of the stock and, scion and the fitting of the bark graft.

The upper end of the scion, the cut surface of the stump and the bark should be sealed with an asphalt emulsion, grafting wax or any good grafting compound.

The Notch Graft or Saw Kerf.

The Saw Kerf or Notch Graft requires more skill than the bark graft but it can be made at any time of the year because it is not necessary to have the bark slip.

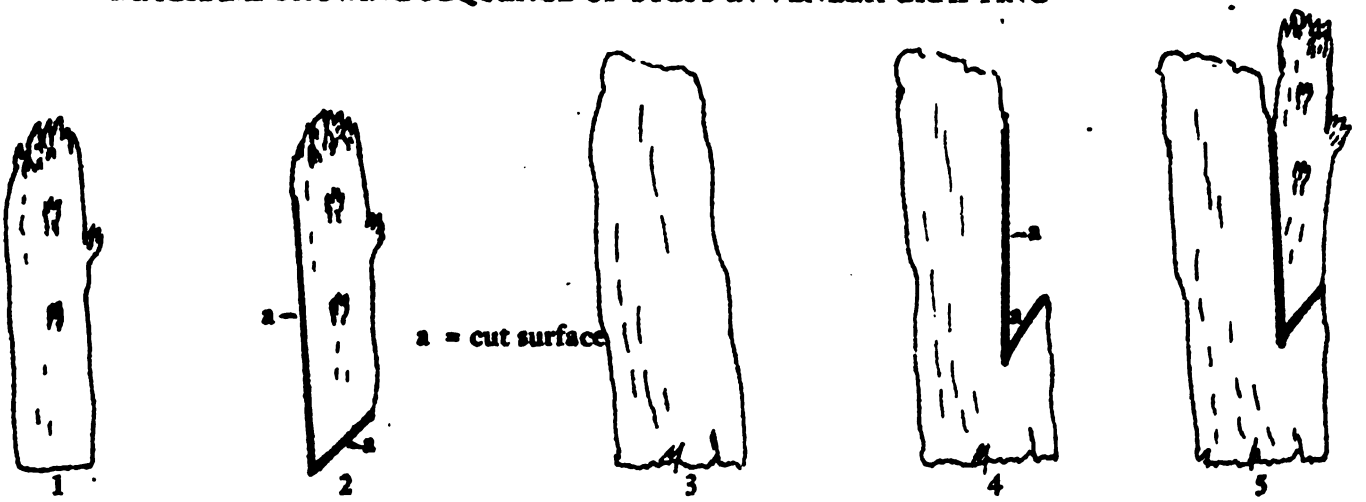
The cut should extend inwards about 2" on the cut surface of the stump and about 3" down the side. With this method, it is important to choose thick, well-matured scions with a greater diameter than that used in the bark graft. The scion is prepared by making 2 sloping cuts 2½ to 3 inches long on each side to make a wedge. The saw cut in the stump is then widened to accommodate the scion. The thick side of the scion faces outward and the scion is driven inside the notch in the stump so that the cambium of the scion matches the cambium of the stump (the cambium being a thin layer of dividing cells between the bark and wood of both scion and stump). The scion need not be nailed but the top of the stump can be wrapped with tape in order to protect the upper edge of the bark. The scions and stumps are sealed as in the case of the bark graft.

The following figures illustrates the preparation of the scion and stock and also the fitting of the notch or kerf graft.

After Care of Topworked Trees

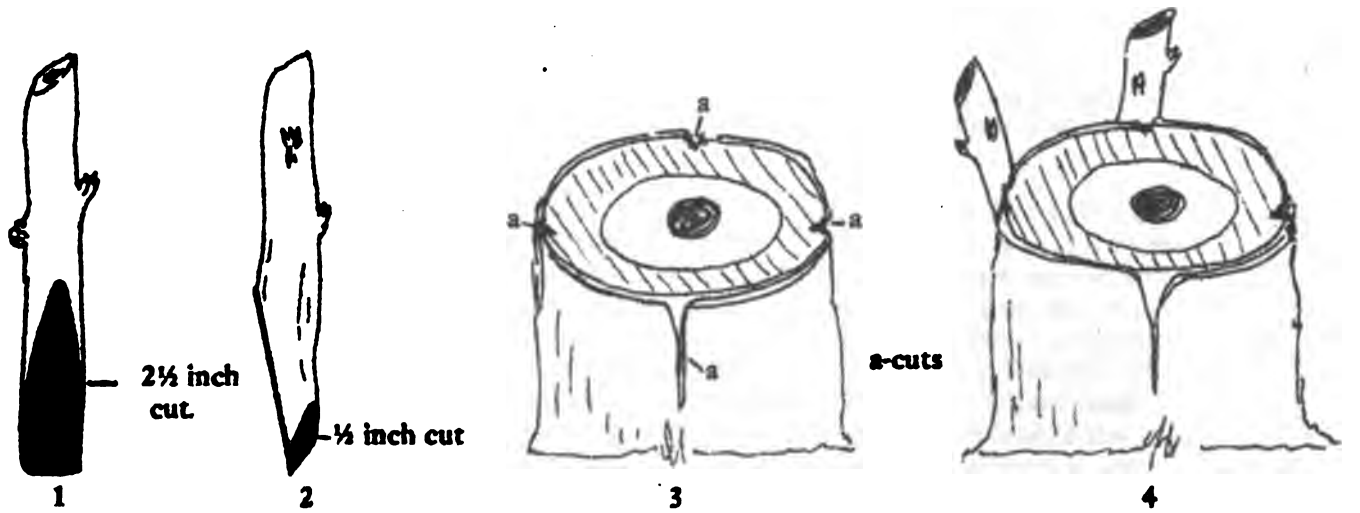
The new sprouts arising from the scions will need support for several years to prevent the wind from blowing them out. Stakes extending four to five feet above the top of the stump will provide such support. As new shoots develop they should be tied at frequent intervals. Remove growth from the old stumps. When scions are about (2) feet tall select the best grafts to form the new tree. Regular spraying for the control of pests and diseases should also be carried out.

DIAGRAMS SHOWING SEQUENCE OF STEPS IN VENEER GRAFTING



Key: 1 & 2 - Scion
3 & 4 - Rootstock
5 - Scion fitted to rootstock.

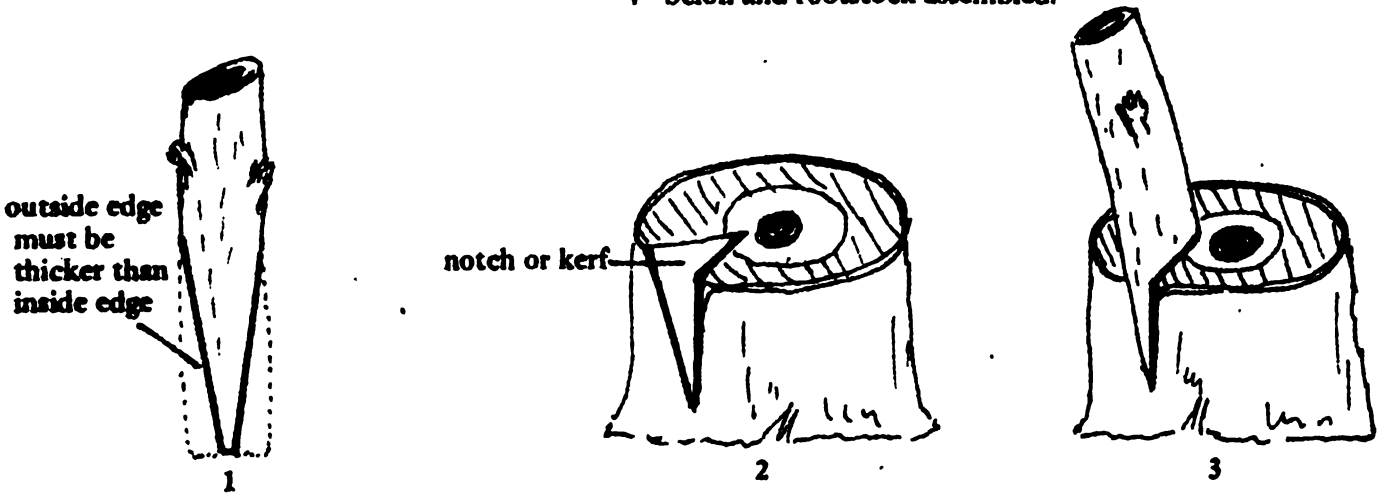
a = cut surface



Face towards wood surface.

Face towards bark surface.

Key: 1 & 2 Scion showing the two cuts
3 Rootstock with cuts
4 - Scion and rootstock assembled.



Key: 1 - Scion
2 - Stock
3 - Scion fitted to stock

TREE CROPS – COMMENTS ON PROCESSING ASPECTS

Miss Mabel Tenn - Grace, Kennedy & Co. Ltd.

During 'Workers Week', the Prime Minister and Minister of Agriculture, the Hon. Michael Manley, launched a tree planting programme of one million trees for Jamaica.

As one who is employed and has worked for many years in the processed food industry, I welcome this programme enthusiastically because of the great benefits to be derived by so many. When we consider that the life span of a tree is some forty to fifty years or more, the farmer/owner of these trees who will have made an investment in the future. Through this programme the processor sees raw material being provided in the years to come - the trader sees opportunities of trade and markets to be realised - the factory worker sees job security for himself - the consumer – food and shelter – the banker – future investments – the tax collector sees taxes to be collected for use by the government - the planners see protection of watersheds and rainfall patterns and future development and the nation recognises that efforts are being made for its future prosperity.

I hope some thought has been given to the planting of orchards of fruit trees, or at least on boundary lines of property. Serious thought should be given to the varieties and types of trees to be planted, and of course in the areas and manner which enable proper care and eventual reaping and transportation. As a processor, I will do the rest. Convert the fruit to finished product, or packing fruit for export.

This paper will take a look at that processing, set out what happens in a factory and identify the desirable features in a fruit from the point of view of the processor.

Breadfruit

Breadfruit is highly perishable. It has to be picked with care, not allowed to batter or fall to the ground. It has to be transported quickly and at night when it is cool because the fruit ripens rapidly. This is undesirable in the factory as the fruit becomes too soft, and results in a mushy pack. Ideally, the breadfruit should be picked young and not 'fit'. The pack is not uniform as peeling and slicing are done by hand. Some uniformity can be achieved however in colour, and therefore the white breadfruit is preferred by processors. It is also a hardier fruit. Most Jamaicans I know, prefer the Yellow Heart because of its sweetness and when roasted or fried it is delicious. The colour of the Yellow Heart also is quite attractive. For canning however, the Yellow Heart is not required.

At the factory the breadfruit is peeled, the heart and spongy material around the heart is removed, then it is blanched, drained and packed in a 2% salt solution, after which the air is exhausted, the can sealed and retorted under pressure for sterilization and cooking. Shelf life is fairly short if the air is not properly exhausted. It may be of interest for you to know that we have exported canned breadfruit not only to the ethnic markets in North America and England, but as far away as Middle East and a potentially valuable market could be developed there. I am also told that canned breadfruit makes a delicious Vichyssoise served either hot or cold.

ACKEE

Ackees, as you all know, have to open naturally. They are cleaned, packed in a salt solution, air exhausted, sealed and retorted under pressure for sterilization. The problems of ackee processing are well known because it is a delicate fruit and therefore cannot withstand the long processing time necessary for its sterilization. It becomes soft and mushy and does not travel well. Shelf life tends to be short.

The major problem of course is its Hypoglycin content, and for several years now this item has been banned from entering the U.S.A. The levels at which its toxicity becomes harmful is unknown; but let me say that there is continuing research in this field and hopefully we may have the answers in the not too distant future.

GUAVA

Here is a potentially viable crop. We regard it in Jamaica as a pest in pastures and something to be chopped down. Processing of guava products such as nectar, jams, jellies, puree and guava cheese is well known and I will not dwell too long on the processing aspect. Instead, the problems are:-

1. Since it is looked at as a non-crop, this fruit tree suffers from lack of care, resulting in worms and fruit flies. The guavas are reaped either too ripe or too green, which can cause a horrible concoction of squashed fruit interspersed with too high a proportion of green fruit. The processor cannot create a silk purse out of a sow's ear. Instead, he must necessarily incur high cost in selection, and a large percentage of fruit is wasted. As a result, farmers get low prices and the whole vicious cycle starts again - lack of motivation, scarce supplies, high prices therefore reduced market, and the continued chopping down of trees.

   It may interest you to know that Japan is a large international purchaser of Guava Puree. Some years ago, the Federal Government of the U.S.A., recognising guava's high potential, backed research at the University of Hawaii to develop suitable cultivars.

   Our guava, although having a good flavour, has a layer of hard stone cells which gives the nectar a sandy texture. This could be an area for the geneticist to develop a hybrid which would have the flavour of our common guavas with little or no stone cells. The guavas in Brazil are similar to ours, bright pink in colour but smooth textured.

PAPAYA

There are no problems in processing, the fruit is already known internationally and canned as nectar of fruit in syrup. The problems are however:-

1. Variation in colour - The processor must have only one colour to give uniformity. Different colours make the pack unattractive.
2. Size – The local variety, 'El Salvador', is too large. During transporation, the weight of these heavy fruit squash each other, and the women in factories are unable to handle them.

ACEROLA CHERRY

This berry must be processed very quickly. It is desirable because of its high Vitamin C content, and subtle and delicate flavour. It must be processed however, very quickly after reaping. Both colour and flavour are not heat stable, and therefore the berry does not lend itself to canned hot pack. Many years ago it was processed extensively for the extraction of Vitamin C for the Baby Food Industry. With the advent of cheaper synthetic Ascorbic Acid, however, its use declined. I understand that renewed interest is being shown in this berry where it is now being grown in the Dominican Republic and Puerto Rico, then frozen and shipped to the United States.

SOUR SOP

Soursop produces a very strong-flavoured, thick juice. It is being processed successfully in Puerto Rico by Goya Foods. We have not been successful however, because it tends to make people sick. We believe that the seed may contain some form of toxin, but no work has been done to identify the toxin, if any. We have examined the techniques being used in Puerto Rico and can see no difference to what we are doing in Jamaica. Let me say however that the Puerto Rican product seems to be far more diluted than ours. And the fact remains that this diluted product is what is selling in the International Market. It is exported mainly to the East and West Coasts of the U.S.A. where it is sold mainly to Hispanic groups.

We hope to do some work with the University here with Soursop, with a view to identifying any toxic material that may be in the fruit or the seed.

MANGOES

The variety that is processed in the largest volume is the Beef Mango which is fermented and packed in brine for export, for use in Chutney manufacturing. Indeed, this Jamaican mango is preferred in the U.K. because of its good colour, lack of fibre and firmness of texture.

Unfortunately, the U.K. gets most of its supplies from India because we are unable to supply their demand, and also because our prices are considerably higher. The other factor is inconsistency of supplies. A small quantity of this variety was processed in sugar and packed in #10 cans for the pastry industry in New York, but we have had to give up this export trade because the Metal Box stopped producing #10 cans and we had no means of hermetically sealing any other large container.

The other variety which was processed in small quantities was Bombay. Packed in syrup, it became a substitute for canned peach slices. This fruit however priced itself out of the market eventually,

Black mangoes are packed whole in syrup. Smaller mangoes are preferred so that there are about 5-6 mangoes per A2½ can, or 4-5 in an A2 can. The problem associated with this variety is due to its green skin. The ripe mango is not easily recognised, and one has to feel the mango during selection, which gives a bruised appearance to the finished product.

The most popular mango for processing into juice, mainly for the domestic market, is the No. 11. It has a strong flavour, it is not fibrous, and an attractive bright yellow colour. While these attributes appeal to the Jamaican taste, however, the turpentine flavour is far too strong and the nectar too thick for the export market. It must be remembered that affluent societies of the North do not dilute their juices, but frequently prefer to drink them straight – sometimes directly from the tin..

In Mexico, the variety most commonly used for juice is the Kent which is also sold as a fresh fruit. The work of Mr. Matthias of Adelphi is well known and his orchards of Anne, Kit and Tommy Atkins are variations of the same variety. These mangoes have a good colour, are not fibrous, a more bland flavour and, what it important to the processor, an excellent seed/flesh ratio. The Hayden also has similar characteristics. These varieties are therefore the ideal mangoes for propagation as they can be sold both as fresh fruit and for processing. One can also easily distinguish ripe fruit from green fruit.

CASHEW

This is an invaluable economic tree crop in that nothing is wasted. The pod or fruit is packed in syrup, and should be packed in glass as a gourmet pack. Canning in tins is not recommended as the juice from the fruit generally turns dark. For jam making where the fruit has to be cut into small pieces or crushed, the juice again turns dark and the stainy astringent flavour becomes more pronounced. This gives a most unattractive colour and unpleasant mouth-feel to the jam. The seed is roasted and the kernel or nut extracted and roasted. It seems to me that this crop would be an excellent one to promote, particularly in those areas in which we wish to develop a tree crop economy. It is especially suited to the rural areas where the roasting and extraction of the nut can be done on a cottage industry basis, as is done in India. and Madagascar which are the two largest producers of cashews in the world.

There is not much time to comment on the many other fruits which have possibilities for the processed food industry. Already some might think that I have perhaps dwelt too much on the fruits which are traditionally being processed. Nevertheless there is a very good reason for this. These fruits are already being marketed not only by Jamaican food processors, but also by other countries, and the traditional tropical fruit juices are already well-known in the markets to which we wish to export. These markets are already developed.

The trouble is, however, that we are not getting our share because we do not have the the local production of the raw materials. And until we plant these orchards, large exports of tropical fruits and juices will remain wishful thinking.

PRUNING OF FRUIT TREES

J.R.R. Suah (CARDI)

Many fruit tree growers pay scant attention to the pruning and training of fruit trees, whether grown in an orchard or in the home garden. However most of them appreciate the benefits of training a young plant in the way it should grow so that when it is grown it will have the desired shape and gives the required production. Since classical times much has been written on the topic, and it is suspected that even from earlier times the matter has been discussed without any hard and fast rules being set to govern the practice, it being both an art and a science.

Evolution of Pruning.

The evolution of this practice probably began in prehistoric times, when man began domesticating animals. This was most likely done on fertile land where wild berries and fruits grew and which added variety to his diet. The animals also found the fruits and twigs a welcome addition to their diet and so browsed on the lower portions of the plants within their reach. This resulted in an inverted basin-shaped tree with one or more bare stems to a height of 4 to 6 feet from the ground supporting a dome of fruit-bearing branches above the trunk.

Perhaps one of man's earliest attempts at pruning was breaking away the lower branches in order to force the vigour of the tree into the upper branches where the resultant foliage and fruits could not be destroyed by the animals. Thus evolved a type of tree known to growers later as 'standard', a type which is still in common use where fruit tree orchards are grazed. It was probably noticed that more fruits grew on the outside of the dome-shaped standard trees, that air and sunlight had a decided effect on the development of blossoms and subsequent fruits on the trees, and that it was these factors which made the tree more fruitful on the outside. They may have also noticed that the twigs and shoots in the more congested and shaded parts of the trees tended to die early.

Value of Pruning

These early beginnings have led to a continuing development of the art and science of pruning. It is of special importance to us in the humid tropics, where plant growth is; rapid and almost continuous through the year. The main objectives of pruning fruit trees are to:

1. Create a desired shape and form of the tree. This includes height, spread, appearance and the distance of the lower branches from the soil. Where it is necessary to produce clean fruits for the fresh fruit market (and this involves the control of diseases and pests) the crown of the tree should be pruned to within easy reach of the spray. This height will also facilitate easy reaping of the matured fruits. The spread has to be controlled to maintain balance of the plant and avoid over-crowding and interference. Even where orchard grazing is not practised it is good sense to prune so that the lower branches are not too close to the soil. Several pests including slugs and ants will be provided added climb-areas on to the plants by the low branches. These also make weed control under the plants difficult, and help to create a damp condition where which becomes ideal for several diseases. Well pruned trees in an orchard add greatly to the appearance and also aid in security as one can see better among the trees.
2. Promote quick growth. The early removal of undesirable branches and foliage will concentrate the plant vigour into quick growth of the desired shape plant. It is common for farmers to allow the shoots on the root stock of budded and grafted plants to grow, compete, and often kill the scion. Since quick growth is also essential for early production it is wise that it be encouraged.
3. Stimulate the maximum production of flowers and fruits. Fruit trees tend to produce more from healthy shoots, well spaced and supported. Regular systematic pruning has increased the production of several fruit trees, for example

ackee, avocado, garden cherry, citrus, mango and soursop. Preliminary observations on bunch pruning of tropical fruit trees has shown no significant beneficial effect.

4. Repair damage caused by strong winds and other factors. Strong winds especially when accompanied by heavy rainfall usually cause severe damage to fruit trees. Most avocado, ackee, breadfruit and mango trees have been allowed to grow too tall. A hurricane passing over the island could cause severe damage to many of these trees. It is advisable that if possible the tall trees should be pruned to manageable heights. In repairing damaged trees the opportunity can be used to reshape them to control height, spread and balance. This should be done as soon as possible after the damage, with wound surface properly cut and protected against the incursion of diseases and pests. All the pruned branches should be removed from the orchard. If left there they will provide food for termites which will later attack the trees.

5. Resuscitate old trees. Periodically there is renewed interest in the resuscitation of derelict fruit trees, and although not a bad idea, the trees should not be left to become derelict to need such a campaign. So long as the root system and stem of an old plant is good, it can be pruned and shaped to give years of production.

6. Remove weak branches. Although weak branches may produce fruits, under a heavy load they either snap or droop to the ground. They could be saved by cropping, but this is most often expensive, unsightly and a bother. Weak branches should either be removed or shortended to increase theeir weight bearing capacity.

7. Remove diseased and pest infested parts. Where diseases such as lime knot, witches broom and die-back, and sedentary pests such as scale insects and mealy bugs are localised on particular branches, these branches can be easily pruned away and destroyed leaving the rest of the tree healthy. Actually this is the only recommended method of control for the diseases here mentioned and others like them.

8. Prevent snagging of utility service lines. Care should be taken especially in home gardens to prevent fruit trees growing to touch utility lines, especially the electricity lines. Many avoidable accidents are caused especially during the times of reaping mature fruits.

METHODS OF PRUNING –

There are several methods of pruning but only the commonly used ones are described here.

1. **Thinning.** – This is done by removing some of the main and lateral branches and sometimes foliage, for the purposes of renewing plant growth and controlling size.

2. **Heading Back.** – This is the removal of branch tips to reduce size, increase flowering and control plant shape.

3. **Heading and Thinning** – A combination of the above two methods works well to reduce the size of vigorous overgrown fruit trees, and increase production.

PROCESS AND PRECAUTIONS IN PRUNING

Fruit trees can be pruned into several sizes and shapes depending on needs. Popular shapes are domes, inverted basins, globe, goblet, columnar, pyramidal and box. The following are some simple guidelines to be used.

1. Decide on the purpose and shape the tree should have and prune to achieve this.
2. Use sharp tools, and if possible the most appropriate ones.
3. In shaping a tree make the cuts just above the buds which point in the desired directions the branches should grow.
4. Remove twigs and all other small undesirable parts, before cutting large branches.
5. Be careful that large and heavy branches to not damage smaller ones in falling.

6. Cuts should be made smooth in a slanting or upright direction to facilitate easy run off of water.
7. Large branches should be removed in two or more pieces according to their length, weight or position.
8. Side branches should be cut back at the fork.
9. Branches should be cut flush with the outside of the stem to avoid leaving stumps.
10. To remove a large branch cut about a foot from where the branch joins the main stem (cut the underside first and then the upper to avoid tearing). Finally, saw off the stump and smooth the surface.
11. Repair immediately any damage that may be done.
12. Cuts over an inch in diameter should be covered with a protecting agent such as fungicide paste or ordinary house plant to prevent the entrance of disease causing organisms.
13. Where diseased branches are removed, the tools should be disinfected after each tree is pruned.
14. Avoid pruning bearing trees, flowering trees, trees in active flush or during severe drought.
15. The best time to prune is just before the spring flush or rainy period when quick growth will give the trees a chance to recover from the shock.

CONCLUSION

When left to grow in their natural forms, fruit trees may become too tall, unshapely with low or weak branches, subject to strong winds and vulnerable to diseases. Regular systematic pruning should be done to correct all these and keep the trees to manageable and attractive sizes. The practice will vary for different crops but the knowledge is available from experienced farmers and agricultural experts. It is advisable that fruit tree farmers should become aware of the value of pruning their plants. Advice is readily available from the Ministry of Agriculture through their Extension Service and from the Caribbean Agricultural Research and Development Institute (CARDI).

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PROPAGATION OF FRUIT TREES

W.N. Prendergast & J.R.R. Suah

Any development programme for a Fruit Tree Industry to meet local consumption, processing, and export demands will require adequate supplies of planting materials for new orchards. A sudden upsurge in demand will place an enormous strain on the traditional suppliers of plants namely the government, a few commodity associations and private nurseries. To prevent this more private nurserymen, farmers, gardeners and schools etc should produce some of the fruit trees they buy or get free from the government. This would also help the traditional suppliers to concentrate on the more difficult and valuable species such as budded or grafted avocado, citrus, and mangoes, or rooted cutting ackee and lychee.

The purpose of this paper is to introduce to the layman the subject of fruit tree propagation and explain various methods which may be used to multiply the common ones in Jamaica.

There are two basic types of plant propagation, sexual by seeds, and asexual which uses the vegetative portion of a plant. Most fruit trees are produced by the latter. It is hoped that in the near future many plants will be produced by a process known as tissue culture.

Propagation Facilities

Whether propagation is by seed or vegetatively, certain basic structures and facilities are necessary.

1. Site. The following criteria should be borne in mind when selecting the site for a nursery regardless of the size.
   (a) It should be preferably a level or terraced area.
   (b) It should be easily accessible, allowing for quick movement of materials and the removal of plants.
   (c) An adequate supply of cheap non-saline water should be available.
   (d) A relatively good source of earth and other materials used in preparing potting mixtures should be nearby.
   (e) There should be adequate protection against wind, flood and animal damage, also from larceny.

2. Shade. While some plants such as coconut and citrus can be propagated without shade, many others require varying degrees of protection from the sun. Good results can be achieved by using simple practical structures. Shade in government nurseries is provided by glass and perspex roofs, saran or polythene, wooden laths, bamboo strips and even tree foliage. Bamboo being easy to get and cheap, is mostly used. It provides the posts, rafters and laths. If treated with a wood preservative its life can be greatly extended. Natural shade is cheap but has certain disadvantages such as root invasion into plant containers the proper adjustment of light, loss of space, and the harborage of pests and diseases. However proper management can easily overcome these.

3. Propagating Bins – The customary concrete bins are now mostly replaced by clear diothene film (4-6 mls thick), which is relatively cheap and allows for diffusion of gases while retaining the high humidity necessary for the successful propagation of cuttings. Simple structures of the diothene sheet stretched over wooden or metal frames as boxes or tunnels have proven quite adequate. Some amount of shading is however required to control the temperature in the enclosed space.

Successful rooting of some semi-hardwood cuttings e.g. ackee, and soursop has been achieved by directly covering prepared cuttings with clear diothene films. This eliminates the need for fixed structures and reduces considerably the need for frequent watering during the rooting process.

4. Mist propagation – This method was developed in the 1950's and is now widely used for vegetative propagation of cuttings with leaves. It is essentially automated for intermittent spraying with water, on prepared cuttings set in a porous rooting medium which supports the cuttings in an upright position. Various devices (time clocks on electronic leaves) ensure that misting is sufficiently frequent to prevent the surfaces of the leaves from becoming dry. Between each spray water evaporates from the leaves absorbing heat to do so, thus cooling them. Experience has shown it is wise to place the propagator under 30% to 40% shade as a protection against the effect of water failure.

5. Propagation Media – A good potting medium for germinating and growing fruit trees should contain organic and mineral matters in proportions adequate to supply sufficient nutrients for healthy growth. The medium should be moisture retentive yet porous enough to allow for adequate drainage and aeration. Alluvial or loam soils with a pH or 5.5 to 6.5 form the base of most of our media to which one or more of the following are added in varying proportions; coir waste, coffee pulp, sludge, farm-yard manue, rotted bagasse decomposed saw dust, poultry manure, sand and inorganic fertilizers. Appendix 1 shows 5 popularly used combinations. Clean sand is used for the propagation of rooted cuttings. Coarse sand and coir mixed in equal parts give good results when used under diothene tunnels and diothene covered structures.

The propagation media should be treated against diseases, insects, nematodes and weeds. This can be achieved by using wet or dry heat at from 140°C to 180°F for 30 minutes or by using chemicals such as Methyl bromide and formaldehyde.

6. Plant Containers – Any cheap convenient sized container that will hold the potting media up to the time the plants are set in the field, can be used. Over the years items such as small baskets, bamboo joints, clay pots, used tins and small cartons served the purpose. In recent times diothene bags (250 to 400 gauge) clear or black, perforated or gusetted, have largely replaced these. Black diothene containers significantly outlast the clear ones and have less weak growth but are more expensive. Bags of the size 4" x 7" x 9" are used for most fruit trees where planting will be done within 4 to 8 months. Plants which are to be budded or grafted in containers e.g. avocado and mango along with plants which will be kept in pots in excess of a year should be potted in sizes 5" x 9" x 10" or 6" x 11" x 11" bags.

SEXUAL (Seed) PROPAGATION OF FRUIT TREES

Despite the advantages of vegetative propagation mentioned before, many fruit trees in Jamaica with the exception of avocado, citrus and mango (which are budded) and garden cherry, breadfruit and grape (grown from cuttings) are grown from seeds. Table 1 shows the fruit trees which are propagated by seeds as well as other methods.

Successful propagation of fruit trees from seeds depends on the following factors.

(a) Seeds should produce plants as true to type as is possible; this is by obtaining seeds from vigorous trees that have consistently produced fruits with the desired horticultural characteristics.

(b) Seeds should be viable, germinating within the known germination period. They should be washed free of pulp, dried in the shade, if possible treated with a seed protectant, placed in closed containers or sealed bags and stored in a cool dry place.

(c) The proper environment for germination should be provided namely adequately moisture, temperature, oxygen, light or darkness, and the proper pest and disease control for the seeds and the resultant seedlings.

Sowing seeds and care of seedlings. Seeds are sown directly in containers filled with a good potting medium, which are then lined out under shade in beds raised to facilitate proper drainage. The medium should be well soaked before sowing, the seeds inserted in the centre of each container and covered 1 to 2 times their medium diameter. A thin layer of coir dust placed on the surface helps to conserve moisture and reduces weed growth. Just enough watering should be done to enhance germination as too much can lead to seed rot or seedling diseases.

ASEXUAL (VEGETATIVE PROPAGATION)

This method of propagation is obtained from one or more of the following techniques.

1. Air layering
2. Budding
3. Grafting
4. Cuttings
5. Root Sprouts
6. Tissue Culture

The production of good quality plants requires good quality stocks. These may be grown specifically for the purpose of selected in an orchard and kept vigorous and productive, and free from pests and diseases.

Airlayering – This is also known as marcottage, chinese airlayering and circumposing, and is used to induce root formation on branches still attached to the parent plant. It is very useful for fruit trees that are difficult to propagate or where large plants are required.e.g. litchee.

Budding – In this form of propagation, a single bud with little or no wood is attached to the cambium of the stock, usually beneath the bark. It is most successful when the cells of the cambium layer are actually sub-dividing as is indicated by the ready separation of the bark from the wood. There are several methods of budding including T and inverted T, shield or patch and clip.

Grafting – The methods of grafting vary according to the variety and the size of the plant desired. Avocado, mango and pimento are now mostly propagated by this means. There are many variations including cleft, tip or terminal graft, veneer and approach grafting.

Cuttings – In this method bits of plant stems that will produce buds and roots to develop into plants, are used. The common plums, cherry, ackee etc. are produced by stem cuttings.

Root Sprouts – Breadfruit roots if damaged by transverse cuts, will produce a plant shoot while still attached to the parent plant. Upon reaching the desired height the plant with an accompanying portion of root may be removed to a container and planted in its permanent location.

Tissue Culture – This method involves the use of small bits of tissue from the parent plant which is cultured in special media under special conditions. Among its many advantages is rapid multiplication of desired disease free plants from a single plant or piece of a plant. Much more will be heard about this in the near future.

This paper was not intended to describe in great detail the methods of fruit tree propagation. It is hoped that the points raised will encourage discussion and that readers will seek further information in the areas of their specific interest.

The information is readily available from the Ministry of Agriculture Extension and Research Staff and from the Caribbean Agricultural Research and Development Institute (CARDI)

BREADFRUIT – A POTENTIALLY IMPORTANT FOOD CROP IN THE CARIBBEAN REGION [1]

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Regional Importance

Breadfruit (*Artocarpus communis*) [2] is a potentially very important starchy staple in the Caribbean region. It was introduced in the region (St. Vincent and Jamaica) in 1792 by Captain Bligh following his well known first attempt which resulted in the mutiny on the Bounty. The crop is now grown throughout the region and it has attained national importance in a number of territories, e.g. JAmaica, Haiti, St. Vincent, Grenada, St. Lucia, Montserrat, Dominica, Barbados, Trinidad and Tobago.

Despite its importance in many territories, the crop has been the subject of very little research. However, recently breadfruit has been the subject of a reconnaisance study in the Caribbean region by a CIAT/IDB Consultant (Leakey 1977), whose report emphasises the importance of the crop and makes recommendations on various aspects of research and development requirements. The information available indicates extremely good potential for the further development and commercialisation of the crop.

The breadfruit is now grown almost exclusively for domestic consumption. Very small quantities are exported to the U.K., Canada and the U.S.A. from Jamaica, St. Lucia and Trinidad and Tobago. Like most of the other food crops grown for local consumption, there is a paucity of reliable statistics relating to total production and yields. Although important as a source of food for many rural homes, the crop is not often cultivated in pure stand. As a result, breadfruit trees tend to be scattered throughout farms, along road sides and in backyards. Attempts have been made to count the number of trees and to estimate total production from data on yield per tree. This approach can result in very large errors and can lead to faulty conclusions; alternative accurate and cheap methods are, however, not available.

It is tentatively estimated that there are now in cultivation a minimum of 3 million trees in Jamaica, 100,000 in Grenada, St. Lucia and Trinidad and Tobago, 50,000 in St. Vincent and Dominica, 30,000 in Barbados and 10,000 in Montserrat, St. Kitts, Nevis and Anguilla. Of these, about 60% are bearing trees yielding at least 30 fruits per tree per year.

The Crop

The breadfruit plant in the Caribbean is a tall, much-branched, evergreen tree which normally requires a warm, humid climate for successful cultivation. Temperatures in the range 21°-32°C and rainfall of 200 - 250 cm are said to be the optimum range. However, Leakey (*op cit*) notes that the breadfruit can be found under a wide range of ecological conditions and viewed this as a possible indication of the presence of some genetic diversity with regards to climatic adaptation.

The main economic product is the fruit which is formed from the whole inflorescence. There are seeded and seedless forms, the latter being more commercially important and commonly referred to as "breadfruit". The seeded forms are called either "breadfruit" or "chataigne" (the latter in Trinidad). In the seedless forms the central core is surrounded by edible pulp, but in the seeded forms the fruit contains 50-100 seeds which are eaten boiled or roasted. The nuts and flesh of the immature seeded fruits are also eaten.

The nutritional value of the breadfruit has been well summarized by Leakey (*op cit*). In general, the fresh breadfruit has 22-30% dry matter of which 83-86% are carbohydrates, 3-7% crude protein and 2.0-2.5% fat The protein, although limited in total quantity, is of very good quality and is relatively high in the following amino-acids - lysine (twice as much as wheat), isoleucine, phenylalanine, threonine and valine. Also, the seed of seeded varieties are reported to be high in protein content.

Trees take about 5-6 years to come into bearing. Propagation of the seedless forms is

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[1] Seminar on Research and Development of Fruit Trees (other than Citrus), Jamaica, June 26, 1980.

[2] Synonyms *A. altilis* and *A. incisa*

Trees take about 5-6 years to come into bearing. Propagation of the seedless forms is by vegetative means, but propagation in the seeded forms can be achieved vegetatively or by seeds.

Products other than the fruit are of minor importance and include (1) latex, which may have industrial application, (2) fibre, from the bark, (3) timber, from the mature trunks, and (4) the green leaves for feeding livestock and (5) male inflorescences which are used in confectionaries.

The Potential

The yield potential of the crop appears to be particularly high. Purseglove (1968) reports that annual yields can be as high as 700 fruits per tree. Although this figure was not intended to suggest the average yield of the breadfruit, it certainly indicates the potential. Using 0.8kg per fruit and 89 trees per hectare (36 per acre), Leakey (*op cit)* derived a yield of 56 tons per hectare (22 tons per acre) of fresh fruit from Purseglove's data. However, Leakey estimated annual yields in the Caribbean at 7.7 tons per hectare (3.12 tons per acre) and in his report quotes reported estimates of breadfruit yields in Barbados at 16.5-33.1 tons per hectare (6.7 - 13.4 tons per acre). Leakey based his estimate (7.7 tons per hectare) on existing systems of cultivation and using existing varieties and therefore gives the *status quo* but not the potential. Thus, in viewing the potential yield of the crop, the upper yield limits must be taken into account. It seems physiologically possible that annual yields of over 50 tons per hectare could be attained and that yields of over 25 tons per hectare should be commercially possible with improved cultural practices and high yielding varieties. Such yields compare favourably with the yields of other starchy staples such as rootcrops and cereals now grown in the Caribbean region.

As mentioned earlier, the crop appears to have some genetic diversity as far as environmental adaptation is concerned and it may be possible to cultivate the crop in areas that are not suitable for other crops. In the Caribbean, many of the territories are hilly and this greatly restricts the amount of arable farming that can be achieved. Productive agriculture is restricted to tree crops and many of the areas are simply left in forest or bare and hence experience severe soil erosion and reduced water conservation. The cultivation of breadfruit in these areas is an attractive possibility particularly if dwarf types could be developed which might serve both as a very important erosion control measure as well as providing food.

The breadfruit can be utilized in the fresh or processed state in a variety of ways thus allowing for a multi-purpose industry to be developed around the crop. Fresh breadfruit, which is in great demand, is well liked by the Caribbean people. The processed products are particularly attractive and work has already been done by Professor George Sammy of the University of the West Indies in the identification of agro-industrial possibilities for this crop. Some of the possibilities are (1) breadfruit flour for incorporation in a composite flour programme and for use in snack and breakfast foods, (2) fried chips for use as a snack food, (3) dried chips and pellets for use in the livestock industry, (4) starch for textile manufacture, (5) canned breadfruit for export and (6) alcohol for industrial use.

The Limiting Factors in Production

There are a number of plant factors which have limited the cultivation of this crop over the years. The more important of these are (1) difficulties in propagation, (2) late bearing, (3) poor keeping quality of the fruits and (4) tall plant habit which makes it very difficult and expensive to harvest the fruit.

Propagation of the seedless forms is of necessity by vegetative means. Root cuttings are traditionally used. Roots of breadfruit have a natural tendency to produce adventitious shoots and it is this natural tendency which is exploited. The system of propagation is, however, slow (8 - 20 months to field planting), and the degree of success can be highly variable (20-90%). (Garner et al., 1976) In spite of these limitations it is the only method used to propagate the crop on a commercial scale. Other methods of propagation tried are root suckers, stem cuttings, layering, budding and grafting.

Root suckers, stem cuttings and layering have all met with little success. The number of successful rootings has generally been low and heavy losses have been encountered in transplanting particularly for root suckers.

Propagation by budding and grafting has been tried using root stocks of *Artocarpus communis* (seeded and seedless forms), *A. heterophyllus* (jackfruit), *A. rigida*, *A. champeden* and *elastica* with variable but generally low rates of success. However, the available information is scanty and poorly reported.

A rapid micro-propagation technique recently developed in Jamaica (Prendergast personal communication 1979) appears to have the possibility for commercial application and it it proposed to investigate this method more fully.

This is evidently the need for the development of new propagation techniques for the rapid and commercial propagation of this crop. A reliable system of budding or grafting may help to in the development of small stature plants through the use of dwarfing rootstocks, if or when they are identified.

Late bearing (5-6 years after planting) of existing cultivars greatly affects the development of the breadfruit as a cultivated crop because of the long time taken before the first fruits are ready for harvesting. The crop comes into full bearing between 10 and 15 years for planting.

Fruit are easily damaged and because of the tall plant habit severe loss is experienced by fruit falling to the ground on harvesting. Damaged fruits are of use only if consumed within a matter of hours after harvesting. It is estimated that over 30% of the total production of breadfruit in the Caribbean is lost as a result of damage during harvesting or failure to harvest. Dwarf varieties will certainly help to solve this problem.

Breadfruit is well known for its poor keeping quality. Fruit keeps for a few days only after after which they ripen and then deteriorate rapidly. They are sensitive to chilling injury and cannot be kept at low temperatures for extended periods. Some interesting results have been obtained from storage studies in Jamaica (Thompson et al 1974) but these are still to be applied.

Finally, the available information on the agronomy of the crop is rudimentary. There have been no reported works on fertilizer requirements and little or nothing on plant density. Other cultural requirements have not been determined.

In some areas in the Caribbean, e.g. Trinidad, there is a severe root disease caused by a species of *Rosellinia* but little work has been done on its potential importance or control. Other pests and diseases known to occur in other parts of the world also need to be investigated.

Research Requirements

There is therefore need to develop a programme of research aimed at:

1. The introduction and selection of high-yielding, good quality breadfruit varieties for cultivation in the Caribbean region (the range of cultivars at present grown being very limited).
2. The development of systems of propagation for rapid multiplication and for subsequent commercial production of plants of selected varieties.
3. The development of agronomic practices for the production of the crop including nutritional requirements and fertilizer use, spacing and any necessary disease control measures.
4. The promotion of the cultivation of improved varieties with suitable production systems in those Caribbean countries ecologically suitable for the cultivation of the crop.

5. The development of systems of storage to reduce post-harvest losses.
6. The development of commercially feasible processing possibilities for the crop.

Research and Development Proposals

It is suggested that these objectives be met through the implementation of a multi-disciplinary research and development programme. The Faculty of Agriculture of the University of the West Indies is anxious to initiate such a programme involving:

1. The worldwide collection of existing varieties of the breadfruit and the establishment of a broad based germ-plasm collection in a selected territory in the Caribbean. This can best be achieved by sending a collecting expedition to the Pacific which is the centre of greatest diversity of the breadfruit. Such material should be suitably quarantined before introduction to the region. It will also be necessary to collect for evaluation, all material now grown in the Caribbean.
2. The mounting of an intensive research programme to develop a method of rapid vegetative propagation. Various approaches should be investigated including root and stem cuttings, layering and budding and grafting on to rootstocks of seeded forms, jackfruit *(A.heterophyllus)* and other related species. Rootstocks should be evaluated for dwarfing characteristics. Micro-propagation techniques should also be investigated, including tissue culture for rapid multiplication of any lines selected.
3. The selection from among the germplasm collection for the following characteristics:
   (a) High yields
   (b) Earlines to first bearing and to full bearing
   (c) Small stature plants to permit easier harvesting
   (d) Ease of propagation
   (e) Fruit characteristics such as suitability for fresh market, export market, keeping quality and suitability for processing
   (f) Resistance to pests and diseases
4. Studies to determine cultivation practices for the selected varieties. Factors requiring study include methods of field establishment, planting density, fertilizer response, suitability for intercropping, etc.
5. The biology and control of pests and diseases known to affect the breadfruit in both the Pacific and the Caribbean.
6. Evaluation of promising varieties for yield and other desirable characteristics at a number of contrasting sites in selected territories e.g. Trinidad and Tobago, St. Vincent, Haiti and Jamaica, to determine their ecological adaptability.
7. Studies on the physiology of growth and development of the crop. The problem of premature fruit drop requires particular attention.
8. Studies on the importance of mycorrhizas in the growth of the crop.
9. Investigation on harvesting and post-harvest problems with a view to extending the shelf life of the fresh fruit.
10. Studies on alternative methods of utilization of the crop, particularly in the area of processing. Among the areas requiring study are the production of breadfruit flour, breakfast foods, snack foods, livestock feeds, starch and industrial alcohol.
11. Investigations on the potential for the industrial utilization of latex.
12. Studies to determine the economics of production at the farmer level and also

national and regional implications in the development of the breadfruit industry.

13. The development of technological packages for the production of the crop.

Possible Benefits

If the objectives of the proposed programme of research are acheived, it will have significant benefits for nearly all Caribbean territories and as such any efforts to develop this crop should ideally involve the participation of all such territories.

The development of high yielding and otherwise acceptable varieties could result in the marked increase in the cultivation of the crop, thus increasing production and making it possible to develop the agro-industrial aspects of the crop. The development of a composite flour programme for import substitution of imported wheat flour can result in substantial foreign exchange savings for the region. Foreign exchange savings can also be a achieved through the use of locally produced breakfast cereals and snack foods.

It is also hoped that the increased production of breadfruit will change the crop from being a luxury in some territories to a staple, and in the long run lead to a reduction in the food import bill for the region. The possibility of incorporating breadfruit in livestock feed rations will also lead to the reduction in the importation of livestock feeds and meat and dairy products, and thus result in possible substantial savings in foreign exchange.

Increased employment will be generated in the agro-industrial sectors. At the farm level, farmers will have the choice of a "new" crop for cultivation and this is expected to increase farm incomes and eventually raise the standard of living of the rural sector.

If it proves feasible to establish breadfruit in areas under-going re-afforestation, then the impact of the project will be even greater in terms of employment generation in both the agricultural and industrial sectors. It could also provide an important crop in many hilly areas which have been devastated by the growing of annual crops.

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THE VALUE OF STANDARDS IN THE PRODUTION OF FRUITS FOR SPECIFIC END USES

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The basic tenet of marketing is "make what you sell". This is inapplicable to primary production without modification, so the word "grow" may be appropriately substituted. Moving one step further to the processing of primary products, the word "produce" covers both the primary and secondary production functions. The writer's view is that, by and large, the production of fruits in Jamaica for export or for processing has always started at the wrong end, i.e. we have been selling what has been produced.

At the International level, the function of standards that has the greatest popularity currently is their value as an aid to trade. Throughout the world, the long established, as well as the newly emerging standards bodies, have found common bases for the development of international standards. Despite making some allowance for the inability of developing countries to comply with requirements, compliance with agreed standards will be the basis for international trade in the future. This is published in the "Standards Code" which is the document summarising the latest GATT discussions. In short, it boils down to the following: Countries which agree to the code will be able to participate in international trade. Those countries which do not accede will be limited on a per time basis to the exchange of goods and services, with only those parties that are willing to accept non-conforming goods or services. In the light of this agreement, Jamaica does not seem to have a choice but to conform in order to maintain existing trading agreements or expand markets and specifically to gain entry into new markets. This fact brings us to consider the Jamaican Bureau of Standards and its role as it relates to the topic of this seminar, but also its role in general.

The Bureau's History

The Bureau had its beginning as the Processed Foods Division of the then Ministry of Trade and Industry. The principal function was to ensure that canned grapefruit segments and orange juice manufactured for export to the United Kingdom met the requirements of the importing market. This aspect of responsibility was paid for by the Government of Jamaica. Over time, and in particular due to the substitution industry that was fostered by the last world war, the Food Processing Industry has grown to become a viable sub-sector of industry generally. During this time also, the Processed Food Division has grown to become the Bureau of Standards with overall responsibility for the promotion of standardization in all its form.

To date, the Bureau has interacted mainly with food processors, since contact at this level permits reasonable assessment of the acceptability of incoming materials and overall control of processing to end product. The statement is true for products originating from plant sources.

Some amount of visiting coupled with advisory work has been done in the area of animal production because processing in this area has far more intricacies than crop oriented processing. In addition, animal products have much shorter shelf-life than plant products. This fact makes pre and post mortem inspection important since the holding times for allowing ample testing to be carried out on the products might have to be reduced considerably.

Ideally, the same level of consciousness that exists among processors regarding the importance of product quality should exist among exporters of fresh agricultural products. The farmer who grows these products should also be fully conscious of all the requirements. He should know each criterion, the reasons for the limits set and be able to relate these to his choice of variety, planting times, general husbandry practices and so be party to the integrated approach necessary for producing acceptable quality exports.

More recently the Bureau has established an Agricultural Commodities Committee

to help develop and maintain awareness. The Committee has not been as active as would be desired, but this does not prevent the Bureau from offering standards related information to persons or organizations having an interest in the various aspects as they are affected by standards.

It appears important to treat the subject in a practical manner, while at the same time emphasizing the value of standards. Efforts will be made to achieve both aims throughout the rest of the paper.

One definition for "standard" is as follows:

A standard is a technical specification or other document available to the public, drawn up with the co-operation and consensus or general approval of all interests affected by it, based on consolidated results of science, technology and experience aimed at the promotion of optimum community benefits and approved by a body recognized on a national, regional or international level.

The important points of this definition which merit highlighting are:

availability to the public
participation in evolution
agreement by all interests
requirements substantiated by data
approval at national, regional or international level
benefit to all interests in the particular community.

Applying the definition to tree-crop production for the two named end uses, viz: processing and export, it is reasonable to proceed from the end and work back to the beginning in discussing the value and/or application of standards to either situation.

Firstly - What does the market want, i.e. what will they sell?Take ackees, a case around which an argument can be developed. It is well known that there are two varieties - labelled "butter" and "cheese" because of their relative hardness and other characteristics in processing. Whereas butter ackee has a much better flavour and is ideal for preparation for immediate consumption, it is unacceptable for commercial processing since it breaks up with heat treatment. The processor knows that product acceptance is based to a large extent, on appearance - - something called aesthetics, so although broken "but "butter" ackee pegs may taste nicer, he knows whole "cheese" ackee pegs look better on a plate and must cater to thi s criterion. He promotes his canned product to a buyer in a foreign market, undertakes to supply that quality and then returns to base to produce X cases to fill the order. The argument can be carried through to its logical conclusion to indicate why processors will only buy "cheese" ackees from farmers.

A farmer who plants a crop with the intention of supplying the processing industry should consider the relevance of the variety he plants to the designated end use. Given time, this type of information should be available in a standard document called a "Code of Practice" which would contain specific information pertinent to planning and procedural aspects of production. When consulted during the planning stages, the document as an input, helps avoid costly errors like growing the wrong variety of crop for a particular end use.

Another example is guava. Through experience gained over time, processors are aware of the quality, colour, sweetness, etc. of fruits available from different areas at different times. For export to some markets, the product needs to meet colour and clearness criteria without the use of additives. It therefore becomes critical to start with the right quality of fruit in order to come up with the desired end material.

In the preparation of a product standard, recognition would be given to factors which are critical, and in some cases varieties are named to ensure conformity of the end product with market requirements, e.g. Marsh Seedless and Duncan varieties of grapefruit are identified in the standard as suitable for processing to produce canned segments. It is possible to arrive at this position only after consultation with all in-

terests to determine the best combination of inputs for the greatest common (optimum) benefit. This fact underscores the importance of participation by all interests in the standard drafting exercise.

While all information may not be reduced to the terse terms found in a standard document, providing it helps identify what is acceptable or will satisfy the requirements of a particular market, it may be seen as standards related and of value to decisions pertinent to production or selection for processing or for direct sale. Since it is critical to satisfy export market requirements, the word export is stressed, but it is fully appreciated that separate efforts would not be made to produce for fresh consumption locally as opposed to production for export.

Where production is aimed at fresh consumption markets, such considerations as flavour, size, colour, shelf life, ease of peeling, are important, e.g. "Solo" variety of papaya is more acceptable. Bombay is a good "table mango", ortanique is ideally suited for the criteria set by importing markets.

Within each product class, grades and standards can be established based on conformity to the "ideal" in terms of colour, size, belmishes and so on. This has the value of permitting the use of objective criteria for establishing price differentials, thus rewarding producers for extra effort. It is also a valuable tool when used to ensure that not more than an agreed percent of a stipulated grade gets included in a consignment/shipment of product. This last point is a very important consideration where trading agreements are based on agreed product standards.

The requirements of the processing industry may be different but invariably the characteristics most favoured are derived from experience. Some of these would include:-

Variety- linked to desirable process characteristics, e.g. black mango, suited for canning while beef mango for chutney.

Size - to permit accommodation by processing equipment or containers, also avoidance of waste, e.g. pineapple for making slices.

State of maturity - a function of texture and /or storage and transportation, as well as organoleptic qualities,. Most fruits for processing are reaped in the firm mature stage.

Overall, it seems very important that serious consideration needs to be given to such questions as contract growing of there is to be meaningful and beneficial co-operation between producers and processors, whether for canning or export.

Other aspects of standards application to the subject under consideration include the following:-

Packaging

Product characteristics determine the nature of packaging material that permits maximum preservation whether fresh pack or processed pack. The optimum weight of product per unit container, the shape of the outer container, the packing medium where used-are all elaborated in standards information for the benefit of the user. In some cases each individual unit must be separated for transportation in fresh state. Different processed foods must be packed in different grades of tinplated cans, or in some instances, in lacquered cans. The need for a specific type of can goes all the way back to variety, hence the importance of the planning step considering what will be grown for what purpose.

Chemical Criteria

Under this heading two broad categories can be identified, viz:

(a) Those resulting from cultural practices such as spraying. Where applied later than recommended, residues occur in the finished product at much higher levels than the agreed acceptable maximum, thus making products unfit for some uses.

(b) Those resulting from natural changes in the starting material and which influence product quality decidedly, e.g. citrus varieties. In some cases bruised fruits undergo bio-chemical changes (autolysis), consequently, the reaping and transportation exercises become critical to end product quality, particularly where pre-process storage occurs at factory site. This is a major hurdle to be surmounted, particularly for the more sensitive seasonal crops.

Microbiological Criteria

Not all processing involves heat treatment high enough to destroy micro-organisms. Again, two broad areas may be considered under this heading -

Pre-harvest Management

Post-harvest Management

Pre-harvest management includes general crop care through reaping. Pertinent points include application of fungicides, pruning, and ensuring that over-ripe or damaged fruit are not reaped and sold for processing, in particular. Post-harvest treatment includes after care such as storage, sun-drying, sanitation. The organisms most frequently encountered include bacteria and moulds. They contribute to reduction in such characteristics as flavour, colour and keeping quality. This is secondary to their potential damage to health and safety. Both chemical and microbiological considerations form major criteria of product standards irrespective of end use.

Gross biological criteria including insects and insect parts -

Mite damage, scab, slug damage as well as insects on the mature fruit delivered, affect end product quality and influence the grade allocated to a consignment. Proper cultural practices can reduce problems of this origin to a minimum.

The role of the standards body in the Jamaican economy may be conceived in terms of the overall programme of activities of the country for economic development, raising the level of local technology, and improving export earnings. It is concerned as much, if not more, with the implementation of standards as with writing standards. Standards can only be implemented if there is co-operation among all interests, particularly primary producers, interests in industry and commerce, public sector agencies, e.g. advisory services and purchasing organizations who should combine efforts with the standards body to maximise the composite benefit of standards. There are several standards related vehicles pertinent and applicable to the subject of this seminar. They include grades and standards, certification, quality control, labelling, and so on.

The value of the standardization concept for the overall improvement in operations can be realized only after all interests at all levels agree to co-operate with the standards body, with the aim of achieving the highest possible quality of output. This is accomplished by merely remembering to -

(a) plan with standards, and

(b) keep standards at the centre of operations.

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THE FRESH EXPORT MARKET FOR NON-TRADITIONAL FRUIT CROPS

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Mr. Chairman, distinguished guests and participants in this Seminar, I am indeed grateful for the opportunity to present this paper on the "Fresh Export Market for Non-traditional Fruit Tree Crops".

Fruit trees in agricultural circles are regarded as a very important economic input in a mixed farming entity. This is so because of their relatively long life and yields with minimal care and husbandry. The tendency in recent years is to develop pure stands in say Mango, Avocado or Papaya etc. has lead to more products being available to the fresh fruit trade and for processing.

In this paper, I will examine briefly certain fruit trees, analyse the export markets and their requirements and then try to state Jamaica's position as a potential exporter of fruit tree crops.

Products

Mango, Avocado, Papaya, coconut, lychee are considered exotics by Europeans and certain North Americans and are fruit tree crops gaining in popularity in these fruit tree trade centres. Research by U.S.A., Israel and South Africa has resulted in the development of varieties which are prolific bearers with strong market appeal. The *Tommy Atkins* and *Keitt's* mango varieties are steadily gaining importance over *Hayden, Bombay* and *Kent* as choice fresh trade products. Israel's work on the *Haas* and *Fuerte* varieties of Avocado and their expensive public relations strategy creates in the consumer's minds the understanding that only those two varieties are really Avocados. The work by Hawaiians on Papaya, particularly the *Solo* variety whose origin is attributed to Barbados, underscores that with concerted effort fruit tree development can contribute positively to G.N.P. of a country.

Lychees are relatively new on the market and are being exported mainly by South Africa. In examining the market for fruit tree crops we will look generally at two markets, EEC and North America (New York and Toronto).

European Economic Community

Mango is considered the second most important of the minor tropical fruits on the EEC market. It is highly perishable and air shipments are recommended for safe passage to markets. However, over the last five years, experiments and trial shipments by South Africa have indicated that ocean shipments can be equally successful. No one supplying country dominates the market due to the short production period to supply high quality mangoes. The list of suppliers is long and includes India, Kenya, Mali, Senegal, Upper Volta, South Africa and some Caribbean countries. France is mainly supplied by French West India, while the UK by India, Kenya, South Africa and Caribbean countries. Holland is supplied by Mali followed by Mexico, South Africa and Venezuela.

In 1975 total estimated consumption for fresh mangoes was in the range of 3,000 - 3,500 metric tons. The main importers were UK followed by France and Holland. West Germany is increasingly becoming an important importer with imports moving from 109 tons in 1971 to 231 tons in 1975. By 1978 West Germany was importing 404 tons and this was increased to 947 tons in 1979. Mexico was the largest supplier with 245 tons followed by South Africa and Kenya. The main varieties include *Alpbonso, Kent, Julie* and *Hayden.*

Avocado

Avocado is the leading minor fruit imported into the EEC. The increase in consumption over the past 15 years has been rapid and Avocado has become an household name. A total of 23,000 - 25,000 tons of fruit was imported into the EEC during 1975 and this was increased to 33,013 tons in 1978. France is the main market which in 1978 accounted for 71% of imports followed by UK and West Germany in that order.

Israel is, by far, the most important supplier followed by South Africa and Martinique. Most European consumers prefer a bright green pear shaped avocado, typified by the *Fuerte* and *Ettinger* varieties.

In 1978, Israel supplied 21,212 tons, followed by South Africa with 7,244 and Martinique with 1,183 tons.

The demand is highest during the period October - April. In summer, competition with local grown fruit somewhat affects the price obtained.

The market requires a firm avocado, fully mature but unripe and properly size-graded. Usual counts per carton is 12, 14, 16, 18, and 20 units. Air transport has lost its importance as most exporters are using ocean freight.

Papaya

This fresh fruit is a relatively new comer to the trade. Although it is not significant when examining fruit trade statistics and is usually grouped together with guava, mangosteen, etc. Papaya is a very important exported fruit to the Ivory Coast. In 1975 they were the only exporters to the EEC supplying 150 tons. Papaya is now going to the market from Kenya and U.S.A.

France is the leading importer followed by West Germany and Netherlands. The UK market is small and is being serviced in fibre-board cartons per count of 6 or 12 units. The main variety is Solo. The fruit should be reaped at 3/4 ripe stage and treated for insect and decay control.

Coconut

Coconut falls into the same category as Papaya being a relatively new-comer on a wider European market. Traditionally, it is used for processing into edible oil and soaps. However, in UK and Netherlands the demand for fresh fruit is estimated at 4,000 bags per month or 20,000 nuts monthly. From every indication this market is becoming important, however, at present more conclusive statistics are unavailable.

Lychee

Lychee is a fresh fruit recently introduced in the market with supplies coming predominantly from South Africa into the UK market. There are hardly any specific statistics on this fruit as it is normally published along with guava, mangosteen, etc. The UK trade is fairly brisk in this exotic and there is every indication that the market will continue to grow.

North America:

The New York market may be considered the largest single market in N.A. In this market competition is very strong and fresh products from most exporting countries of the world are available. Another important consideration is the availability of produce from other states which have easy access to N.Y. markets, hightens the competition and leads to tariff barriers. The market also serves areas like Chicago, Philadelphia and Washington. Therefore, one is looking at an expanded market opportunity for the distribution of fresh fruits and vegetables in general. Trading activity is centred mainly at Hunts Point Market where millions of dollars worth of fresh fruits are sold every year. This market although very large presents serious problems to exporting countries due to tariff barriers to protect domestic productions. With the broadening of the G.S.P. these inequities are slowly being removed.

Toronto is the main market for fresh fruits in Canada. It predominantly handles fresh fruit production and imports from U.S.A.. In recent years countries e.g. Cuba, Haiti and other American states are being attracted to this market. Sales in winter months are increasing and in 1977 total imports of (fresh and canned) foods amounted to $107.m Canadian.

Avocado

Domestic production of this tree crop in California and Florida accounts for the bulk of trade in this fresh fruit. The main non-US sources are Mexico, Honduras, Haiti and Dominica Republic. It is very difficult to analyse Avocado imports as it is grouped with Papaya, Mangoes, Pineapple in US statistics. At the end of December, 1978 non-US source accounted for approximately 7,590 tons of fruit in this group. New York market accounted for 70% of the distribution of these fresh fruits.

Avocadoes are available right throughout the year with varieties making the difference for any given month. The main varieties are *Fuerte* followed by *Haas* and rigorous grading methods are in place. With total annual US production in excess of 100,000 tons.

The Toronto market is mainly supplied by Florida and California. These two states dominate the marketing of Avocadoes into the Canadian markets. Normal distribution channels is through the wholesale markets and then to large chain stores and specialized fruit distributors.

Mangoes

It has been already indicated that US statistics groups Avocado, Mango and Papaya together. The main exporting countries are Mexico, Haiti and Dominica Republic in that order. Involvement of US investment in these territories has created a vertically integrated situation of production and marketing. This makes it very difficult for third countries to compete effectively in the market. Domestic production in Florida was 2,676 tons in 1970 seemed unimportant to world production then, however, Florida is noted for its work in development of new varieties. There are no US standard grades for Mangoes.

The Toronto market is mainly supplied by Florida and Haiti with small offerings from Mexico.

Papaya

The entire commercial supply of fresh Papaya in U.S.A. is from Hawaii. More recently, Dominican Republic and to a lesser extent, Puerto Rico and Haiti have become important suppliers. Papaya can be flowering and fruiting throughout the year so supply is not sharply seasonal. The Solo variety predominates the market and both New York and Toronto are excellent outlets.

Coconut

The market for coconut in shell in US is fairly large. In 1978 approximately 19m lbs., were imported with Dominican Republic as the largest supplier sending 10m lbs. Honduras and Mexico are the two other important suppliers. In Toronto trade in this area is limited to English speaking Caribbean countries such as Dominica and St. Lucia.

Jamaica's Position

Jamaica's exports of fresh fruit tree crops have been very limited. The market exist but somehow production for exports and the development of pure stands orchard has been limited. We enjoy the EEC favourable tariff measures under the Lome Convention governing trade with EEC and ACP states. The US and Canada's GSP arrangements makes it possible for us to enter these markets duty-free with certain fruits. Products like Mango, Avocado and Papaya would present a problem due to significant domestic production.

EEC and Canada are not known to produce the fruit trees already discussed. The main areas of competition would be from domestic production of other fruit trees. With this in mind, there is added advantage if Jamaica can concentrate our production base to capture the off-season or winter market between October and April.

In addition to duty free concessions, Jamaica because of its central position as a transhipment port has easy access to EEC and Noth America. Weekly sailings to these destinations with several shipping concerns gives us a great advantage over other Caribbean, Latin American states. The availability of air cargo space should not be overlooked in assessing the access of transportation.

Favourable climate and some experience in the production of the fruit trees gives us a head start to other areas.

The major problem as we see it is not the availability of profitable markets. Our number one problem is production. This involves not only the physical production i.e. planting or orchards but also the will to produce successfully. Fruit tree crops are relatively long term investments for other developments must be forthcoming from our local financial institutions, or efforts should be made to obtain foreign investment in this area. Production has to be on medium and large sized farms or collection and packaging becomes a very ardous task. Can we do it? We are of the opinion that we can. Certain recent developments have indicated that with proper management and dedication it can be done. Mango production comes to mind readily, and Jamaica since 1973 has been exporting some fair quantity. In 1976/77 434,000 lbs. were exported to all markets mentioned in this paper. Avocado has been exported in small quantities and in 1973/74, 130,000 lbs. were exported.

There are other crops which should be taken into consideration which has some experience in the export market; Naseberry, Sour Sop and Sweet Sop. As mentioned already, because of dispersed nature of production, collection and other post-harvest discipline are difficult to control.

In closing we wish to encourage you all to seriously review the role of fruit tree production to take advantage of the lucrative markets that awaits us. We have in place the necessary marketing channels to service efficient and reliable production. Cooperation and dissemination of information is necessary to jointly make this possible.

A P P E N D I X

Select statistics of Exports of Jamaican Fresh Fruit. (Source: extract of Statistics Produce Inspection Division, Ministry of Agriculture)

PRODUCT*	1.4.73-31.3.74	1.4.74-31.3.75	1.4.75-31.3.76	1.4.76-31.3.77	1.4.77-31.3.78
Pineapples	3,257	8,978	1,840		142
Mangoes	274,073	244,366	401,810	434,103	255,394
Plantain	97,164	72,573	135,074	109,303	123,297
Naseberry	5,498	12,093	11,682	7,656	6,708
Papayas	30,548	32,853	27,063	11,578	10,429
Sour Sop	26,358	29,420	35,448	50,395	36,733
Guinep	6,249	13,074	12,622	4,256	2,163
Avocado	130,839	107,138	100,412	66,714	76,066
June Plum	944	18,132	11,980	12,768	10,851
Sweet Sop	6,781	2,584	9,087	1,923	7,231

* All product figures given are in pound (lb.) weight.

THE ROLE OF FRUIT TREES IN SOIL CONSERVATION

H.R. Stennett
Soil Conservation Division - Ministry of Agriculture

Introduction

Conservation may be described as the proper management of land to maintain the quality of its soil and water resources and to sustain or improve its productive capacity.

Any system of land use which fails to take account of this close relationship will result in soil degradation.

One of the most significant and far reaching effects of soil degradation occurs as a result of incorrect land use practices or over-intensive land use, which exposes the soil to erosion from rainfall and surface runoff. This runoff removes the fertile top soil and thus reduces the potential for adequate vegetative cover and moisture holding capacity. The direct result of this is increased surface runoff; leading to first rill erosion, then gully erosion and finally accelerate flow velocities, higher peak stream-flows and heavier sediment loads. The problem is worsened by the fact that rapid runoff reduces infiltration into the soil and is thus accompanied by the decrease in reliable base-flow.

In the upstream region the higher peak flows causes in-channel erosion both of the channel floor and banks as well as local deviations and damage to land and structure. The reduced base-flow decreases the value of the water for continuous uses save where reservoir impoundment is technically and economically feasible. However, many recent schemes for valley storage dams have had to be shelved because of the large proportion of the storage which must be allocated for sediment inflows. The high sediment inflows also reduce the effective life of the dam.

In the lower reaches of the watershed the transported sediment is deposited in the stream channels, raising bed levels, water levels and aggrading the water courses.

The result is that streambanks are overtopped more frequently and valuable land, often the most productive for agriculture, is inundated.

The long term effect is waterlogging and impeded drainage due to a raised water-table.

The control or prevention of soil erosion is a secondary objective of the establishment of fruit trees on steep slope which are unsuitable for intensive cultivation. The importance of fruit trees for the above purpose has been long recognized in Jamaica and there are many excellent examples of this, particularly on the shale and conglomerate deposits of the North-west Clarendon and on the granodiorite deposits of North-east St. Catherine.

Land Capability

Land capability classification is the blue print towards proper use and conservation of the land resources. The capability of land being used for different purposes depends on its inherent stability and on the particular features that give that stability. The capability classification of any piece of land for a particular use must depend on whether the perceived hazzards of instability brought about by that use can be preferably prevented or overcome by appropriate systems of management.

The main cause of soil erosion and land degradation in Jamaica is a direct result of the unwise selection of land for intensive farming without proper measures for conserving the soil. Many small farmers are intensively cultivating land in excess of twenty degrees slope mainly because they do not have access to gentlier slopes.

The fact over 51% of the total land area of Jamaica exceeds slopes of twenty degrees.

A current land capability classification being used by the Soil Conservation Division recommends that lands between 25° - 30° slope should be planted to permanent fruit trees. This however, is the most intensive use for these lands and does not imply that lands of lesser slopes should not be devoted to the planting of fruit trees if the economical status of the farmer or the soil conditions calls for less intensive farming enterprises.

Fruit Trees and Erosion Control

Because most erosion processes is the result of exposing the soil to rain drops or to overland flow of water, control measures have concentrated on protecting the surface soil particles from direct contact by the rain drops and diverting or reducing surface runoff. To achieve this, both mechanical and vegetative measures are employed. Mechanical structures such as various kinds of terracing and gully control structures retain water and or divert it into safer channels because of their low gradient or wider cross sections and thus there is reduced channel erosion and an increase in the infiltration rate.

These mechanical measures are extremely useful and essential in situations where the runoff volume has been drastically increased because of land use changes e.g. where lands formerly protected by vegetation has been converted into intensive farming. In such situations the new runoff volumes will be too large for the original drainage channels and the use of mechanical structures will be necessary to prevent accelerated erosion.

However, it should be recognized that the effect of mechanical soil conservation works should be seen as an interim measure while the primary cause of erosion which is exposive of the soil to raindrop erosion is addressed.

The most important aspect of erosion control is the use of vegetation to cover the soil in order to protect it against splash erosion caused by raindrops. This has been adequately demonstrated by Michell (1963) who studied the effects of raindrops erosion on a bare excarpement at James Hill in Clarendon and showed that soil losses in the region of 1.5 inches in depth and 188 tons per acre were occuring on an annual basis. It is evident that preventing splash erosion can greatly reduce soil loss and more importantly advanced forms of soil erosion are prevented from developing.

This can be effectively done by the establishment of fruit trees which maintain a dense multi-storied vegetation cover above the ground as well as a continuous mat of protective litter over the soil. The foliage of the fruit trees reduce the energy of the falling raindrops and allow them to fall gently to the ground where the spongy layer of the litter and other vegetation physically prevents the soil particles from becoming dislodge.

In addition to preventing splash and sheet erosion the vegetative cover provided by fruit trees will usually prevent the growth and development of small gullies as well as stream bank erosion. In other areas fruit tree vegetation will reduce the frequency of land slides. Compared to mechanical measures the vegetation of exposed surfaces have the additional advantages of low cost, more increasingly effective annual benefits, less maintenance and the production of saleable products.

The efficiency of vegetation, be it fruit trees, forest plantation, grass or shrubs in preventing the erosion processes is due to:

(a) The protective canopy which breaks the impact of raindrops and guard against splash erosion.

(b) The layer of litter which further protects against raindrop erosion and slows down surface runoff.

(c) The channels left in the soil by the decayed roots of the fruit trees allows for greater infiltration of rainfall into the soil.

(d) The roots of fruit trees physically bind the soil mantle and anchor the soil mass to the parent material. In so doing there is a reduction in the incidence of soil creep and landslides.

(e) There is also an improvement of the soil structure and its water absorbing capacity through the addition of organic matter.

(f) The process of transpiration continuously removes water from the soil thus increasing soil water storage capacity and extends the period of infiltration hence reducing surface runoff.

In arid and semi arid regions however, transpiration and interception losses are usually undesirable characteristics and in this case fruit trees may result in an unfavourable reduction of soil moisture.

As a result, in areas where moisture is likely to be a limiting factor the planting of shallow rooted crops such as grasses on lands otherwise earmarked for fruit trees seems desirable. In addition fruit trees are un-likely to do well on very shallow soils or on soils with pronounced hardpans near the surface and in these circumstances grasses are preferred as a vegetative means of erosion control.

Choice of Fruit Tree Species for Erosion Control

The choice of fruit tree species for rehabilitating eroded lands and combating incipient erosion is important. Nearly all fruit trees and the understory of vegetative cover which they allow are capable of some degree of protection.

Shrubby types of fruit trees such as garden cherries are more valuable for erosion control. On suitable sites fruit trees provide the best long term alternative for protection against soil erosion. Compared to grasses or forest plantations they allow for relatively quick, renewable and sustained economic activities.

Some desirable characteristics of fruit trees suitable for the conservation of soil are:-

(a) Ability to survive and achieve fast growth on shallow and or impoverished soils.

(b) Ability to produce a large amount of litter

(c) A vigorous root system of a fibrous nature. In areas prone to landslides deep rooted fruit trees are essential.

(d) Ease of establishment and need for little maintenance are important characteristics.

(e) Capacity to form a dense crown and to retain foilage year-round particularly during the rainy season.

(f) Resistance to insects, diseases and unpalatability to livestock.

(g) Soil improvement such as nitrogen fixing.

(h) Provision of economic returns.

When establishing fruit trees for erosion control interplanting of cover crops between the trees or establishing mixed plantings of two or more species may offer advantages over mono species stands. For example better results may be obtained if both deep rooted and shallow rooted species are planted together or if shade tolerant species are established under light demanding species.

Fruit Trees in Symbiosis

Fruit trees play an important role in the symbiosis with other crops through their crowns and roots. First, through their crowns they protect the soil and the crops over which they stand both against too much exposure to the sun and against the impact of intense tropical rainfall; the two main factors in the degradation of tropical soils.

In addition, by constituting an additional level of photosynthetic activity it allows for the maximum utilization of the sun's rays for productive purposes, provided the mixture of crops is compatible.

Further, through their roots fruit trees drawn from the deeper soil layers nutrients which are eventually restored to the soil surface and thus made available to shallow rooted crops and other plants.

The falling dead leaves also replenish the stock or organic matter in the surface soil.

Because of their positive role in controlling soil erosion and of their economic yields fruit trees have an irreplacable role to play particularly in the development of steep hillside and upland watersheds by small hillside farmers.

The small farmer resents fruit trees and or forest trees because they compete with his pre-agriculture and livestock rearing. Consequently, peasant farmers will accept fruit trees only if they are integrated or harmonized with his agriculture and are advantageous to him.

Consequently, the concept of Agro-Forestry systems, Mini-Convertible Terracing, Orchard Terracing or other systems of discontinuous terracing of hillside lands enable the farmer to practice some amount of intensive farming while growing fruit trees.

Fruit trees can also be used as windbreaks to give protection to cultivated fields and help to minimize the drying effect of wind on the soil. They also provide a habitat for insect eating birds and are especially important to wildlife.

The establishment of fruit trees allows for good management particularly of hillside, lands; most of these lands yields greater returns in crops, forage and prunings for fuel. With good management soils stay in place, the streams themselves stay in their banks and the incidencies of flooding reduced. In this way there will be good clean water for our cities, for recreation, for industry and for agriculture.

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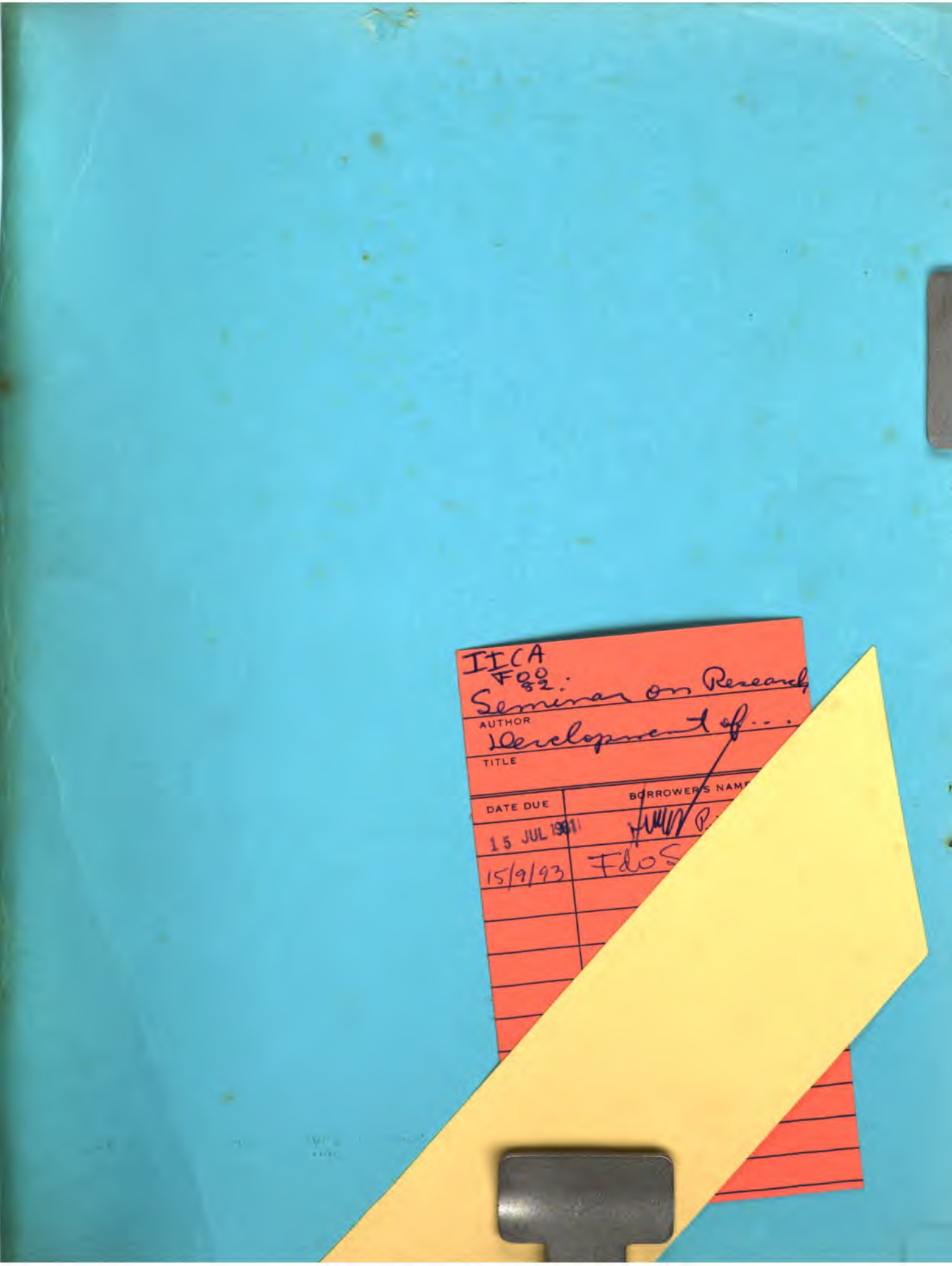
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