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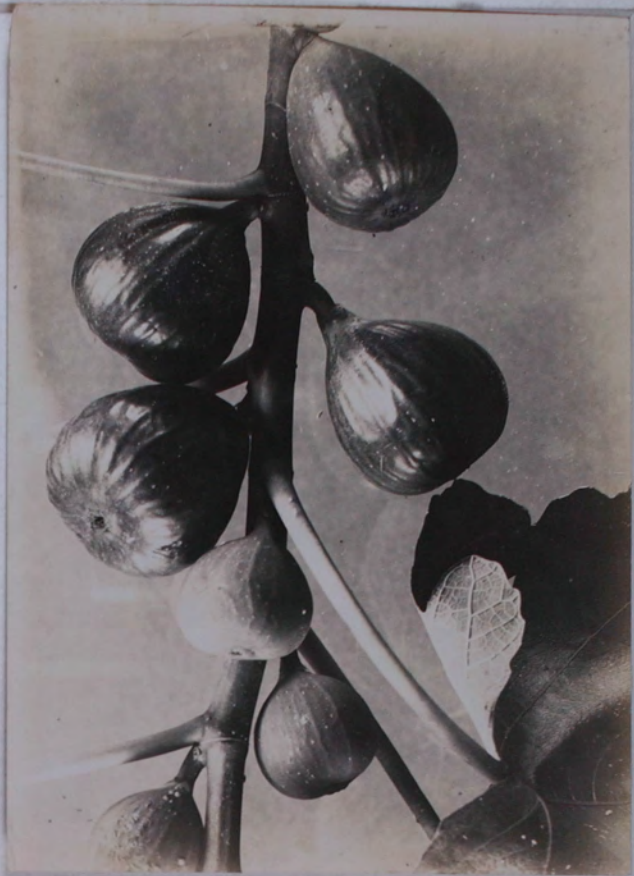
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The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.



Chap. 7

83

Fig Brunswick

137019  
Hentz  
Sedus

Method of bearing fig fruit

Courtesy A. H. Hume



rhbbh

5" x 7"

12

2956

10

60



















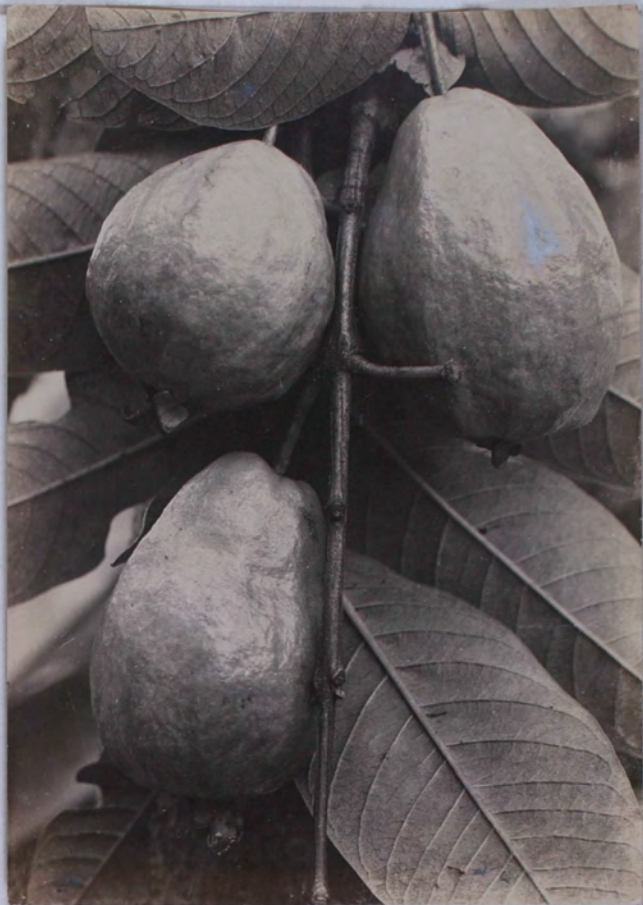














Chap. 32

13

(84)

Guava *P. Guineense*

Guava fruit and foliage.

Courtesy H.H. Hume

Crop as indicated.  
make cut.

1949

25 paces wide

(will be just about  
same size)

Herb. Garden  
133-10





## Chapter 12

### The Nut Fruits

Nuts are botanical fruits but not horticultural ones. They are not often grown as dooryard trees but some of them merit considering for home use. Nuts are highly nutritious and can be stored for long periods without special care. One of the largest nuts, the coconut, is a tropical plantation crop of immense value, but its culture is highly specialized and beyond the scope of this book. Included in this chapter are cashew, macadamia, pili, pecan, and walnut.

#### The Cashew

Unlike any other species, the cashew (Anacardium occidentale) produces both a nut and a horticultural fruit. Culture as a fruit tree is discussed in Chapter 11. The cashew-nut is of great value on the world market, the roasted nuts being very popular for eating out of hand in many countries. Native to northeastern Brazil, this species was taken by the Portuguese to Goa and Mozambique in the 16th Century; ~~and~~ today the world crop is very largely grown in southwestern India and East Africa, some 100 to 150 million pounds being harvested in each. The Philippines produce a 5 to 6 million pound crop, but Brazil markets only a few thousand pounds. Haiti is the only other commercial producer, with a crop of 100,000 to 200,000 lb. The cashew tree has long been established in all parts of tropical America and has even become naturalized in some semi-arid regions, but is most common in coastal areas.

The name cashew is adapted from the Portuguese caju, itself taken from the native Tupi name, acaju. In Spanish-speaking America the usual name is marañon, indicating its introduction ~~by Spanish~~ from the Brazilian state of Maranhão.

Cashews are strictly tropical in their climatic requirements, tolerating little or ~~not~~ frost. Consequently, they succeed only below an altitude of 3000 ft. and grow best near sea level. The tree has a notable ability to persist in areas

So Florida

with a long dry season and on infertile sandy or stony soils, but such trees produce little crop. Best production is obtained on good loam soils with plenty of rain. Good drainage is essential. In India culture has been successful with a range of rainfall from 30 to 120 in.

The cashew tree is small, rarely over 25 ft. high, evergreen, and rather straggling and spreading in habit. Leaves are oblong, prominently veined, from 4 to 8 in. long, and somewhat leathery. Loose particles of tiny, fragrant, pink flowers are borne from branch tips ~~in spring~~, much as in the related mango. About 2 or 3 months later the fruits are mature, the nut having developed from the ovary of the flower, while the "apple" represents the greatly enlarged pedicel of the flower. The nut consists of a thick shell derived from the ovary wall, inside of which is the seed, the "nut" of commerce. The seed constitutes only about 20% of the total weight of the nut <sup>seed</sup> and is by far the most valuable portion. It contains about 45% oil and 14 to 20% protein. However, the shell yields an oil of considerable value (perhaps 5% that of the seed) for manufacture of varnishes, electrical insulation, brakeband linings, indelible inks, floor tiles, and other industrial uses.

One of the limiting factors in production of cashew nuts is the highly corrosive nature of the shell oil in its fresh state. This caustic oil causes severe irritation of the skin of anyone who breaks the outer surface of the nut, a reaction like that of the related poison-ivy. Roasting the nuts causes decomposition of the irritating compounds, after which they <sup>shell</sup> can be opened safely to extract the seeds. In the roasting process the oil, which constitutes about half of the shell weight, is expelled and may be conserved.

In past years commercial production of cashew nuts has been based in India on growing the trees with a minimum of investment and of culture. Yields per acre were very low but costs were even lower, so a small profit was made. In



recent years there has come the realization that returns per acre can be greatly increased by more care in selecting seed sources and more intensive culture. On good soil with good care, trees from selected seed can yield 50 lbs. of nuts, where the average crop at present is under 10 lb. A maximum yield of 200 lbs. is reported.

Propagation has been exclusively by seed until recently, and this is still the principal method. Marcottage is easy, and allows reproduction of high yielding trees with more assurance than seeds do. However, selection of seeds only from trees bearing good crops of heavy nuts raises the average yield greatly. The higher the specific gravity of a nut, the higher will be its rate and percentage of germination and the vigor of its seedlings. The best nuts for planting are those that do not float in a solution of 1 oz. cane sugar in 5 oz. of water (sp. gr. 1.075). Nuts should be planted fresh, with the large end up, about 2 in. deep, in friable, free-draining soil. Germination takes about 3 weeks. Because seedlings are transplanted with some difficulty from ground beds, it is best to grow them in containers 12 in. or more deep if they are not planted in situ. The usual practice is to plant 2 seeds where the tree is to stand and eliminate the ~~weaker~~ seedling during the first year. Shield-budding on seedling stocks has been successful, and veneer-grafting as for mangos is even easier. ~~It is doubtful whether either would prove practical economically.~~

Spacing of cashews should be at least 20 x 20 ft., and on deep fertile soil with abundant rainfall it should be 30 x 30 ft. Flowering usually begins the 3rd year, with a fair crop the 5th year. By the time it is 10 yrs. old the tree should be in full bearing, and it should continue so for another 25 years. Thereafter decline should be expected. The cultural practices suitable for mangos ~~or oranges~~ <sup>are</sup> will be satisfactory for cashews. No pruning is customarily practiced, and few pests of importance have been observed, although some can be expected if culture becomes extensive. Nuts are ready to harvest when the "apple" is ripe.

## The Macadamia

Native to the coastal rainforests of southern Queensland and northern New South Wales in Australia, the macadamia (Macadamia integrifolia) bears a nut which commands a good price in competition with almonds, cashews, and other choice nuts. The tree is extensively cultivated in its homeland, as well as harvested in the wild, but is grown on an even larger scale in Hawaii, where more than 3500 acres of macadamia orchards are planted. California has started commercial culture, but so far no other country is so engaged.

The climate of the area to which the macadamia is indigenous is warm subtropical rather than strictly tropical. In Hawaii it thrives from sea level up to 2500 ft., and with from 40 to 200 in. of precipitation. These are the same areas as guava thrives in, and in tropical America macadamias should do well where guavas do. Macadamia trees are able to endure a long dry period after they have become well established. Soils must be well-drained, but may be of a wide range of types otherwise. Of course, growth is much better on fertile loams than on sands.

The tree is evergreen, 25 to 30 ft. high, with <sup>40</sup> rounded head of foliage. The shining, dark green leaves have short petioles and strap-shaped leaves, 4 to 8 in. long and 1 to 1½ in. wide, with <sup>the</sup> margins often entire or only spiny on the distal half, usually. New leaves are pale green to bronze in color, ~~at first.~~ The customary pattern is for 3 leaves to be borne at each node, although there may be only 2 in young seedlings and 4 are found occasionally on older trees. Tiny, creamy white, perfect flowers without petals are borne in clusters of 3 or 4 along slender racemes in the leaf axils on new shoots. A raceme may have up to 500 flowers, with an average of about 100. Flowering occurs several times a year <sup>if</sup> there are not marked wet and dry seasons. The fruits mature in about 6 months from blooming, and consist of a leathery hull enclosing a spherical nut with hard, smooth, glossy, light brown shell. At maturity the drying-out

of the hull causes it to shrink and eventually to split lengthwise at some point. Further shrinkage often follows until it covers only a small portion of the nut surface, and the nut falls to the ground. Within the tough, moderately thick shell is a round white kernel of delicious taste, either fresh or roasted. It constitutes about 30 to 40% by weight of the whole nut and contains from 60 to 80% oil and 8 to 10% protein. The nuts are very difficult to crack by hand without <sup>crushing</sup> mashing the kernel, but special machinery has been developed to handle this problem commercially.

The smooth-shelled species, M. integrifolia, <sup>above described</sup> is the one grown almost exclusively in Hawaii and California. Unfortunately, the botanical name has been changed in recent years. Formerly it was called M. ternifolia var. integrifolia. A <sup>by related</sup> very close species, M. tetraphylla, is called the rough-shelled macadamia because its nuts, broadly elliptical rather than round, have slightly <sup>rough</sup> bumpy surfaces. This species is distinguished, as the botanical <sup>name</sup> indicates, by having normally 4 leaves at each node; the <sup>leaves</sup> being longer than in M. integrifolia and heavily spiny along the margins. There is <sup>only one</sup> a blooming period <sup>a year,</sup> in spring only. The nuts are as large as, or larger than, those of the smooth-shelled type but are considered less satisfactory for processing (in Hawaii), in part because of <sup>the</sup> thicker shells. In Australia the rough-shelled species is more grown than the other.

A number of named varieties have been selected and propagated in Hawaii, and these ~~are being tested in California and Florida~~. Selection was made for yield primarily, but also for nuts of fairly large average size and thinner than average shells. Clonal varieties are being grown in Australia, also. Grafted trees of the best adapted varieties usually have yields 3 to 5 times <sup>as many</sup> the average <sup>seedling crop.</sup>   
*Trop am* <sup>fruits as the average seedling.</sup>

Propagation may be done by either side-~~for~~ veneer-grafting on seedling stocks. Seeds should be less than 4 months <sup>old</sup> for good viability. It is best to plant them



very closely, about 1 in. deep, in boxes of coarse sand in full sun, but kept constantly moist. When seedlings have 4 matured leaves, they should be pulled up and transplanted to nursery rows--about 8 in. apart in 3 ft. rows. Care must be taken that the remains of the seed are not broken off from the little seedlings, as they still need the food it contains. Weeds must be kept down in the nursery.

When the seedling stocks have a diameter of  $3/8$  to  $3/4$  in., usually at 1 yr. of age, they are ready for grafting. Scions should be about  $1/2$  in. in diameter and from wood several seasons old. They should be prepared by girdling the branch 6 to 8 weeks before they are needed, to assure a good supply <sup>of food</sup> in the scions. Branches up to 1 in. thick may be girdled, and many scions cut from their smaller ramifications. Scions should be about 5 in. long and have at least 2 whorls of buds, with the leaves removed. Stocks are cut back to 18 in. high and defoliated on the lower 6 in.; it is essential that there be several leaves above this point.

The side-grafting technique developed by the Hawaii Agricultural Experiment Station gives a high percentage of successful unions if careful attention is paid to the many details involved. ~~It is suggested that prospective orchardists or nursery men write to this station for full information.~~ The standard veneer-graft may also be used. When the scion has grown to 6 or 8 inches, the stock can be cut back to the union.

The grafted trees are usually left for a year in the nursery. About 4 months before they are to be moved to the field they should have the taproot cut 15 in. below the soil surface, to stimulate development of fibrous lateral roots. Such root-pruned trees can be transplanted bare-root like orange trees if the roots are not allowed to dry out. Tops should be cut back to 30 in. to assure branching below this height, and half of the remaining leaves removed to decrease loss of moisture.

Macadamias should have a bearing life of 50 years, and so should be given plenty of growing room. Spacing may be 30 to 40 ft. apart, depending on soil fertility, and ~~anticipated tree size~~. Because macadamia root systems often do not provide deep anchorage, trees are often blown over in windy locations and <sup>they</sup> should be provided with windbreaks under these conditions. Preferably ~~these~~ should be planted before the macadamias are set out. The newly transplanted trees require the usual aftercare of water and weed control. Sometimes, especially with certain varieties, the young trees must be tied to a sturdy stake for a few years to prevent their falling over from topheaviness.

Training of young trees is very desirable to assure wide crotches which will be strong. Macadamias are unusual in having 3 buds, in vertical file, in each leaf axil. If the trees are topped at 30 in. height at setting out, the uppermost buds in the 3 axils constituting the whorl of leaves just below the cut will each push out. Only one of these 3 shoots should be allowed to grow and become a leader; the other 2 should be cut off close to their origin. The next-to-top buds in the same leaf axils should now be stimulated to develop, and will form wide crotches. (The third set of buds usually remains dormant.) Usually the central leader will form whorls of lateral branches hereafter, and these should not be allowed to develop closer than 18 in. above the nearest scaffold limbs.

Like other orchard trees, macadamias must make vigorous growth each year if they are to bear heavy crops. If new shoots are strong and foliage color good, without any fertilizing, the trees probably need none. If shoots are weak and chlorotic, fertilizers are needed. Irrigation will usually be necessary in semi-arid climates. Pests are few.

Harvesting is done simply by gathering <sup>nuts</sup> from the ground, since <sup>they fall</sup> at maturity ~~the nuts fall~~. They should be collected at least every 2 weeks in the rainy season, or at monthly intervals at other times. Usually the crop matures over 6 months

or more. The hulls are often still around the mature nuts and should be removed within a few days of harvesting unless the fruits are spread out in a thin layer. Removal is a slow business by hand. The hulled nuts will suffer spoilage in storage if they are not promptly dried so that the initial moisture content of about 20% is reduced to 3 or 4%. Drying should be done in shade, in shallow trays of wire mesh. Well-dried nuts can be stored for several months in good condition or may be taken at once to the cracking plant to extract the kernels.

#### The Pili

Less well-known than the two previously discussed nuts, but fully as good in quality, is the pili nut of the Philippines, Canarium ovatum. Some 10,000,000 lb. of pili nuts are harvested there each year, largely from semi-wild trees, but there is no appreciable production elsewhere and few western consumers are aware of pili nuts in their mixed-nut packages. The tree has been introduced into Central America with success and merits serious consideration there as a commercial venture.

The pili is adapted to tropical lowland conditions, thriving in a warm, humid climate with abundant rainfall, preferably fairly evenly distributed. From sea level it may be grown up to an altitude of 1500 ft. in the tropics. Good soil drainage is more important than the specific soil type, but growth will be better on fertile loams than on sand or stony clay.

The tree may reach large size, to 60 ft. or more high, in time, but growth is rather slow. In Honduras, trees 20 yrs. old have not reached 30 ft., perhaps because they are in a region of long dry periods. Leaves are somewhat like those of walnut, compound, about 10 to 15 in. long, with 7 to 13 leaflets each 4 to 8 in. long. Flowers are rather inconspicuous in small racemes, followed by small clusters of fruits like giant olives. These are oval in shape,  $2\frac{1}{2}$  to 3 in. long, almost black at maturity, consisting of a pulpy flesh enclosing a triangular nut with thick, hard shell. Nuts are 2 to  $2\frac{1}{2}$  in. long, triangular in cross-section,



somewhat lanceolate in vertical profile, with the basal end tapering and the apex rather bluntly acute. A single kernel or seed is contained with the shell, constituting about 20% of the whole nut by weight. It has about 75% oil, 12% protein, and 5% starch, and is delicious either roasted or raw. The pulp around the nut is edible when cooked and yields an oil used in its native haunts for cooking and lighting; it might be a by-product of some value. The bark of the tree yields an oleoresin, Manila elemi, of very considerable industrial value, although it is doubtful whether it could be obtained profitably from trees cultivated for the nuts. In the Philippines it is considered that mature trees should have an average annual production of 200 to 300 lb. of nuts; a maximum yield of 10,000 lb.<sup>7</sup> has been recorded, and conversely, some trees bear only 50 lb. or less. Trees usually do not bear before they are 10 yrs. old.

Preparation of nuts for market requires first their separation from the fleshy exocarp. The most satisfactory procedure is to soak the fruits in water at a temperature of 110 to 115°F. Temperatures a few degrees above or below this range are definitely unfavorable. As soon as the pulp is felt to separate easily from the nut, it is removed by hand pressure, and the nuts are rinsed and dried in the sun. If well dried, they can be stored for 4 or 5 months. The hard shell is somewhat difficult to crack at the table, but is amenable to commercial cracking machines.

Almost all trees at present are seedlings, although there is no bar to selection of superior specimens and their propagation by budding or grafting, except that semi-wild trees are abundant in the Philippines. Germination requires 30 to 40 days usually, and while removing the shell speeds up germination somewhat, it reduces the percentage. Instead of removing the shell, it is recommended to hasten germination by carefully cutting off 1/8 in. of the basal end of the shell.

No orchard experience has been reported, but assuredly the trees would respond to cultural practices suitable for fruit trees of more familiar kinds. Spacing should not be less 25 ft. apart, and on deep fertile soil may need to be 35 or 40 ft. No pests have thus far been observed to be serious.

#### The Walnut

The genus Juglans, to which all walnuts belong, is very widely distributed over the surface of the globe, with species in Asia and in North, Central, and South America. Most of these are valued as sources of fine timber, but the nuts are harvested in some cases also; and in North America there are a few farm groves of the native black walnut. The only important species as an orchard tree, ~~however~~, is the Persian walnut, Juglans regia, often called English walnut in the United States. The tree is native to Persia, although the indigenous area extends somewhat beyond the boundaries of that country, and was only introduced to England a few centuries ago, so that the name Persian is much more fitting; but in the United States the tree was known as introduced from England and so the name English walnut early became fixed. Sometimes the name Regia walnut is used to avoid any geographical connotations.

This walnut is a very important commercial crop in California, and to a less extent in Oregon and Washington in the United States; and is cultivated extensively in Persia, western China, Chile, and around the Mediterranean in southern Europe. (Actually, there are very few trees in England.) For many years it has been grown on a small commercial scale by Indians around Momostenango, Guatemala, which indicates the suitability of climatic conditions for culture in Central America; and probably many areas of the Americas will prove satisfactory.

The tree needs a subtropical rather than a tropical climate, <sup>with</sup> ~~and needs~~ a growing season that is not too hot. The so-called Mediterranean climate with dry weather during the growing season and rain limited mostly to the cool, resting season is ideal. Such temperatures are found between 6,000 and 9,000 ft. of

*Mestropuca*

X

elevation in the American tropics. A certain amount of chilling during the resting period is required for the differentiation of flower buds, as is true of apples and peaches. Varieties of walnut differ considerably in chilling requirement, and those with a low chilling need will probably prove more satisfactory. Little information has been acquired hitherto about the behavior of this species in tropical America from the standpoint of chilling need. (See the discussion of this matter on p. .) The altitude at Momostenango is 7,000 ft. Soil for Persian walnut trees must be well drained and deep, at least 5 ft. in depth. A heavy loam with 6 to 9 ft. of good drainage is excellent.

The Persian walnut is a large, deciduous tree, 50 to 60 ft. high and equally broad. Leaves are alternate, compound, from 8 to 16 in. long, with 7 to 9 leaflets. Male and female flowers are borne separately on the same tree. Pistillate flowers appear in small terminal clusters on new shoots at the beginning of the growing season. Staminate flowers are differentiated during the previous season and are borne in short spikes (catkins) from nodes on last year's twigs. Pollination is by wind. There is no compatibility problem, but sometimes pollen is shed before or after pistillate flowers are most receptive. Neither pistillate nor staminate flowers have petals. The fruits consists of a nut developed from the ovary, enclosed in a hull developed from the flower parts which surrounded the ovary. At maturity the hull becomes dry, cracks open, and allows the nut to fall. Nuts must be gathered every few days, lest the kernels become dark and the shells stained. Harvesting is speeded up by shaking the trees or thrashing the branches with long bamboo poles after some nuts have fallen naturally. The freshly harvested nuts have a high moisture content, 20 to 30% usually, which must be reduced to 7 or 8% by drying in the sun or heat, so that nuts can be stored without spoilage. Varieties in which the two halves of the shell are not tightly sealed together do not keep well; but the ease of separating these halves and the easy extraction of the whole kernel are among the important points of superiority of Persian to all other walnuts. The kernels have about 65% oil and 15% protein.



In various countries with commercial orchard plantings of this walnut, seedlings with superior characteristics of yield and nut type have been selected and propagated as varieties. In the walnut-growing region of the United States, varieties with low chilling requirements include Blackmer, Placentia, and Payne, all of which have nuts of good quality. Payne bears earlier than most varieties and tends to be smaller in tree size so that more trees can be planted per acre; but it is unusually subject to walnut blight in warm, humid areas. Where there are already many seedling trees, careful selection among them may disclose a tree worthy of propagation as a well adapted variety. In areas where walnuts have not previously been grown, the above varieties should be tried; but seedlings should also be grown from them, to give opportunity for a possibly better adapted variety to appear.

Propagation of varieties is usually done by patch budding on seedling stocks of the Persian walnut or some other Juglans species. Where native species occur wild, they should be tried. In California the native J. hindsii has proved better adapted than J. regia, but this might not be the case in tropical America. Hybrids between these species, called Paradox as a group name, often are superior to either as stocks, and hybrids of Persian with native walnuts would be well worth investigating anywhere. Nursery stocks are budded at 1 yr. of age. Old seedling trees can be topworked during the dormant season by cleft-grafting.

*young grafted trees*  
Walnut budlings are planted *when about one year old* a year after budding, by which time they *are* have 4 or 5 ft. *in* height above ground and a deep tap root which must be cut not less than 30 in. below the surface. To accommodate this tap root, the planting hole must be 3 ft. deep, but it need not be more than 8 in. wide for most of this depth. Spacing of walnut trees must be quite wide, 45 to 60 ft. each way, if they are not to crowd at maturity, with consequent bad effect on yield. It will be many years before the trees will need all of this space, however, and fruit trees which bear early and become senile early may be interplanted at the start. Such trees should never be allowed to crowd the permanent walnut trees.

The trees are often allowed to grow naturally, with no pruning at all, but some training in the formative years is desirable. The modified leader system used for apples seems well suited to walnuts, but main branches should be spaced more widely than for apple trees. Watersprouts often develop from latent buds and should be pruned off promptly. On good soils, no fertilizers are likely to be needed for many years. Indeed, if fertilizing is necessary, walnut culture may not be profitable. Pests are seldom serious enough to need control; the principal one, bacterial blight, is related to climate and prevents growing this crop in humid areas.

Walnut trees are slow to start bearing, 7 or 8 years from setting out in the orchard for most varieties. Even when in full bearing, after 12 to 15 years, yields are usually low. A crop of 1500 lbs. per acre is an exceptionally good one as an average for mature trees in favorable soil and climate. However, the trees are long lived and require little maintenance.

## The Pecan

The most important tree fruit found in the United States by European settlers was a nut which the Indians of the Mississippi valley used extensively and which they called pecan. This nut, Carya illinoensis, was native to the valleys of this great river and its tributaries, from Iowa to Oklahoma, and to river bottoms in Texas and northern Mexico. While the crop harvested from wild trees in Oklahoma and Texas is larger in quantity, that from orchards of grafted trees from Texas to South Carolina is superior in quality. It belongs to the same family as the walnut, and like it is called in Spanish nogal. Rather surprisingly, this excellent nut has not been cultivated very extensively anywhere outside the United States. In the state of Oaxaca, Mexico, it is a common economic tree, and scattered specimens may be found in Guatemala and Honduras which produce good crops. Probably there are many areas in tropical America where it would thrive.

Like the Persian walnut, the pecan is subtropical to warm temperate in its climatic needs; but it is adapted to both humid and semi-arid conditions. In Middle America it thrives at altitudes of 3000 to 6000 ft. Cool weather during the dormant season is needed to enable buds to end their rest period, but hot weather is desirable during the growing season. In its native habitat the tree grows in deep alluvial soils, but any deep, well drained soil seems satisfactory, even sandy ones if fertilized.

Many varieties have selected and propagated in the United States. Adapted to humid climates are Schley and Frotscher (large nuts with thin shells), Curtis (small, thin), Stuart and Success (large, medium thick), and Moore (small, medium). For semi-arid climate, Burkett and Western Schley (both medium size) and San Saba (small) are all thin-shelled. These are all worthy of trial in tropical America.



Pecan trees are long-lived and reach large size, 50 to 70 ft. or more, with spreading branches. Leaves are deciduous, alternate, compound, 10 to 20 in. long, with 9 to 15 leaflets 4 to 8 in. long. Male and female flowers are borne separately on the same tree, with no petals. Pistillate flowers are produced in few flowered, loose spikes at the tip of new shoots, while staminate flowers appear from nodes of 1 yr. old twigs in clusters of 3 catkins (long, dense spikes). Pecan varieties range from strongly proterandrous (pollen shed before stigmas are receptive) to strongly proterogynous (stigmas no longer receptive when pollen is shed). Schley is regularly proterogynous and should be interplanted with a regularly proterandrous variety like Moore for sure pollination. Curtis and Stuart often are proterogynous, and in seasons when they are, need pollination by a somewhat proterandrous variety like Success for good crops. ~~San Saba is likewise a reliable pollinator for Burkett.~~ The fruit consists of a nut, derived from the ovary, enclosed in a dehiscent leathery husk. In better varieties the nut shell can be cracked easily by thumb and finger, so that the kernel can be removed whole. This kernel is greatly esteemed as a confection, fresh or roasted, and has 9 to 10% protein and 70 to 75% oil.

Propagation is commonly by patch budding in the second growing season on seedling stocks. Nuts should be planted soon after maturity, about 6 in. deep and 6 in. apart in rows 4 ft. apart. Seedlings should be  $3/4$  in. or more in diameter for budding; those too small may be left until the following dormant period and whip-grafted then. Budding can start as early in the growing season as mature buds become available on new shoots. As soon as buds are well united, in 3 or 4 weeks, the seedling top may be cut back to 8 or 10 in. above the bud, forming a convenient stub to which the bud sprout may be tied. At the beginning of the next growing season, this is pruned back to the bud union.

At the end of one season of growth, the budlings should be 4 ft. or more high and ready to be transplanted to the orchard. The long, sparsely branched taproot must be cut at 30 in. depth, and planting holes be made accordingly about 3 ft.

deep. The top of the tree is cut back about one-half to compensate for root loss in digging. Spacing of trees in the orchard should not be less than 50 x 50 ft. even on poor soils (if trees at this spacing do not crowd each other in 25 yrs., the soil is too poor to use), and on fertile soils should be 60 to 70 ft. apart.

On good soils, pecans may not respond to fertilizing for many years; on sandy loams it may be profitable from the start to fertilize. Little or no pruning is customary after setting out in the orchard, as the trees are naturally strong and shapely. Irrigation will be needed in regions of low rainfall. Weed control is not so important as with shallow-rooted trees, but mowing will be necessary just before the harvest season to facilitate picking up nuts.

Trees are slow to begin bearing, usually being 8 to 10 yrs. old before any considerable crop is borne. At maturity the husk normally splits along 4 lines lengthwise, allowing the nut to drop to the ground eventually. The dropping can be hastened by shaking or beating the branches; sometimes this must be done a second time after 2 weeks or so. The nuts must be dried in thin layers under shelter until they have reached a fairly constant weight. They do not keep well from one year to the next except in cold storage. While there are records of exceptional trees with a crop of 1000 lb., a good average production for a tree 20 yrs. old of an adapted variety on good soil with good care would be 50 to 60 lb. of nuts, or about 800 to 1000 lb. per acre.

Several insects are serious pests of pecan in the southern United States. Whether any of these would be present in Central or South America cannot now be stated. Likewise, pecan scab, a fungus disease of the nuts and leaves, seriously limits yields in humid areas on some varieties. Schley is extremely susceptible to scab and can only be grown in humid areas with the aid of regular spray programs. Curtis and Stuart are quite resistant to scab. Control requires spraying with 4-1-100 Bordeaux (4 lb. copper sulphate, 1 lb. hydrated lime, 100 gal. water) when catkins appear and leaves are half grown, followed by 6-2-100 Bordeaux every 3 weeks for 3 applications.

### The Abiu

The abiu (Pouteria caimito) is native to the tropical lowlands of northeastern Peru, and is cultivated along the Amazon basin as far as Belém, as well as along the coast at Salvador and especially at Rio de Janeiro. It deserves much wider culture. Similar to its sister species, the canistel, in tree habit, foliage, flowers, and fruit size, it is distinguished by differences in color and taste of fruit. At maturity the skin color is bright yellow, and the melting, translucent flesh is white, sweet, and of excellent flavor. There are 20 or 30 seeds the size and shape of those of the canistel, but lacking the rough ventral area. Like other sapotaceous fruits, this one contains a milky latex until it is fully ripe, and an unripe fruit sticks unpleasantly to the lips on biting into it. The abiu is more tender to cold than the canistel, but thrives in warm, humid areas. Seedling trees vary considerably in fruit quality, and superior ones can undoubtedly be propagated by veneer-grafting in the same way as the canistel is.



The Bignay (Antidesma bunius)

Native across southern Asia from Ceylon to the Philippines, and even to northern Australia, the bignay is a common dooryard tree in Indonesia which deserves wide cultivation in Tropical America. As a source of fruit for jelly, not even the guava surpasses it. Usually it is a shrubby, evergreen tree, to 6 or 7 m. high, although it is reported to reach over 15 m. in Java. Leaves are alternate, leathery, shining green, oblong, 10 to 20 cm. long. Flowers without petals are borne in terminal or subterminal racemes, with male and female flowers on separate trees. Fortunately, female flowers set fruit abundantly without pollination. Fruits mature about 3 months after bloom, in racemose clusters of 20 to 40 fruits. The fruit is a drupe of about 10 to 12 mm. diameter, with a thin-walled "stone" surrounded by soft, juicy flesh and a thin skin. While fruits are commonly seedless, they appear to be seedy because of the "stone". Skin color changes from green to red, and then to almost black at full maturity, but very often some fruits in a cluster mature later than others. The ripe fruit is sub-acid, not very pleasant for eating fresh, but makes a red jelly of excellent quality. Blooming and fruiting continue over a 2-month period, and there may be two bloom periods a year. Yields are usually very heavy, the drooping clusters nearly concealing the tree.

The bignay endures light frost, but grows best in a warm, humid climate. Any well-drained soil seems suitable. Propagation is easy by stem cuttings or marcottage. Seeds, when they occur, germinate very slowly. Mealybugs and soft scales, both controlled by malathion and the scales by oil emulsions also, are the most common pests.

### The Sapucaia Nut

Several species of the tropical American genus Lecythis produce a nut of excellent quality, similar to the closely related and better known Brazil nut, and known as sapucaia or paradise nuts. Most of the nuts in commerce come from the Brazilian L. usitata and are harvested from wild trees. L. ollaria from Venezuela has been grown in Malaya <sup>and Puerto Rico have</sup> and is being tried in Puerto Rico. El Salvador ~~now has~~ bearing trees of the Colombian L. elliptica.

Lecythis elliptica is a handsome tree of ~~medium~~ small size, 5 to 7 m. high, with leathery, oblong leaves 15 to 20 cm. long and 5 to 7 cm. wide. White flowers 3 to 5 cm. across are borne in dense terminal racemes to 12 cm. long. Trees may bloom when only 2 m. high. The fruits are about 8 cm. in both length and diameter, and consist of a thick-walled, woody capsule with a wide lid which becomes free at maturity, and filled with 6 to 10 slender nuts about 3 cm. long. These have white meat of very pleasant taste, and are high in oil and protein. The capsule remains on the tree, while the seeds fall to the ground. Since the seed coat is thin and affords little protection, the seeds must be collected from under the tree every few days.

The tree is strictly tropical, intolerant of any chilling. Although native to a region of heavy rains all year long, it does well in areas with long dry seasons if irrigation is provided. Soil must be well drained. Propagation is easily done by seeds, which germinate in about 2 months. Seedlings should be shaded until they are well established in the field.

### Miscellaneous Fruits

There are a great many fruits of the tropics which have little commercial possibility but which are excellent for dooryard culture. Some are pleasant to eat out of hand, while others make attractive and tasty jellies or preserves. They can add much to the pleasure of living at little cost. Nearly all of them are intolerant of frost.

#### Barbados-cherry (Malpighia glabra)

This tropical American indigene has recently come in for commercial exploitation in Puerto Rico and Hawaii after many years of quiet existence as a valued dooryard shrub. The basis for commercial interest is the very high Vitamin C content of the fruits, 1000 to 4000 mg. per 100 g. of flesh. But for home culture, the fruit is enjoyed for making jellies, jams, sherbets, and beverages. The plant is native from southern Texas down to Surinam and Peru in the lowlands. In Puerto Rico the name acerola is used, a name belonging properly to the European hawthorn, which is not found in that island; but the name Barbados-cherry has been standard in English since 1690, when Sloane recorded it in Jamaica. The scientific synonym M. puniceifolia is also preferred in Puerto Rico.

The Barbados-cherry is a large evergreen shrub which may reach a height of 15 ft. although easily kept lower. The thin, opposite leaves are 1 to 3 in. long and half as wide, those on fruiting spurs being smaller than those on long shoots. Flowers on different seedlings range in color from white to deep rose, and are about 3/4 in. across. They are followed a month later by mature fruits, which are soft, juicy, thin-skinned, about an inch in diameter, with 3 prominent lobes, and orange-red to purplish-red in color. Within are 3 parchment-like, crested "stones", each of which may contain a seed; often no seed is present. The flesh may contain from 4 to 8% sugar and 1 to 3% acid, so that different seedlings may range from rather sour to pleasantly sweet. Since the principal flavor acid is malic, the taste is somewhat like crabapple. There is usually a succession of bloom periods, so that 3 or 4 crops may mature in a year.



Superior seedlings are easily propagated by marcottage or by veneer-grafting. Heavy fruiting depends on production of vigorous new shoots; water and fertilizer may have to be supplied to obtain this. Annual pruning by heading back, after the last crop matures, will keep plants within bounds and stimulate new fruiting shoots. Any well-drained soil free of rootknot nematodes <sup>1-2</sup> will be satisfactory. The shrub grows well in both humid and arid regions, if irrigated in the latter, but tolerates little frost. Probably it should not be planted above 5000 ft.

Carambola (Averrhoa carambola)

Native to Malaysia in areas with some dry season, where teak thrives, the carambola is cultivated widely as a dooryard tree all over the tropics of southern Asia. It is more popular in China than in India but nowhere is it planted in orchards. The name carambola is the one the Portuguese found being used for this fruit on the Malabar coast of India in 1563. The tree has long been cultivated in Brazil, Hawaii, and Florida, as well as in the West Indies. It endures light frost but grows best in warm, humid climates; well-established trees tolerate considerable drought. Any well-drained soil seems suitable.

The tree is small and slender, 20 to 25 ft. high, with pinnately compound leaves, 6 to 8 in. long, composed of 5 to 11 leaflets which decrease in size from the terminal one towards the base. Small clusters of tiny pink flowers are followed some 4 months later by oblong, golden-yellow fruits, 3 to 5 in. long, deeply 4- or 5-ribbed longitudinally so that cross-sections are star-shaped. The thin skin is waxy and translucent. The pleasantly fragrant flesh is fragile and juicy, and on some seedlings is quite sour, while on others it is pleasantly sweet and acidulous. The sweet forms usually also have larger fruit size than the sour ones; they are sweeter only because of less acid, not more sugar. They may be eaten out of hand, but the sour forms are stewed for sauces, made into tarts, jellies, and jams, or used to make a refreshing drink. Star-shaped slices of fruit are admired as salad garnishes. The acid present is chiefly oxalic, so that it removes iron

stains well. Several small, flattened, soft seeds are imbedded in the flesh. Often the fruits are borne cauliflorously on the trunk and large branches, but sometimes at branch tips. There are usually 3 or 4 crops a year from a succession of bloom periods.

Propagation is usually by seeds, which germinate in 2 months, but superior seedlings can easily be multiplied by veneer-grafting on seedling stocks. No special pests are known. Making provision for cross-pollination often increases yields.

Cashew-apple (Anacardium occidentale)

The cashew-nut has already been discussed in the Nut-Fruits chapter, but the tree yields a fruit as well as a nut. The cashew-apple develops from the flower pedicel or stalk, but it has typical fruit appearance and taste. It is 2 to 3 in. long, oblong in shape, with shining skin either crimson or yellow in color. The very juicy flesh is pleasantly fragrant, sweet, and acidulous, but is somewhat astringent. Usually it is enjoyed more when cooked than in the fresh state. It contains 6 to 7% sugars and is fairly high in vitamin C content, 330 mg./100 g. of flesh. The tree grows well in both wet and dry regions and on a wide variety of soils. Excellent jelly and wine are made from the fruit. See p. for further discussion of propagation and culture.

Ketembilla (Dovyalis hebecarpa)

Native to Ceylon, this fruit has become well established in southern Florida and the West Indies. It is usually shrubby in habit, with many stems from the base, but may form a small tree to 15 ft. high. Branches are slender and drooping, and are armed with small thorns, an inch or less in length. Leaves are lanceolate, 3 to 4 in. long, velvety when young, with the larger veins tinged with rose-pink. Flowers are inconspicuous, with staminate and pistillate ones usually borne on separate plants; occasionally a plant is found with perfect flowers. Normally care must be taken to have male and female plants close together in order to

assure fruiting. It takes about 4 months for fruit to mature from bloom, but flowering and fruiting both extend over several months. The fruits are round, from  $3/4$  to 1 in. across, reddish-purple when ripe, and covered with a velvety fuzz. Within the thin skin is a soft, purplish flesh, juicy and rather acid, containing several small, flattened seeds. The thorns and acid fruit reminded Englishmen in Ceylon of the gooseberry of their homeland, and so they called the fruit Ceylon-gooseberry, although there is little real resemblance. The ketembilla is highly regarded for making jams and jellies, for which some unripe fruits should be included to supply pectin; it is too tart and astringent to be eaten out of hand. Usually the female plants bear heavy crops, especially if adequately cared for. It is adapted to warm, humid climates, and needs good soil moisture. Propagation is usually by seeds, which germinate in about 2 weeks. Cuttings are easily rooted and make possible having plants of known bearing ability. There is no variation among seedlings, except for flower type.

The closely related D. abyssinica from Ethiopia has no common name yet, but is likely to become more popular than the ketembilla because of sweeter fruit. It is also a bushy shrub commonly, with slender twigs that are often unarmed, though sometimes bearing spines like the ketembilla. Leaves are similar in shape, somewhat smaller, and lack the velvet coating and the reddish veins. Flowers are also very similar and borne on separate male and female plants. Fruits are rounded, about an inch in diameter, with thin, apricot-colored skin without pubescence. The soft, juicy flesh is orange-yellow, slightly tart but pleasant for eating fresh, with a suggestion of apricot aroma and taste. Maturation of fruit from flower takes 4 to 5 months. Propagation and plant care is the same as for ketembilla, and climatic adaptation is similar. No perfect-flowered plants have been reported thus far.

A natural hybrid of the above two species has arisen in Florida, and its first generation seedlings have yielded abundant crops of fruits intermediate in character to the parents. Selections have been made of forms with large fruits; most of the seedlings have either perfect flowers or male and female flowers on the same plant,



The Mangosteen (Garcinia mangostana)

The combination of beautiful coloring with delicate, enticing flavor entitles the mangosteen to rank above all other fruits of the Asiatic tropics, and to compare favorably with the best fruits of the Temperate zone. Yet, in spite of unstinted praise by travellers for 400 years and repeated efforts to introduce it into cultivation elsewhere, it remains today a rarity except in the Malaysian region to which it is native. An orchard was established in coastal Honduras in 1927, which is probably still the largest one in the world, as the fruit is mostly produced on dooryard trees in Indonesia; but no other plantings of commercial size are known in tropical America and dooryard trees are very rarely seen. The slow growth of the trees, the erratic bearing habit, and the difficulty of transporting the tender fruits to distant markets are among the reasons why culture has not expanded.

The mangosteen is exceedingly exacting in its climate and soil requirements. It is strictly tropical, not tolerating even temperatures below 40°F. without injury, and is adapted only to very humid conditions--tropical rain forest--such as characterize the Caribbean coast of Central America near sea level. It will tolerate a dry period of a few months with irrigation, but needs well-distributed rainfall for best growth. Soils should be well-drained to a depth of several feet, but retentive of soil moisture--not wet but moist at all times. Clay or silt loams, or sandy loams with high organic matter content, are most satisfactory. There are many areas in the American tropics where these conditions can be found, and trees have done well in several places in the West Indies and Central America.

The mangosteen tree is a handsome evergreen, rather columnar in habit, reaching a height of 30 to 40 ft. The deep green, leathery leaves are opposite, elliptic-oblong with sharply pointed tips, from 5 to 10 in. long, and glisten in sunlight. Perfect flowers, 2 in. across, with 4 fleshy, purple petals, are borne singly or

in pairs at branch tips. Small clusters of male flowers are also produced. The fruits are the size and shape of Dancy tangerines, 2 to 3 in. across, with a smooth, thick rind of red-violet or purple color at maturity. Inside are 5 to 8 white sections of delicately flavored, sweet but slightly acidulous flesh. A few of the sections usually contain a single "seed" each. The fruit is opened by cutting through the rind in the equatorial plane; lifting off the top half of the rind exposes the white sections nested in the purple rind. The pulp sections constitute about 1/3 the weight of the whole fruit, and contain about 16% sugar and 1/2% acid. They are always eaten fresh as a dessert. When picked from the tree the rind is like soft leather, but after a few days it becomes woody and loses the attractive color, although the pulp sections remain unchanged for a week or two.

Propagation has been almost wholly by "seeds", because no seedling variation is known; all trees bear fruit exactly alike. This is because what appear to be seeds are actually small vegetative bodies which originated somewhat like nucellar embryos in oranges, except that no true embryos ever develop. These "seeds" remain viable only about a week at tropical temperatures, but may be kept in good condition for 6 to 7 weeks if stored in damp sphagnum at 65 to 70°F. Seedlings are delicate and must be started in rather heavy shade, which can gradually be reduced to half of full sun in the course of 2 or 3 years in the nursery. Potting soil should be high in organic matter and very free draining, but should never become dry. It is best to grow the seedlings in containers, as transplanting from open ground is difficult. Transplanted to the orchard or dooryard at 2 or 3 yrs. of age, the plants should still be protected from full sun and gradually exposed to it over a further period of 2 y<sup>ears</sup>. Seedlings do not bear earlier than 6 to 8 yrs of age, and may be well over 10 yrs old. Marcottage and cuttage have both been found very difficult. Inarching and veneer-grafting are both fairly easy, but the benefits have not seemed worth the extra trouble.

In favorable climates and suitable soils, the tree requires no special culture.

Naranjilla (Solanum qui toense)

This species is native to the Andean regions of Ecuador and Colombia, at elevations of 4000 to 7000 ft., and is rather extensively cultivated there, but is not much grown elsewhere. It is not a tree but a vigorous herb, reaching under favorable conditions a height of 6 to 8 ft. Leaves are also large, to 18 in. long and 12 in. across, dark green and glabrous above, with prominent purple veins, and densely whitish pubescent below. Indeed, all parts of the plant except the upper leaf surfaces are pubescent. Flowers are borne in small clusters in the leaf axils, in a long succession of blooming, and are pale lilac in color, about  $1\frac{1}{2}$  in. long.

The fruits are round, from  $1\frac{1}{2}$  to  $2\frac{1}{2}$  in. across, and golden yellow at maturity, looking much like small oranges (hence the name, naranjilla) except for their being coated with short, brittle hairs. These are easily rubbed off, however. Inside the tough skin is a dark-green pulp, much like a tomato in texture, which tastes like a combination of orange and tomato. The juice is much used as a refreshing drink, and to flavor sherbets and ice cream, or for making jellies, jams, etc. As long as new growth is made, new flowers are produced, so that fruits ripen every month in the year. Imbedded in the pulp are many small, flat seeds, like those of tomato.

Propagation is usually by these seeds, which germinate quickly. Herbaceous cuttings shorten by a few months the time until the first fruits mature. No variations worthy of vegetative propagation have been observed. The roots are very subject to attack by the rootknot nematode, and if the soil is infested with this pest, the naranjilla must be cleft-grafted on some resistant native species of Solanum. Fortunately, virgin upland soils are likely to be free of this parasite. Usually plants begin flowering in 3 or 4 months from seed, mature the first fruits about 3 months later, and should continue in production for 3 or 4 years.

In their native area, rainfall is regular and plentiful. Soil must be very free draining, but preferably a loam. Many parts of Central and South America should have highlands where the naranjilla will flourish.



Pejibaye (Bactris gasipaes)

Native to tropical America, this is probably the only palm except the date which is cultivated for its edible fruit. It is often called "peach palm" in English, and the older botanical name (Guilielma utilis) is better known than the presently accepted one. This palm occurs wild or naturalized from Nicaragua down into Bolivia, but while it is commonly seen in dooryards in this area, only in Costa Rica and Panama are there small commercial plantings.

The pejibaye may reach 40 ft. in height, and has a slender, spiny trunk. The feathery leaves are 5 to 6 ft. long, with abundant spines on the petiole and midrib. Separate clusters of male and female flowers are borne in the leaf axils of the same tree. The fruits are in compact clusters, below the foliage, which weigh ~~ing~~ 15 to 25 lb. commonly. They are oval in shape, about 2 in. long (like a hen's egg), and range in color from light yellow to orange-scarlet in color. Usually each fruit contains a large, hard seed, but sometimes palms are found with fruits which are seedless or have very small seeds. The fruits may resemble peaches in appearance, but not in texture or taste. The flesh is mealy, like a baked potato, and must be boiled in salted water or roasted to make it palatable. Thus prepared, it has a sweet, nutty flavor and is highly nutritious, with about 35% carbohydrates (mostly starch) and 5% fat, as well as several vitamins in good quantity.

Propagation is commonly by seed, but it is worthwhile to attempt to root the suckers around the base of the palm in the case of seedless specimens. Seedlings may begin to bear in 3 or 4 yrs. under favorable conditions. Mature palms should yield 4 or 5 large bunches of fruit a year. The plants should be spaced about 15 ft. apart, and an orchard should produce 10,000 to 20,000 lb. of fruit annually for many years. Because it is so easy to grow and yields so abundantly of nutritious, palatable fruit, the pejibaye deserves much more extensive cultivation. It is adapted to humid, tropical lowlands, below 3000 ft., and does not fruit well in dry climates. No pests are known.

10  
~~or Xocote~~  
Red Mombin  $\Delta$  (Spondias purpurea)

Native to tropical America, the red mombin is a fruit of considerable importance in many parts of Mexico and Central America, but is not planted commercially anywhere. Fruit from dooryard trees appears commonly in village markets. In Mexico and Guatemala it is known by its ancient Nahuatl name Xocote,  $\Delta$  <sup>or Xocote</sup> and in the West Indies it is often called Spanish-plum. In many Spanish-speaking countries, it is known simply as ciruela (plum). The tree flourishes from sea level up to 6000 ft. of elevation in the tropics but is intolerant of frost. It thrives in both wet and dry regions.

The red mombin forms a small spreading tree, with stiff trunk and rather stout twigs, rarely over 25 ft. high, and deciduous for a few months of dry or cool season. Leaves ~~of~~ <sup>are</sup> pinnately compound, 6 to 9 in. long, with 15 to 21 leaflets, 1 to  $1\frac{1}{2}$  in. long. Small clusters of purple flowers are produced from the previous season's twigs before new leaves appear. About 5 months later the fruits are mature. They are  $\Delta$  <sup>usually</sup> maroon or purplish red,  $\Delta$  <sup>but sometimes yellow</sup> oblong or oval, from 1 to 2 in. long, and usually are borne in clusters of 2 or 3, or singly. The soft, juicy, acidulous flesh is covered by a thin, delicate skin and encloses a large stone with rough surface. Very often there is no seed inside the stone. Unfortunately, the amount of edible flesh is commonly small in relation to stone size, but occasional seedlings have large fruits with sufficient flesh to be worth propagating. The somewhat aromatic flesh is eaten out of hand commonly, but may be stewed as preserves, or boiled and dried for future use. ~~There is a yellow fruited form in cultivation in the West Indies, called S. purpurea var. lutea. It has yellow flowers and fruit, larger tree and leaves, and later season of maturity, all characters which suggest that it may be hybrid of S. purpurea with S. <sup>mombin</sup> lutea, the yellow mombin or jobo. Fruit quality is like the red mombin, however.~~

Propagation is commonly by large stem cuttings, 2 ft. long, of wood 1 yr. old or more. Set half their length in the ground at the beginning of the rainy season,

these usually grow vigorously and fruit within 3 years. Often trees are established in this way as living fence pests. The trees grow on a wide range of soil types, though a rich, moist loam is best. Fruit-flies are a troublesome pest, not readily controlled.

Tamarind (Tamarindus indica)

This native of tropical Africa was introduced to India in pre-historic times and is now a common tree in all parts of India and Pakistan. The annual crop in India is said to be 250,000 tons. The name tamarind, which is universally used except in southern Asia, is of Persian origin and means "the date of India", referring to the common practice of drying and storing the fruit in India somewhat as the Persians did with dates. The tree is easily injured by frost, but endures salt spray well. It is widely grown in tropical America, and is a commercial crop of some islands of the West Indies, the principal export usage being for the manufacture of Worcestershire sauce.

The evergreen tree may reach large size, 70 ft. or more high, but is slow growing. It forms a handsome, rounded head of feathery foliage and is very resistant to wind. The leaves are 4 to 6 in. long, pinnately compound, with 20 to 40 leaflets about  $\frac{1}{2}$  in. long. The flowers are rather inconspicuous, though individually ~~rather~~ attractive, about 1 in. across, the yellow petals marked with red veins, borne in small racemes. It takes nearly a year for the fruits to mature, each one a brown pod, 3 to 6 in. long, somewhat flattened,  $\frac{1}{2}$  to 1 in. across. The green pods are quite firm, but as they mature, the pulp softens and shrinks away from the outer covering, which is then quite brittle. The mature pulp is dark brown, soft, often somewhat fibrous, high in sugar (20 to 30%) but also so high in acid (8 to 14%) that the taste is acid. Several large, flat seeds, like Windsor beans, are imbedded in the flesh; often the fruit is constricted somewhat between seeds. The pulp<sup>is</sup><sub>^</sub> stirred into water to make a refreshing drink, or may replace both sugar and lemon in tea. The fruit is popular for eating fresh, especially with children.



As noted, it is an important ingredient of Worcestershire sauce, and is used to flavor preserves and in preparation of chutney, curries, etc. When packed into casks, it keeps indefinitely, and a brine made from it preserves fish well. The acid is chiefly tartaric. While the pulp does not spoil readily and harvested fruits may be stored for long periods, fruits left on the tree after maturity are soon attacked by insects. The seeds contain 16% protein and 60% carbohydrate, and may be eaten boiled or fried after soaking until the seed coat can be removed. They are also rich in pectin for jelly making.

Propagation is commonly by seeds, which germinate in about a week and retain viability for months if well dried. Seedlings vary greatly in pod size, and types with low acid content--sweet tamarinds--occasionally are reported. Such superior seedlings are easily multiplied by veneer-grafting, shield-budding, or marcottage. Seedlings may begin to bear at 5 yrs of age, though still rather small. No cultural practices have been developed for the tamarind. It thrives on a wide variety of soils, calcareous or acid, but they must be well drained. While growing well in humid areas, the tree seems very well adapted to semi-arid climates under irrigation.

White-sapote (Casimiroa edulis)

Native to the highlands of Central America and Mexico, the white<sup>s</sup>apote has never attained much importance elsewhere, though an important dooryard fruit in its indigenous area. The Aztecs called it cochizapotl, the "sleepy-sapote," because bark, leaves, and seeds contain a sedative glucoside, but eating the fruit has no such effect. ~~Likewise~~ Another common name in Mexico and Guatemala <sup>is</sup> Matasano, (~~"kill health"~~), ~~has no basis in fact~~. The fruit is perfectly wholesome and widely consumed. It is unfortunate that some writers list this species in English as a variety of sapote, for it is in an entirely different plant family from the sapotes and bears the same relation to them that sweetpotatoes do to potatoes. White-sapotes are actually in the same family as oranges, although only a botanist would suspect this.

The evergreen tree is of medium size, 25 to 40 ft. high, and spreading in habit. Leaves are alternate and palmately-compound, with 5 leaflets usually, each 3 to 5 in. long. Flowers are inconspicuous, greenish-yellow in color, borne in small clusters on old twigs before the new growth flush. Some 4 or 5 months later the fruits mature. They are greenish-yellow, from 1-1/2 to 3 in. across, somewhat flattened or nearly round. Under a very thin, delicate skin is a soft, melting flesh, ranging in color from white with flecks of yellow to golden yellow, with slightly gritty texture like pears. There are 1 to 5 large seeds, each with a thin, white, fibrous covering which is the "stone". The sugar content of the flesh is high, 12 to 20%, and the acidity very low, so that the taste is very sweet; commonly it is also slightly bitter, like quinine, especially if the fruit is picked before the first yellowing. Seedlings differ much in the size and also the bitter aftertaste, and some produce very palatable fruit.

Another form of white-sapote occurs from Yucatan to Costa Rica and is distinguished by pubescence on the lower leaf surfaces and by much larger fruits, to 4 in. diameter. The name C. tetrameria is in the literature, but it seems very doubtful that this is a distinct species; rather it is probably a mutant, polyploid form of C. edulis. The only common name which is distinctive is woolly-leaved white-sapote. Fruit characters, except size, are identical in the two forms. Both are eaten out of hand principally.

Propagation is commonly by seeds, which germinate in 2 weeks and only retain viability for a month or so. Superior seedlings may easily be grafted on seedling stocks using whip- or veneer-grafting. Buds unite easily but are difficult to start into growth. Seedling trees take 7 or 8 years to bear, whereas grafted trees should bear in 3 or 4 years.

As a highland tree, the white-sapote thrives in the tropics only at elevations of 3000 to 6000 ft., although in the subtropics it grows well at sea level. The tree tolerates almost as much cold as the orange. It seems better adapted to semi-arid than humid climates, but needs irrigation in long, dry periods. Any well-

~~The Icaco~~

Asiu

Mammea americana

Breadfruit

Durian

~~Pine apple, Melon apple~~

~~Cyphomandra~~



The Durian (Durio zibethinus)

In Malaya, Thailand, and Indonesia, where it is indigenous, the durian is so highly esteemed that during the harvest season armed guards live in little huts at the base of each tree to prevent stealing of the fruit. Yet, so offensive is the odor of the ripe flesh that few people ever learn to like it in areas where it has been introduced. It is rare in southern India, and hardly found outside of a few botanic gardens in tropical America. So far as soil and climate are concerned, it thrives where breadfruit does. The tree is large, much like a mango in habit and foliage, except that the undersurface of leaves is yellow. The large, white flowers have an unpleasant smell. The ovoid fruits are 6 to 12 in. long, greenish-yellow at maturity, with a thick, fibrous rind covered with large, pyramidal, woody spines. A falling fruit is a highly dangerous object. Within, the fruit is 5-celled, with 2 or 3 ovoid seeds an inch long imbedded in a mass of soft, cream-colored pulp in each cell. The flavor is rich and is considered delicious by those who like the fruit, but a powerful odor of rotten onions deters most would-be tasters. Propagation by seed is easy, and superior trees may readily be multiplied by budding on seedlings.

See p. 1 of Guava chapter!

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[Looks like Herbert Woffe's  
handwriting]

Rose-apple (Syzygium jambos)

The rose-apple, or pommarrosa, is widely distributed throughout the tropics and subtropics of the world, but had its origin somewhere in the vast Indo-Malayan area. It is of very ancient culture in India, and has escaped from cultivation in parts of the West Indies, Hawaii, and other regions. The name, Eugenia jambos, is also used. The tree is a handsome and easily grown ornamental, valued more for shade than for fruit usually. Of small to medium size, rarely over 30 ft. high, and round-headed, it endures considerable frost and is tolerant of a wide variety of soils. The slended, opposite, glossy green leaves are 5 to 8 in. long, and are wine-colored on new shoots. Flowers are produced terminally in small clusters, and consist chiefly of a mass of greenish-white stamens in a spreading pompon, some 2 to 3 in. across. About 2 months after a flower opens, the fruit matures, a pale yellow globe from  $1\frac{1}{2}$  to 2 in. across and bearing at its distal end the persistent 4-parted calyx. There is a large central cavity, containing from 1 to 3 brown seeds, and a thin shell of crisp, whitish flesh, about  $\frac{1}{4}$  in. thick. With 10% or more of sugar and less than  $\frac{1}{2}\%$  of acid, the flesh has only a sweetish, rose-water taste. Candied or otherwise preserved with flavoring material, the fruit is more acceptable than in its fresh state. Often it is used to impart the rose-water smell to jellies. The seeds are polyembryonic and come uniformly true to type.

It succeeds equally well in warm, moist tropical regions and in the cool and dry subtropics.



Malay-apple (Syzygium malaccense)

This tree, also called Eugenia malaccensis, is native to Malaysia. Before 1300 A.D. it had been taken to the Hawaiian Islands in canoes, and there it became a naturalized forest tree covering hundreds of acres. In 1500 the Portuguese introduced it to Goa from Malacca, and later it reached the West Indies from India. While cultivation is rather sparing in tropical America, where the names in Spanish are usually ponarrosa or manzana, the fruit appears in markets over a wide area. The tree is of medium height, rarely over 40 ft., with opposite, elliptical, leathery leaves, 6 to 12 in. long and half as wide on rather thick twigs. The flowers are very showy, much like those of the rose-apple but with bright red stamens and petals; yet, because they are borne mostly on older twigs and branches inside the canopy, they are not conspicuous from a distance. Late in the blooming period, however, the ground under the tree is usually carpeted with the abundant red petals, making a brilliant display of color. The pyriform fruits, 3 to 4 in. long, mature 3 to 4 months after the bloom, and are scarlet-red. The flesh is white, crisp, not very juicy, and has a distinct odor of roses. The taste is sweet but mawkish, with 6% of sugar and almost no acidity. These colorful fruits may be eaten out of hand, or may be stewed with flavoring materials. There is a single, large seed which develops without fertilization and usually reproduces without variation. The tree is exceedingly tender to cold, so that it is suited only to tropical lowlands, and grows well only in areas with no dry period during the year.

The Indian Jujube (Zizyphus mauritiana)

Native to India, Assam, and Burma, this tree is also cultivated widely in Malaya. It is little known in tropical America, but is worthy of extensive culture in dooryards because of its heavy production of nourishing fruit. The island of Vieques, Puerto Rico, is one area of considerable production. Culture in India, where it has been grown for 3000 years, has expanded rapidly since 1945 because the crop matures in winter when other fruits are scarce, and the trees are so easy to grow. They are evergreen, usually from 15 to 25 ft. high but sometimes much larger, straggling in habit, with drooping branches and slender, thorny branchlets. The ovoid leaves are  $1\frac{1}{2}$  to 2 in. long, rounded at the tip, and clothed below with a fine, tan pubescence. In the West Indies, as in India, the current season's twigs bear small clusters of tiny yellow flowers in the leaf axils from July to November. Fruits mature from November to March, and are the size and shape of large olives, from  $\frac{3}{4}$  to 1 in. long. The thin, tough skin ranges in color at maturity from light yellow to reddish-brown. The whitish flesh is crisp and somewhat mucilaginous, sweet, and mildly acidulous. In the center is a sharp-pointed stone, very much like an olive pit, to which the flesh adheres. Each stone has 2 seeds. Analysis of the fruits has shown about 12% sugar and 1% protein. There is considerable variation in fruit quality and size among seedlings, and some are very good for eating fresh, while all make good preserves and jelly. When dried, the fruits have much the texture and taste of dry dates. Propagation by seed is customary, the seeds germinating in 2 weeks if removed from the stone but requiring several months if not removed. Superior seedlings may be multiplied by shield-budding or by marcottage. Trees with no stones have been found in India and have been propagated on a large scale. The trees are able to endure as much cold as mangos or pitangas, but grow and fruit best in a hot, dry climate. They are very tolerant of infertile and poorly drained soils, although maximum yields should

not be expected under these conditions. Very high humidity and heavy rainfall all year are unfavorable factors because they encourage foliage diseases.



The Tree-tomato (Cyphomandra betacea)

This native of the Peruvian Andes is extensively cultivated in India, Ceylon, and New Zealand, but is rarely seen in the Caribbean area. It is often found in Mexico and Central America, where it is called arbol de tomate or simply tomate. It is a highland species and requires a cool growing season such as is found at elevations of 3000 to 9000 ft. in the tropics, but may be found at lower elevations in the subtropics. Yet it does not endure more cold than the West Indian avocado. It forms a shrubby tree, 6 to 10 ft. high, with large, heart-shaped leaves, soft in texture and pubescent, from 4 to 10 in. long. Clusters of small, pinkish flowers appear on new shoots, and are followed in about 6 months by mature fruits in clusters of 2 or 3. These are the size and shape of hen eggs, with skin color ranging from reddish-yellow to purple on different plants. Internally the fruit is very similar to a tomato, to which it is closely related botanically. It may be eaten raw, but is usually stewed with sugar to make a jam or preserves. Skin and seeds should be removed before cooking. The harvesting season usually extends over several months, as in the tomato proper. The tree is precocious, beginning to bear in its second year, and usually continues to bear for 10 years or more. Propagation by seeds is easy, but there is much seedling variation and superior seedlings may readily be multiplied by cuttings, hardwood or softwood. While fairly tolerant as to soil, the tree-tomato is most productive on a rich loam and is intolerant of poor drainage. It seems to prefer a somewhat low atmospheric humidity, but needs abundant water for good crops.

The Icaco (Chrysobalanus icaco)

Although it is a fruit of very little value, the icaco is used extensively in some parts of the American tropics by the poorer people. It is native to coastal areas from southern Florida, where it is known as cocoplum, to northern South America, and perhaps also to Africa. Primarily a large shrub, but sometimes a small tree to 25 ft., the icaco has small, obovate leaves, about 1 to 2 in. long, which are leathery and dark green. Clusters of small, white flowers are followed by ovoid fruits, from 1 to 2 in. long, ranging in color when ripe from pinkish-white to almost black. The thin skin encloses a cottony, white flesh, insipid in taste, which adheres to a single, large seed. Usually the flesh is cooked with sugar and lime juice to make a preserve. This is a plant of very easy culture, and has merit as an ornamental shrub. Propagation is easy by seeds or cuttings.

The Mamey (Mammea americana)

Native to the West Indies, like the star-apple, the mamey is grown widely in tropical America as a dooryard tree. Mamey is the original Carib name, which sometimes appears in English as mammee-apple. In a few areas, such as Cuba, where the sapote is erroneously called mamey colorado, the true mamey is distinguished as mamey de Santo Domingo. It is primarily adapted to the tropical lowlands, rarely seen above 3000 ft., and thrives in areas of high rainfall, although enduring several months of drought on deep soils. A wide variety of soil types is satisfactory if drainage is good. The evergreen tree is tall and handsome, up to 60 ft. high, with leathery, dark green leaves, oblong in shape, from 4 to 8 in. long. Fragrant white flowers, 2 in. across, are borne on new shoots. The fruits mature about 3 months from bloom and are large, nearly round, from 4 to 8 in. long, with a slight nipple at the apex. The skin is thick, leathery, russet in color, and rough. It encloses a firm, yellow or reddish-yellow flesh, ranging in taste from sweet to subacid on different trees. From 1 to 4 large seeds, enclosed in stones like peach seeds, are imbedded in the flesh, which often adheres to them tightly. While the flesh may be eaten fresh, it is usually preferred in stewed form, when there is a resemblance to apricots, or as preserves or jam. Studies in Puerto Rico suggest that it may be unwise to eat large quantities of mamey, but no evidence of any injury has been reported. Propagation is by seeds.



Breadfruit (Artocarpus altilis)

In Polynesia, only the coconut compares with the breadfruit as a food source, but nowhere else does it rank so high in value. Native to the Malay archipelago, this was one of the food plants taken to the Pacific islands in prehistoric times, where it literally became the staff of life for the Polynesians--of far greater importance than it has ever had in Malaysia or India. Because of the enthusiastic report by Captain Cook's expedition on the ease with which the tree produced large quantities of food with little or no effort on the part of the natives, the British admiralty sent an expedition to Tahiti to introduce the breadfruit to the West Indies. The famous mutiny on the "Bounty" made the first attempt unsuccessful, but four years later, in 1792, Capt. Bligh made a second and very successful voyage which brought hundreds of breadfruit trees to Jamaica. Unfortunately, the fruit has never had in the West Indies more than a small fraction of the popularity which it has in Polynesia, and it is only a very minor food source anywhere in the American tropics, with Jamaica and Puerto Rico leading in production. This is strictly a dooryard tree; nowhere in the world has it ever been planted in orchard form. In Spanish-speaking areas the usual names are arbol del pan or panapén.

Like the mangosteen, the breadfruit is ultratropical in its climatic requirements. Not only is it intolerant of any frost, but it is likely to suffer injury when temperatures hover around 40°F. Only in the tropical lowlands, below 2000 ft., can it succeed. A well-drained soil is essential, and either abundant and well-distributed rainfall or irrigation in dry periods must be present for good production, although mature trees in deep soil tolerate several months of drought. Under favorable conditions, breadfruit trees may yield over 100 lb. of fruit annually.

The tree is a handsome evergreen, reaching 40 to 60 ft., with a thick crown of glossy green foliage. Leaves are very large, from 12 to

18 in. or more long and nearly as wide, deeply incised into lobes. The flowers are individually inconspicuous, but are produced in dense spikes of separate male and female flowers at the branch tips. The male inflorescence is club-shaped, from 6 to 12 in. long, and is shed by the tree after discharging pollen. The round female inflorescence, about 2 in. across at anthesis, develops into a round or oval fruit some 5 to 8 in. across, composed of the ovaries of the many flowers which made up the inflorescence. On maturing, about 5 months from bloom, the fruit turns yellowish-brown and has a thin but tough rind of rough texture like coarse sandpaper. The flesh inside is white and spongy in immature fruit, with freely flowing white latex, and is filled with starch. When ripe, the flesh is yellowish, soft, and aromatic, with no latex flow, and the starch is largely changed to sugar, although not so completely as in the banana. In Tahiti it was always used immature, while in Hawaii it was used ripe, but immature or ripe, the breadfruit is always cooked before eating, like a plantain. Usually it is baked or boiled. As in bananas, the protein content is very low.

Besides the breadfruit, which is seedless, the species contains a form with seeds known as breadnut or pana de pepitas. Tree, foliage, flowers, and fruit are very similar to the breadfruit in appearance, but the rind is covered with small spines. There is very little flesh, but a large number of brownish seeds about 1 in. long and 3/4 in. thick. These are very nutritious when boiled or roasted, having about 5% protein and 25% starch.

The breadnut is easily grown from seeds, which lose viability in a week or so, but the breadfruit must be propagated by cuttings. Traditionally, root cuttings have been used, pieces of root 1 in. thick and 8 to 10 in. long giving a high percentage of successful cuttings if laid horizontally in a well-aerated medium. In recent years, stem cuttings have been used with success, terminal cuttings with leaves removed being cut 12 to 15 in. long and the basal ends dipped in 1%



Hartmann, 1953

Most olive varieties need mid-winter mean temperature below 50°F in order to initiate flowers. All the California varieties behave thus, & they include most Mediterranean ones.

Agagnostopoulos (1956) indicates that there are in Greece a few olive varieties which do not have this chilling requirement.



## THE OLIVE

Though brought to the Americas by Spanish colonists at an early date, the olive has not been successful, commercially speaking, at any place within the tropics. In the valley of Leiva, Department of Boyacá, Colombia, a few trees still exist which are believed to date from Colonial times. There are also a few small groves in this valley, planted within the last century (this does <sup>not</sup> mean much when we are talking about olives; there are trees in Israel which are said to be 800 years old) which produce enough fruit so that one can, in favorable years, obtain a few pickled olives or a bottle of oil in one of the local tiendas (small shops) - just enough, really, to have encouraged further plantings from time to time. In the hope that varieties better adapted to this region might be found, the Colombian government imported a collection from California in the 1930s. The results were not satisfactory.

In southern Ecuador, old olive trees are to be seen in several valleys of the province of Azuay. They occasionally produce a little fruit. There are mature trees in the highlands of Guatemala which produce nothing.

These regions lie between elevations of 6000 and 8000 feet. Investigations by Professor Hartmann of the University of California have shown that olives, to produce satisfactory crops, need relatively cold winters, such as those of the Mediterranean region. Without sufficient cold you get nothing but handsome ornamental trees, excellent for planting in parks and along highways.

Unless there are unforeseen developments, it does not seem wise to undertake commercial planting of olives within the limits mentioned.

Gainesville, 16 March 1966

Dear Bob:

Dr Wolfe and I have been working on "Fruit Growing in Tropical America" in the following manner. He does a first draft on each subject, based on his own experience (in such cases as the avocado and mango, with which he had experience at Homestead) and then on the literature. We have worked this way, because he has been in touch with the recent literature and I have not.

Being a scholar, I sometimes think he has a more profound respect for the literature than I have, especially when it comes to accepting figures regarding areas in cultivation, production and some other matters. Where I have grave doubts, I am insisting that we hedge, by not mentioning figures. One example - but I am ahead of my story - is the figure on enclosed page 8, that ten million pounds of pili nuts are harvested in the Philippines each year.

To get back to the problem: I am enclosing what he has written about the Pili Nut. I have not re-written this as yet, and shall not do so until I have your comments - if you will be good enough to prepare some. You probably know more about pili nuts than any other man in tropical America - and I am not throwing any flowers at you, so don't blush and begin to argue. What I hope you will do for is *as siguiente*:

Go over this pili section carefully and make all the corrections you can, and, especially, add a lot of cultural information. I could add some but you can add much more. Per ejemplo:

We know the pili can be grown in Central America ~~upto~~ 2500 feet (he says 1500) and still produce good crops. I would not recommend it for commercial cultivation that high - at our latitude ~~it~~ would you. I do think nearer the equator, in a moist climate, we could safely say up to 2000 or maybe 2500 feet. What say? As for soil, I think it is rather obvious that it will grow better on fertile loams than on sand or stony clay. Any self-respecting tree would do so. I would say that it has done well in Panama and Honduras on loams and on clays - as at Lancetilla. I don't doubt that it would do well on sandy loams also?

Regarding the size of the tree, I think he is about right - 60 feet at Lancetilla, 30 at Zamorano which however is not pili climate, really. But he fails to mention that the tree is dioecious. Chice and I checked the trees at Zamorano once, and it was pretty close to 50-50, staminate and pistillate. Apparently Dr Wolfe did not find anything in the literature about the distribution of the sexes, nor that the pili is dioecious, but isn't that a fact? And wouldn't you say that, more or less, the distribution of sexes among seedlings is about 50-50. You probably know a lot about this.

I am not inclined to say the fruits are like giant olives. And as for the size of the nuts, I have in mind those trees at Lancetilla. Some produce nuts much larger than others. What would you say about this?

I don't know anything about the Manila elemi which the bark yields, since I have never heard or read of it; but this is a book about fruits not other products of the tree - e.g. lumber, - and I am inclined to omit this note.

Obviously his maximum yield of 10,000 lbs of nuts per tree is a typographical error which he did not catch. We can forget this; I will change it to 1000 though I don't believe it safe to use this figure, do you? And didn't the seedlings at Lancetilla, that nice little ~~tree~~ -



come into production before they were ten years old? Since it seems to me climatic conditions at Lancetilla are pretty nearly optimum, I would take the history of these trees as my standard, for bearing age.

What do you know about preparation of fruits for market in this instance?

I don't see just how the fact that "semi-wild" trees are abundant in the Philippines constitutes a bar to the use of budding or grafting. I would like to add a note about vegetative propagation, and you can doubtless give me this.

Beb, I think you feel that I do, that the pili nut can have a really good commercial future in our part of the world. If you do feel this way, let's put more experience and therefore more information in this book. I hate to ask you for this help, busy as you are, but you are the only man who can do it. I thought of the pili nut three days ago when Hugh and I went to see poor Joe Permar. He is just about the same as he was when we last saw him two or three years ago. Doesn't recognize anybody and of course doesn't understand anything said to him. I wish he could have given me his experience with the pili nut. I believe he is the first man in tropical America to have any real experience in growing this tree.

There is no reason to push yourself to get this information to me, as we will not go ahead with this chapter on "Nut Fruits" as Dr Wolfe has headed it, until I come back here for the summer. You might bring your comments up here with you, when you come thru on your way to Edinburgh, and leave them with Hugh, or if he is not here either (he has several short trips on the docket) you could leave them with Kathy Jones who is Dr York's secretary, ergo, makes care of most of Hugh's business also. Or you could leave them with Chris Gallagher in the Soils Dept. Doc Wolfe is going to Europe for a time - I don't know just how soon, and then to Michigan for a vacation during the summer. Prof Watkins is going in late April to Portugal, then later to the International Hort Congress in Maryland.

Ever yours,



NO LO DIGA - Escríbalo

FECHA: 13<sup>th</sup> April.

A: Doc. POPEHOE

I have tried to answer  
all the points brought  
out in your letter. I  
believe we are still very  
weak on cultural practices.

Please excuse this short  
note - we leave early  
tomorrow morning

DE Robert M. Mason

ESCUELA AGRICOLA PANAMERICANA, INC.

QUESTIONS AND ANSWERS CONCERNING  
SPECIFIC DATA ON PILI-NUT CULTIVATION

1. Elevations in Central America:
  - a) Preferably at elevations below 1000 ft.
  - b) Rainfall 60 inches or more and preferably well distributed.
  
2. Soil Preference: Light clays and fairly heavy sandy loams are preferred, will not tolerate light or coarse sands but resists poor drainage well.
  
3. Height of Tree: 60 - 70 ft. seems about right for Central America.
  
4. Dioecious Nature of Tree: I don't believe there is any doubt about this. Distribution at Zamorano is as follows:-  

Staminate:- 33    Pistillate:- 38

Total:    71 trees - % Pistillate    =    53.5%
  
5. Description of Fruit: large plum like? See attached "Introduction" paragraph 6.  
Size 6 to 7 cm long.
  
6. Description and Size of Nuts: Oblong, triangular, nearly pointed at the ends.  
About 12-16% (dry wt) is kernel.  
See also tables I & II attached.
  
7. Manila elemi: is an important by-product of the tree. Authors should use their own discretion whether this is worthy of mention or not.

8. Yield of nuts (endocarp plus kernel) per tree: 75 - 100 lbs.  
= kernels per tree:- 25 - 33 lbs.
- 1000 lbs. would be high even for whole fruit. If you use whole fruit above figures, for nut and kernel would be multiplied approx 4 times 4,000 - 5,000 fruits per tree is a fair figure.
9. Bearing age: Based on my experience here in Honduras I would say 7 - 8 yrs old for first crops
10. Preparation of Fruits for Market: As a whole this merely consists of removal of the pulp (pericarp) prior to marketing.  
Several methods of pulp removal were tried by Austria and may be summarized as follows.
- 1) Soaking of the nuts in water heated to a temp. of 40° - 50° C was most practical and recommendable.
  - 2) At water temp. below 40°C the removal of the husk was greatly delayed.
  - 3) At water temp. above 50°C the nuts in storage became rancid in a short time.
  - 4) At 80°C the kernels became rancid in a month and the embryos were killed.
  - 5) At 60°C about 50% of the nuts in storage got rancid in 6 mths.
  - 6) At 40°C the nuts remained in good condition for a year or more.
11. Vegetative Propagation: If we are to get commercial yields this is a must. ie. the need to reduce the number of male trees per acre plus the need for selection of high yielding trees based on kernel weight and not whole fruit weights. (See introduction #7 attached.)  
Experiments at Lancetilla proved shield budding to be the best with patch budding a close second. Rootstocks used where of C. ovatum seedlings but others such as C. album and C. pinela could be tried. Since the tree does well on its own roots there seems no reason for not using C. ovatum.



INTRODUCTION (4)

2 | The genus Canarium of the family Buseraceae is native to the Philippines and East Indies. It has some 80 species, about ten of which bear edible nuts. (1)

3 | Canarium ovatum (Engl), the pili nut of commerce, has often been exported from the Philippine Islands in considerable quantities, up to 1,186 short tons per year at one time (1955). Total production in the Philippines that same year was 4,800 tons with a value of \$350,000 (U. S. dollars) (4).

4 | C. ovatum is a fairly large tree growing to a height of about 20 meters and a trunk diameter of 40 cm. Leaves are alternate compound with opposite, smooth leaflets, rounded at the base and pointed at the tip. The leaflets are from 10 - 20 cm. long.

5 | The species is dioecious, with the flowers borne in rather large terminal clusters. The ovary contains 3 locules, each with 2 ovules but nearly always all but one of these 6 ovules fail to develop. Two-seeded or three-seeded fruits are rare.

6 | Fruits consist of a single, nearly cylindrical, oily, pleasantly flavored kernel, a hard thick endocarp and a thin layer of soft pulp which has a glossy skin, dark purple when ripe. The edible kernel, rich in oil, has a flavor resembling that of sweet almonds (2, 4).

7 | Since the dioecious nature of the tree makes vegetative propagation almost imperative, the systematic selection of high yielding trees for scion material becomes a logical first step. Gonzalez and Bunoan (3) working in the Philippine Islands have

shown that great variation does exist in the fruiting characteristics of seedling pili nut trees.

8 | However, since it is only the commercially valuable kernel which is of economic interest to us, the ratio of kernel to whole fruit can, on occasion, have greater significance than the yield of fruit per tree.

The object of the present investigation was to select ten representative trees from a group of 71 growing at the Escuela Agricola Panamericana, El Zamorano, Honduras, and to establish the percentage yield of kernel to whole fruit on a weight basis.

Since pili nut flavor is thought to depend largely on oil content an additional check on the oil content of each sample was carried out by a group of students under the supervision of Dr. Abdul Bari Awan.\*

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MATERIALS AND METHODS (5)

All trees in the group were numbered for identification purposes and their selection was made on the basis of the following criteria:

- 9 | ← ————— 1. Vigor and crown spread (5a)  
 2. Estimated fruit yield  
 3. Size and shape of fruits

From the ten trees selected in this fashion 100 fruits were harvested from each on February 4, 1965.

\*Professor of Soils, Escuela Agricola Panamericana.

TABLE I

Comparative weight, in grams, of component parts  
of Pili Nut (Canarium ovatum) fruits\*

<u>Selection</u>	<u>Whole fruit</u>	<u>Pericarp</u>	<u>Endocarp</u>	<u>Kernel</u> (ENDOSPERM)
B. 1	28.92	21.28	5.92	1.72
B. 3	43.66	36.94	5.25	1.47 <i>Smallest</i>
B. 5	25.22	17.79	5.65	1.78
B. 8	26.68	19.79	5.29	1.60
B. 10	23.54	15.79	6.01	1.74
B. 18	26.06	18.31	5.94	1.81 <i>Largest</i>
B. 21	27.24	19.37	6.11	1.76
B. 28	23.82	16.77	5.32	1.73
B. 34	30.60	22.26	6.66	1.68
B. 39	32.34	22.84	7.80	1.70

\* Based on samples of 100 fruits per selection and later reduced to a unit basis.



TABLE II

Relative weight of component parts  
of Pili Nut (Canarium ovatum) fruits  
(Expressed in % of whole fruit)

<u>Selection</u>	<u>Pericarp</u>	<u>Endocarp*</u>	<u>Kernel</u>
B. 1	73.58	20.47	5.95
B. 3	84.61	12.02	3.37 <i>Smallest</i>
B. 5	70.54	22.40	7.06
B. 8	74.17	19.83	6.00
B. 10	67.08	25.53	7.39 <i>Largest.</i>
B. 18	70.26	22.79	6.95
B. 21	71.11	22.43	6.46
B. 28	70.40	22.34	7.26
B. 34	72.75	21.76	5.49
B. 39	70.62	24.12	5.26

\* Includes hard stony layer formed by hypodermal cells of endocarp.

TABLE III

Per cent oil content (Dry basis) of kernels,  
by weight, from ten selected trees  
of Pili Nut (Canarium ovatum)

<u>Selection</u>	<u>Per cent oil</u>
B. 1	59.15
B. 3	71.25
B. 5	66.45
B. 8	56.85 <i>lowest</i>
B. 10	71.40 <i>highest</i>
B. 18	69.70
B. 21	68.70
B. 28	62.35
B. 34	69.20
B. 39	64.55

He has seen Lychee, Pineapple, Guava  
Sapodilla, Papaya

Gainesville, 22 Sept 1966

Dear Johnny:

Those notes on the chapters sent you are pregnant with pertinent criticisms. Good, but they are really excellent. Of course I may differ with you on one or two points; it would make me out a nincompoop if I didnt.

First, about weights and measures, metric vs English. We have debated this pro and con and vice versa. Finally decided to use English in the English edition, Metric in the (later) Spanish. Lots of our readers who know English ~~are~~ not accustomed to using the metric. We have to stick to one or the other. I think the latinos who will read the English edition will also know English measurements. And remember, the book is not only for latinos; how about our brethren in Jamaica Belice, Trinidad und so weite?

I dont like "the common guava" either, but after all the cattley is a guava. Incidentally, I want to get away from those headings "The mangos and its relatives", por ejemplo. I am inclined to say "The guava, and some other myrtaceous fruits" or something like that. You question bringing in the delicious pitomba. You, of all persons! Frankly, I think Ud ha planteado un problema. Or as Jaime Villegas used to say, Doctor, is a question! Shall we try to include all the tropical fruits which anyone might ask about (except those folks who have read Hoehne, add who floored me that time at the Rare Frt Council) or shall be limit ourselves to those seem really worth while as fruits. In my Manual I took in just about everything, too many of those Brazilian myrtaceous fruits, por ejemplo. I was not in fvaor of including the jambolan in the present case. El Doctor thought it ought to go in. Nobody is going to plant the jambolan for its fruit. Nor the pera do campo nor Myrtus tomentosus. But there many, many instances where we



are up against de gustibus non disputandum. If we dont include a certain fruit, we will be up against something worse - illegitimus non carborundum. I dont think we ought to include the pitomba; Peg thinks it is nectar and ambrosia; and if we dont include, Joao Povo will say why/did you leave out the best fruit of the campos of Minas Gerais. Hombre, I think I may just as well give up and put in what I think should be in, add take the consequences.

The other guava comments I think are good. Wolfe did this chapter, most of it, ex Ruehle's bulletin. The reason I gave more space to grumixama than to Malay happle (incolunt vocantur) is that I will eat grumixamas, a few at a time, but I wont eat Malay happles at all. Les pauvres diables out in Oceania eat Malay apples because they dont have a chance to eat grumixamas. But seriously, I suppose the Malay apple should go in, unless we adhere to the doctrine of only include fruits which are really worth growing on a considerable scale.

Re Manilkara, I propose to check all the names before we finish the MS (en passant, et apropos de cela) we are going to have to make another draft of every chapter; I can see that, and I fear it is going to be up to me to do it, and only the good Lord, in his infinite wisdom, knows when I can get thru. But I propose this - just as I have insisted Wolfe do with Citrus: use first the name that seems to be accepted by taxonomists as of today, but follow by the botanical name everybody knows. Manilkara is a good example.

Re sapodilla varieties, maybe we had best forget them. But I do like prolific, because it produces sapodillas. But we can hardly say there is a variety well-known to horticulture today.

That zapote business; if we use mamey sapote, we are mixing our drinks, or languages. A carib word with a nahuatl. I dont think King Nezahualcoyotl ever said "bring me some mamey zapoti, ya ya". In Central America we use sapote, no mas; in Cuba it is mamey colorado,

verdad? and you insist that in Mexico it is mamey sapote. I wish I had beside me the 1915 Proceedings of the American Pomological Soc. (I think that was the issue) in which I published a list of tropical fruits with common names which ought to be standardized. This has been followed by quite a few writers; I followed it in my Manual, where I used "sapote" no más. We will fight this out when next I see you. Marquis of Queensbury rules.

Allright: Diospyros digyna but D. ebenaster synonym. And I have just read a Mexican publication where this is one of the most delicious fruits of the tropical world. And I liken it to axle grease. When Doctors disagree, who shall decide?

Note on Tacsonia, accepted; but I think I will boost this fruit a little more for 10 to 15 thousand feet in the Andes. I like it, so do all other bogotafios. I'd like to wet your whistle with a sorbete de tacson, as prepared by doña Mercedes at Hotel Victoria, Bogotá.

Now as to our bete noire, aquel Lychee. Why didnt you tell me how to make it bear a good crop every year. Of course, you think you have told me - plant Mauritius. But Gordon Palmer who wrote that paper on lychees in S Africa says that it is admitted to be an alternate bearer over there. I think I will say, however, that it may be the answer; the only thing is, a given lychee variety may bear better in one place than in another. Aber das macht nichts aus, we'll boost it. Evelyn Smiley says their lychees, Brewster, have definitely been alternate bearers. I have the feeling that alternate bearing is more or less normal, just as it is with Guatemalan avocados. But we have that confounded Hass which insists on bearing every year - and I guess Anaheim too. Maybe even Taylor. At Guatemala City Garcia Salas has four or five trees which I have them about 1928. One tree bears fine crops occasionally; the others hardly ever bear. T W Young says he has worked on all the factors he can think of and total, he hasn't



hit on the secret of lychee production. I am inclined to bet more on a long dry season at about 3000-4000 ft in Central America than any other combination of factors. Prem Singh (1st cousin of 110,000 other Singhs) said at San Salvador that in northern India it is a regular bearer. That might be a climate something like Zamorano? Allright, I'll tone down on the hardness feature; it isn't a problem in tropical America anyway. They do have lychees in Orlando, but I suppose Long Jim Byers would say they get froze pretty often. (Not for quotation). I will cut out reference to Chinese varieties we don't have fruiting satisfactorily in this part of the world. Nobody could get hold of any trees, anyway, and this is a point: not much use mentioning varieties which are not available to tropical horticulturists, tho I probably shall mention Amini and Sandersha, whether you and doña Isabel like them or not. They are the bearingest Indian mangos we have, and like the wine from Oporto, Spain, which I bought from the Chinaman in Panama, some folks like them.

As Bill Barker of Tehuantepec used to say, Basta con lo suficiente. I wish I could get down there again, to go over things with you and others, but as a matter of fact it will be more worth while a bit later. The deeper I get into writing this book, the more I feel that I must give time to clearing up (as far as possible) quite a few questions. I want the book to be just as sound as possible, and we can't get it all out of the literature. I am trying to put myself in the shoes of Julian Gonzales who lives in the Republic of Santa Ana, El Salvador; and I think I must sometimes stick to my own experience which as you know is reasonably extensive, rather than Ram Chunchunder Bhowe of Alhambra, whose observations in Uttar Pradesh may not always be applicable in the República de Santa Ana. Oh, what a job this is! Again, when doctors disagree, who shall decide?

Many many thanks, Juanito I'll send some more shortly, including

your pet. Annonacaeae. Ever yrs



Hugh has pointed out that we haven't mentioned the Hilo subvariety of Smooth Cayenne - Tailored to fit the can. I can't find much on this in the literature - probably a Trade secret. What do you know?

Also we have failed to mention paper mulch. This will be added. And Hugh says we should mention Iron among the nutrients. De acuerdo? Si!

Comments on chapters of Tropical Fruit book sent to J.P.

Chapter on pineapples - would it not be better to describe the morphology of the plant before the varieties so that the reader will know what slips and suckers are? Pg 16 - last line, as an example data from Australia may be considered for Smooth Cayenne.

Chapter on Guavas - shouldn't the title be "The Guava and its relatives?" I hate to lump the guava and the cattley together as Guavas, besides you don't mention the Para guava in the text, much less the other species of *Psidium*. I don't think the name guava needs to be modified by the word common.

pg 1 line 3 - pomologically the guava is the most important member of the family (no need to say "tropical members" as there are no others).

Pg 2. title - The Guava

Pg 3. line 2 - most tropical trees don't sprout up from roots.

" " " 9 - I have seen pretty good production of guavas in our glade lands where they are in standing water part of the year - where have you found production data on poorly drained soils versus well drained soils?

Pg 10 last P. the various named varieties all come true from seed - I have never seen any variation among seedling jaboticabas from the same parent.

Pg 12 - line 13 - I have always been told that the black and red forms of pitenga would not come true to seed. I have no personal experience - however I have five plants from seeds of red fruit which may fruit next year.

pg 13. 1<sup>st</sup> sentence too long. Why give so much space to *grumixema* when you only give 1 sentence to malay apple. Certainly the latter is more important horticulturally, even in tropical America. The same is probably true of *jambolan*. I would be inclined to exclude everything but guava and jaboticaba from this chapter. The *grumixema* and



pitomba aren't of any importance and they never will be.  
Chapter on Sapodilla - botanical name is Manilkara zapota  
(syn. Acras zapota).

pg 4 - line 11 - Russell variety almost extinct in Florida -  
probably should not be mentioned. I understand that the  
Ponderosa variety is no larger than the Prolific, but I  
have never seen it.

pg 5 - I think we must ~~sapote~~ qualify sapote  
for the mamey sapote. There are too many sapotes to  
have one that is not qualified. Besides as you mention  
sapote is a generic name in origin, it does not refer to  
a single fruit like "guava". If you don't want to  
call it mamey sapote call it red sapote or something of  
the sort. True sapote or common sapote sounds  
ridiculous to me because this would make the others  
false or rare. The South American sapote is  
probably grown over a wider area than this one.

Pg 9 - line 22 - correct botanical name for black sapote is  
Diospyros digyna.

Pg 10 - line 22 - we got quite a few ripe fruit and seeds in the  
Antigua market in July when I had the family there 3 yrs ago.

Chapter on papaya -

pg 6 seeds do not germinate well in cool weather nor do  
young seedlings grow well in cool weather. In areas  
subject to cool winters such as S. Florida, N. Mexico  
etc. seeds must be planted in warm weather or else greenhouse.

Bottom of page 6 - and all thru manuscript. - I don't know  
how many Latins know what  $\frac{1}{2}$  bushel is. Why don't  
you use kilos? In fact how can you justify using  
anything other than the metric system anywhere in the book?

pg 17 - Tacsonia won't grow in S. Florida - it rapidly  
dies out just as does *P. ligularis*.

Chapter on Lychee -

pg 2 - lychee is not nearly so frost resistant as orange or  
consider it about equal to the  
over



Mango in frost resistance - I think Fla + Calif. experience prove this - I asked Oppenheimer about it, and he said lychee and mango are about equal in frost resistance in Israel.

On lychee varieties - the No Mai and Hak ip have no promise in our area - they have been fruiting here for at least 20 years but seldom produce a worthwhile crop. The Mauritius is the only one here that has shown regular bearing - the parent import at Homestead hasn't missed a year in the last six or seven except once when all the flowers were frozen. Unfortunately it hasn't been tried enough places or long enough in other locations in Florida.

pg 12 - Melicoccus bijugatus is the correct latin name. Marcottage of this species is easy if large diameter wood (2" and up) is used. I have gotten good roots in 6 weeks on a marcott at the Montgomery foundation.

# Wailuku Hotel

WAILUKU, MAUI, T. H.

26 Sept. 1966

Dear Uncle Wilson,

Thanks for your long letter of 22 Sept. which I found thought provoking.

To begin with, I feel the book you are writing is good and will be very useful even though I don't always agree with some of your policies. For example I don't think use of the English system of weights and measures can be justified. One country after another is switching to the metric system - we will too, eventually. Every educated person who will use your book will be capable of using the metric system.

Second, in regard to the lerd fruits such as grumixama and pitomba and Cattle - they are of no commercial importance now and they never will be. If the aim of the book is to help the fruit grower, these fruits are a waste of space. If these are included you may be able to sell a few more books to the limatic fringe but you won't help develop an avocado or mango industry in Costa Rica.

Now more about the guava - I don't agree with you about the cattley - it's no more of a guava than the pera do camps is a pear or the rose apple is an apple. I don't see how you can consider it seriously. It's grown strictly as an ornamental most everywhere and the fruit is more of a nuisance than anything else. Why should a serious fruit grower be led to believe that this is a type of guava?

Otro comentario about guava - you describe techniques of grafting this plant. I don't question that it can be grafted, but it is difficult and serves no practical purpose. Any possible gain from grafting will be lost by the necessity of continuous suckering. It is easy to make air layers, so why graft? I have never seen an orchard of grafted guavas anywhere, have you? I don't think anyone who knew the crop would try it.

Yours truly, John





September 24, 1966

Dr. Wilson Popenoe  
1722 N.W. 2nd Avenue  
Gainesville, Florida

Dear Doc:

Thank you for your long letter of Sept. 17th, which has just arrived, and also for that of Sept. 4th which, although it did not require a direct answer, I wish to acknowledge and let you know how much both Rie and I enjoyed having all your news. We were also pleased to have news of the Russells, Dorothy Allen, Hugh and Dr. York and their frequent and hectic travels. As you say Hugh is setting a very fast pace and I hope he takes time to rest occasionally.

To answer fully your questions concerning sapucaya nuts will take some thought and I may have to get Chico's firm to supply some of the latest details on the La Cabaña planting. What I can say now is that that species, and the one on the wet hillside by the nutmegs in Lancetilla, are Lecythis elliptica and came originally from Holger Johansen of the Canal Zone (in May 1926). The true sapucaya nut L. zabucao was sent to us, as seed, much later (1953 approx.) by our old friend B.A. Krukoff. The fruit and seeds of this are, as you know, much larger. So far crop yields of the latter have been sparse and erratic at Lancetilla.

Speaking of Lancetilla I agree that Dr. Dunlap is the man to tell that story at the Symposium and, although he hasn't sent in a title as yet, I will send him your suggestion. Also we will put you down for "Techniques of Agricultural Exploration".

Do you know that the Smithsonian Institution have renewed their interest in Lancetilla? We had the visit of Dr. David Challinor, Special Assistant in Tropical Biology at S.I. here a week ago to discuss the project with Bert and I. He is a most interesting and enthusiastic type and I feel more confident that something will come of it this time. I asked him to look up <sup>you,</sup> and Hugh, in Gainesville if he has a chance. In any case we will invite him to the Symposium to meet "all the folks".



-2- Dr. Wilson Popenoe

Tomorrow Galo Plaza arrives for a two day visit and also we have a barbecue for 400 so this promises to be a lively week-end.

More later, meantime our best regards to Hugh and yourself.

Sincerely,

*Bob.* [Armour]



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UNIVERSITY OF FLORIDA  
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

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REPLY TO:

205 Rolfs Hall  
Gainesville, Florida 32601  
September 19, 1967

MEMORANDUM

TO: Dr. Hugh L. Popenoe  
120 A McCarty

We thought you would be interested in the attached news clipping from the Miami News Food Section. You may have this for your files if you wish.

Sincerely,

BETTY JEAN BRANNAN  
Assistant Director  
Home Economics Programs

jc

Attachment

[Attached article on use of limes,  
removed [the Miami News, Food  
Section, Thursday, Aug 31, 1967]