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About the Institute

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.

Preface

The history of fruit growing in tropical America commenced with the second voyage of Columbus. The historian Gonzalo Fernandez de Oviedo tells us (k526) that the first Spanish colonists brought oranges, grapes and other fruits to Hispaniola, while the great Cortés, in his fourth letter to the King, asked that no ship be permitted to set sail for Mexico without bringing plants and seeds of those crops to which the Spaniards were accustomed in the Madre Patria but did not find in Mexico.

At the same time Oviedo, who was the first chronicler to write at length on the natural history of the American tropics, described in detail many of the excellent fruits which had never before been seen by Europeans. Among these were the pineapple, the avocado, the anonas, the papaya and the guava, a galaxy sufficient to form the basis of a fruit economy, in marked contrast to the paucity of good fruits which Europeans found in more northern latitudes.

In spite of climatic conditions which made possible the cultivation of ~~fruits~~ native fruits as well as many of those from the North, the development of fruit culture in tropical America has been slow. It was only toward the end of the past century that things really began to happen. Commercial production of bananas came first. If measured in ^{tons placed upon the market} ~~tons~~, fifty years ago the Gros Michel was ^{banana} ~~probably~~ ^{one of} ~~the~~ most important fruit ^{varieties} ~~varieties~~ in the world.

It was not until 1900 that ~~the art of grafting began to be~~ ~~practiced~~ tropical fruits, on a commercial scale, began to be propagated by grafting. A little work had previously been done along this line in the West Indies, ~~together with the introduction of~~ ^{selection}

based upon the selection of superior seedlings of local origin, and the introduction of grafted varieties of ~~such fruits~~ the mango from the Old World. ~~It~~ It should be remembered, however, that the aboriginal inhabitants of tropical America had ~~not~~ improved many of their fruits through seed selection, thus raising the general level of the species to make the product of greater value to man. The pineapple is probably the best example of improvement through vegetative propagation, which was ~~not~~ possible because superior forms were easily ^{grown from} propagated by suckers. The art of grafting does not seem to have been known - or, at least, practiced, by the aboriginal Americans.

~~xxxxxxThe great interest in fruit production which has developed throughout tropical America during the past half century~~

The situation today is something like this: Commercial production of citrus fruits is extending rapidly. Banana culture has spread into several new regions, and ^{many} more growers are involved than was the case half a century ago. Pineapple culture prospers in several countries. Avocados and mangos are beginning to be planted commercially in several tropical countries, stimulated by the importance which these fruits have attained commercially in California, Florida and several ~~of~~ regions in the Old World. The pressing need for crop diversification is causing horticulturists to devote attention to fruits which have not yet been commercialised on an extensive scale. ^{many} ~~fruits~~ ^{minor} ~~fruits~~ have been included.

All this interest and activity draws attention to many problems, ~~some of the most serious~~ One of these is the local supply of good nursery stock. ~~It~~ Throughout tropical America, nurseries producing well-formed, vigorous, accurately labelled nursery trees are few and far between. ~~This situation exists in the~~ ~~xxxx~~ In past years

have no commercial importance and may never have any, but are of interest to the home gardener.

horticulturists have depended largely upon imported stock. Little material was available locally, and there was a lack of confidence on the part of buyers. This situation is changing, and one of the major purposes of this book is to assist nurserymen regarding best methods of propagation, the choice of varieties of each ~~fruit~~ fruit and the exercise of great care in labelling. As regards commercial fruits, it must be remembered that new ^{varieties} comes onto the market ~~from~~ ~~time~~ ~~to~~ ~~time~~ from time to time. This is especially true of fruits which are relatively new, so far as commercial cultivation is concerned. The planter should pay utmost attention to this subject before he lays out his orchard.

The selection of land for orchard plantings is another ~~subject~~ subject matter of great importance. Many tropical horticulturists do not realise the ^{necessity} ~~importance~~ of ^{investigation} ~~good drainage~~ texture and depth of soil; ^{structure} ~~good drainage~~; ~~and~~ irrigation; and the need of fertilizers. These subjects are treated in the Introduction to this book; the tropical horticulturist is urged to give them the ^{careful} ~~study~~ study they merit.

Pruning is often neglected, especially in the first few years of the life of the tree. In other instances it is overdone, largely because insufficient experience has not been accumulated in connection with the ~~cultivation~~ culture of numerous fruits.

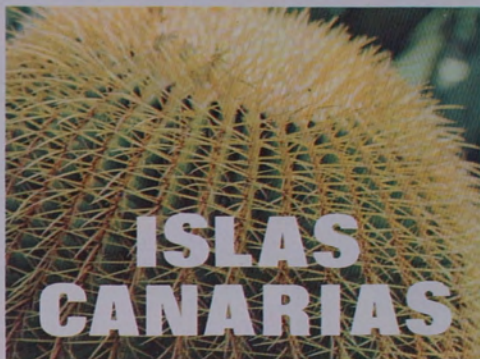
This book is based largely upon work done ^{careful} ~~during the past~~ ~~25~~ ~~years~~ at Lancetilla Experiment Station and the Escuela Agricola Panamericana in Honduras; and ~~upon~~ work at the Subtropical Experiment Station of the University of Florida at Homestead, and the several plants' Introduction Gardens ~~in southern Florida which have been~~ of the U.S. Department of Agriculture in southern Florida. Lancetilla, which was founded in 1925 by the United Fruit Company, has the largest collection of tropical fruits in the America, so far as species are concerned; the Subtropical Experiment Station at Home-

stead the largest collection of varieties of the Avocado, mango and several others. Basic work on vegetative propagation of tropical fruit trees was done some years ago at the South Campus of the University of Miami (Florida) by S. John Lynch, Roy Nelson and others. Other sources of information are too numerous to mention, but it should be added that the material in this book on Temperate Zone fruits in the tropics - a subject to which serious attention has only been given in the last 25 years - has been accumulated mainly in the highlands of Guatemala and at Escuela Agricola Panamericana in Honduras.

Finally, we owe a special debt of gratitude to the following, who have supplied ^{much} information used in the preparation of this book or who have ~~criticised our manuscript regarding these fruits~~ ~~which~~ reviewed chapters which they were particularly qualified to criticise.

(Here will follow a list)

spain



**ISLAS
CANARIAS**

{Found loose}

ORDER OF TREATMENT

- Introduction the Chapter
- Origin and History
- Botanical Characteristics
- Races and Varieties
- Climate and Soil
- Propagation
- Planting and Culture
- Pests and Diseases
- Harvesting - where appropriate

TROPICAL AMERICAN FRUIT CULTURE

Hugh will do II, III and V
 perhaps better at the end of book.

I.	INTRODUCTION	2 pp
II.	CLIMATES AND SOILS OF THE AMERICAN TROPICS	8
III.	FUNDAMENTALS OF DRAINAGE AND IRRIGATION	10
IV.	GRAFTAGE, AND OTHER METHODS OF PROPAGATION	10
V.	CULTURAL PRACTICES	10

Spacing and Planting. The Management of Tropical Soils: tillage, mulching, green manures and fertilizers, including the use of major and minor elements. Pruning, with especial reference to common mistakes.

4094

THE FRUITS = 200 pp

✓ 1.	The Citrus Fruits	30 p
2.	The Banana and Plantain	10
✓ 3.	The Pineapple	10
4.	The Avocado	15
5.	The Mango and its Relatives	15
✓ 6.	The Sapodilla and Its Relatives	10
✓ 7.	The Cherimoya and Its Relatives <i>Other Annonas</i>	6
✓ 8.	The Lychee and Longan - The Rambutan and Others	10
✓ 9.	The Guava and Its Relatives <i>Other Annonas</i>	10
✓ 10.	The Papaya and the Passifloras	10
11.	Miscellaneous Fruits	16
	The Kaki or Oriental Persimmon	4
	The Breadfruit	2
	The Mangosteen	2
	The Fig	4
	The Pejibaye	2

The Durian and a few other Asiatic Fruits 2

Most of the others treated in the "Manual",
but very briefly.

12. The Nut-bearing Trees 15 pp.
 The Macadamias 3-4
 The Pili 2
 The Cashew 2 *referring to description under Mango*
 The Walnuts 2
 The Pecan 3
13. Temperate Zone fruits in the Tropics 20 pp.
 a. Apples, ⁶Peaches, ⁴Plums and ²Pears. The Loquat ²
 b. The Small Fruits, ²Grapes, ²Strawberries, ¹Blackberries
 and ²Raspberries
14. The Care and Handling of Fruits for Market.

APPENDIX

The Classification and Description of Fruit Varieties (Systematic Pomology)

Index 4-5M.

Minor Fruits under each heading to be given very brief treatment
at the end of each chapter.

Perhaps a brief note somewhere as to Why experience to date in tropical
America has been very discouraging with respect to the following:
Olives, dates and pomegranates.

Following sequence to be observed with respect to each important
fruit: Origin and History, Races (where they exist) and Varieties;
Propagation; Planting and Culture; Pests and Diseases.

Climate and Soil,

*A note on fruits
not successful - olives etc*

FRUIT GROWING IN TROPICAL AMERICA

Wilson Popenoe

Director Emeritus, Escuela Agricola
Panamericana

and

Herbert S. Wolfe

Professor of Horticulture, Emeritus
University of Florida

FRUIT GROWING IN TROPICAL AMERICA

Introduction

The Climates and Soils of Tropical America. Some notes on the management of tropical lands. Common cultural mistakes. The proper use of drainage and irrigation.

1. The propagation of Fruitbearing plants in the tropics.
(Seedage; cuttings; air-layering; graftage)
2. The Citrus Fruits
3. The Banana and Plantain.

~~The Pineapple.~~

4. The Pineapple
5. The Avocado
6. The Mango
7. The Sapodilla and its Relatives
8. The Cherimoya and other Annonas
9. The Lychee and its Relatives
10. The Guava, and other Myrtaceous fruits
11. The Papaya and the Passifloras
12. The Fig, the Kaki or Oriental Persimmon and the Loquat
13. Miscellaneous ~~Tropical~~ Fruits

14. Temperate Zone Fruits in the Tropics

Discussion of each fruit to be in the following sequence:

Origin and History (briefly). Races (where they exist) and varieties. Climate and Soil. Propagation. Planting and Culture. Pests and Diseases.

6. The Sapodilla and its Relatives
7. The Cherimoya and Other Annonas
8. The Lychee and its Relatives - the longan, the rambutan, the pulasan, the mamoncillo
9. The Guava and other Myrtaceous Fruits
10. The Papaya and the Passiflora
11. The Nut Fruits - Macadamia, Pili, Cashew, etc

~~12. Miscellaneous Tropical Fruits~~

~~The Fig, the Kaki or Oriental Persimmon, the Loquat,
the Mangosteen,~~

12. The Fig, the Kaki or Oriental Persimmon, the Loquat
13. Miscellaneous Tropical Fruits

The Mangosteen, the Durian, the Pejibaye and

a dozen
several others. *Brief treatments.*

14. Temperate Zone Fruits in the Tropics

An important and lengthy chapter, because of the rapidly developing interest in the cultivation of these fruits in the tropical American highlands

The apple, the pear, the plum, the peach, and the small fruits - grapes, Strawberries, Blackberries and Raspberries

Discussion of each fruit to be in the following order:

Origin and history (briefly) Races (where they exist) and
varieties. Climate and Soil. Propagation. Planting and Culture.
Principal
Pests and Diseases.

FRUIT GROWING IN TROPICAL AMERICA

Introduction

The Climates and Soils of Tropical America. The proper management of tropical soils. Common cultural mistakes. The importance of drainage and irrigation. *Fertilizers and their use*

The Fruits

1. The Citrus Fruits - oranges, grapefruit, lemons and limes and some of the hybrids.
2. The Banana and Plantain. The basic principles which the small grower needs to know. A complex subject, and no attempt is made to into the ~~highly~~ technical problems, *of the great commercial producers.*
3. The pineapple. *Same as for the banana* This is such an important crop that no attempt is made to go into great technical detail.
4. The Avocado. Because of its growing importance and the lack of information in tropical America, this is dealt with in some detail.
5. The ~~Ma~~ngo. Remarks re the avocado apply to this crop. In both cases, the subject of varieties is vital.

Coming, as they do, from Northern climates, these fruit trees need cold weather to complete their normal biological cycles. With the oncome of cool weather in autumn they go dormant. The advent of warmer weather in early spring breaks the rest period, and they blossom and break into growth. If they do not sufficient cold weather to complete the normal cycle they fail to go dormant, they ~~may~~ fail to break into normal growth when the cool season passes, ~~and they may fail~~ which is technically termed "delayed foliation", and consequently to produce normal crops of fruit.

The amount of cold weather necessary to induce normal development and productiveness varies not only from species to species but also from variety; ~~and still more important~~ In tropical America, the lack of sufficient cold weather may be offset in part by other factors, of which the most important seem to be light and moisture. ~~The situation, as presently understood, may perhaps be summarized as follows~~ It is best, therefore, not to be guided by ^{wholly} experience in the United States, where it is current practice to state that ~~xxxx~~ ~~xxxxxxx~~ ~~xxxx~~ apples in general require a certain number of hours below 45 degrees F. to be grown commercially with success, or, as in the case of peaches, that some varieties need only 250 hours below 45 degrees, while others require as many as 900 hours. This is not so simple as it seems, for it has been pointed out that if the coldest hours, which ~~usually occur~~ usually occur during the night, are followed by warm hours during the day, or cold periods of several days or more are followed by warm periods, the statement that 400 hours (for example) does not hold good. And it has also been demonstrated that cold weather must occur before a certain date in late winter if it is to be most effective.

All these points are mentioned just to show that factors beside a given number of hours below 45 degrees in a given instance, does not tell the whole story. ~~xxxxxxxthe situationxxx~~ Mean temperature during the months of coldest weather may be a more accurate guide, especially in the tropics where records of maximum and minimum daily temperatures are not available everywhere.

The two other factors mentioned, light and temperature, seem to play an important part in the tropics - to a greater degree, perhaps, than in the colder parts of the United States and Europe. If this is not true why is it that in the vicinity of Lima, Peru, which lies at approximately the same latitude south of the Equator as Guatemala lies north, apples are grown successfully at sea level, while in Guatemala the same varieties require 6500 feet? Lima is said to have an annual range of temperature between 55 and 85 degrees F. Even ~~taking the xxxxxx~~ during the coolest part of the year, the mean temperature therefore can not be ~~xxx~~ lower than 55. But what about the factors of light and moisture?

The climate of the South American coast which comes under the influence of the Humboldt Current is unique. The sky is overcast during most of the year - intensity of light is therefore extremely low - and rainfall is practically nil. The necessary rest period can be produced in part by limiting the application of water to appropriate periods. The lack of brilliant sunshine during critical months also helps.

From all this it cannot be assumed that the temperature factor can be ignored in general. The behavior of the temperate zone fruits in Ecuador, Colombia, and elsewhere certainly show that this is not the case. In Guatemala ~~xxx~~ none of the important commercial apples of the Temperate Zone seems to be successful below altitudes of

about 6500 feet, and since ~~altitude~~ temperature is closely correlated with altitude, it seems to safe to say that ~~altitude~~ temperature, best express in terms of the mean temperature during ~~the~~ critical months, is the first thing to take into considerations. ~~But light and moisture~~ But favorable conditions of light and soil moisture may definitely be helpful where a region is on the borderline as regards cold weather.

Sweet fruit

In most parts of tropical America, it is wise to proceed on the following basis: apples require the most cold, but there ~~is~~ are very important differences from one variety to another. They produce the best fruit where ~~there is~~ there is sunshine and relatively high temperatures during the ripening season. ~~Pears,~~ Pears, of the European varieties (which are by far the finest from the dessert standpoint) ~~require about the same~~ succeed best at about the same altitudes (i.e., need about the same amount of cool weather-) as those commercial apples which have relatively low chilling requirements. ~~And pears, as was pointed out by Robert Ticho, are more successful in cloudy or foggy regions than apples.~~ The Japanese pears and their hybrids have a much lower chilling requirement than ~~apples~~ the fine European varieties (Bosc, Comice and others) and in numerous parts of tropical American are successful at elevations as low as 5000 feet.

The European ~~plum~~ plums have not been successful anywhere in tropical America, so far as has been observed, but on the other hand, the Japanese varieties (and perhaps some of their hybrids) have low chilling requirements - varying somewhat in this respect, Satsuma perhaps having the lowest - and are successful in Central America above 5000 feet, but better at 6000 to 7500.

Peaches of the Spanish race - but not the peaches most commonly

grown grown in North America and Europe, such as Elberta, J.H.Hale and others, are the most widely adaptable of all the Temperate Zone fruits, thriving in tropical America from 2500 or 3000 feet to 7500 or even higher near the Equator. In recent years, plant breeders in California and Florida have produced varieties of excellent quality and low chilling requirements, but it must be admitted at the same time that among the thousands of seedling trees which are found in dooryards and small ~~plantat~~ orchards in tropical America there are many peaches of very satisfactory quality.

Varieties

WINTER BANANA. At the present time (1966) this is the outstanding commercial apple of the Guatemalan highlands. The tree is a very strong grower, comes into bearing at an early age, and yields good crops of attractive fruit of good size, yellow with a red cheek. The flesh is crisp, juicy, subacid; ~~the quality~~ ^{the} in quality it is considered in the United States "good to very good". As a dessert apple it is not, ^{however,} considered the equal of several more famous varieties, but ~~for the tropics~~ it has the advantage of ~~requiring~~ a low chilling requirement. ⁶⁰⁰⁰ 6500 to 8000 feet in Guatemala. Ripens mid-season, keeps only fairly well.

JONATHAN. One of the fine apples of North America, which has done well in Guatemala at about 8000 feet. It ~~probably~~ has a slightly higher chilling requirement than Winter Banana. The tree is a fairly strong grower, and bears good crops. The fruits are medium-sized, handsomely colored (bright red), and of excellent ~~dessert~~ quality. Mid-season.

DELICIOUS (and its darker red mutant forms) ^{is not so interesting} ~~not so interesting~~ ^{in tropical America} ~~in tropical America because in the cool climate of the highlands all apples tend to have higher color than in regions with hot summers~~. This, the most important dessert apple of the United States, has done well in Guatemala at elevations of 7000 to 8000 feet. The tree is a fairly strong grower, the fruit of good size, attractive in appearance, sweet, ~~rather~~ bland in flavor. Rather late ripening.

YELLOW DELICIOUS (Golden Delicious). A fairly strong grower and bears good crops. Though usually the fruit is of clear yellow color in the United States, in Guatemala at 7500 feet it is definitely reddish at least on one cheek. As a dessert apple it is preferred by many people to Delicious. Early to mid-season.

WHITE PEARMAIN. Interesting for its low chilling requirement, and because it is a good grower, productive, and late-ripening. The fruits are of good size, yellow with a reddish cheek, and of good quality. Late-ripening.

GRAVENSTEIN. Another variety which has a low chilling requirement, is a good grower and produces fruit of excellent quality. It is one of the first to ripen. It has been criticised because the fruits produced in Guatemala are not always of uniform shape and size. This may not hold true everywhere.

BLLENHEIM ORANGEM (known as Emilia in Ecuador, Pennsylvania in Colombia). Not much is known about this variety, when compared to others which have been grown in the same region. It has for years been the popular apple in Ecuador and Colombia, where it has not, however, been grown on a very extensive scale. It is an English variety, of excellent quality and apparently adapted to apple-growing regions in tropical America.

It must be born in mind that with the exception of Winter Banana, experience with all the above varieties is very limited, so far as tropical America is concerned. They have, in their favor, the fact that they are important commercial varieties in the United States which means that they possess characteristics which are desirable in any other region. Cross pollination may be a factor with some of them, and in some regions. For this reason it is desirable to plant two or three varieties in close proximity to each other.

In addition to well-known commercial apples, there are a number of sorts which have been planted experimentally in Guatemala and a few other regions, which it will be interesting to watch. In several instances, these are apples which have shown promise in warm climates. The "Key West" apple from the Island of that name in Florida; the ^{EMILIA BLENHEIM} Guinope

apple from Honduras (a Spanish cider crabapple, according to Dr G M
Darrow; ~~xxxxxxx~~ and the Tropical Beauty apple
from Australia are some of these.

To be described in New Book

W. I.

Waldin 5 to 10% F

Pollock ✓ 6% C

Simmonds

W.I.

Lula 12 to 16% F

Guate

Booth 7 7 to 14% F

Booth 8 6 to 12% F

W.I.

Gottfried ?

Mex

Guate

Hass 20% (Malan)

Nabal ✓ 16% C

Taylor 12 to 17% F

Anaheim ✓ 15% C

MacArthur

Guate

Fuerte Avg, 22% C; avg 18, max 25 to 30 Robinson

Mex

? Puebla 19 to 20% C, max exceeding 25 Robinson

Mex

Duke ✓ 16 to 20% C

Florida 5000 to 5500 ft
Floridaquean 7500 feet
Florida home 5000 to 6500.

Forget minimum number
of hours of temp. 45 or below.

Take mean temp. for January
as the basis of calculation;
reduce min. temp. of Guatemala
City one degree for every addition
of 300 ft or 100 meters elev.
allowing for exposure, cloudiness
and other local factors of course

Mean Temp at Guatemala City
in Jan 63° ? Check this.