Ministry of Agriculture, Food and Consumer Affairs

IICA
OFFICE IN BARBADOS

PROCEEDING OF THE FRUIT CROPS SEMINARS IN BARBADOS

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IICA

INSTITUTO INTERAMERICANO DE COOPERACION PARA LA AGRICULTURA
INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE
INSTITUT INTERAMERICAIN DE COOPERATION POUR L'AGRICULTURE
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Akee, Jamaican Akee	Blighia sapida
Avocado, Pear	Persea americana
Barbados Cherry, Acerola	Malphigia glabra
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Carambola, Star Fruit	Averrhoa carambola
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Dunks	Zizyphus mauritiana
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Mamey Apple, Mammee Apple	Mammea americanum
Mamey Sapote, mammey	Calocarpum sapota
Mandarin	Citrus reticulata
Mango	Manguifera indica
Orange (sweet)	Citrus sinensis
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PREFACE

Barbados, the most easterly of the Caribbean Islands lies within the humid tropics and is located 13 degrees latitude north and 58 degrees longitude west. It occupies a land mass of 431.0 square kilometers, which is relatively flat with the highest peak being 340 metres above sea level. The most widespread soils are shallow with underlined parent rock of coral origin. The population of the island by 1984 was approximately 262,000 people, with a density of 607 persons per square kilometer.

The climate is mostly influenced by the north east trade winds, and the precipitation is the most variable climatic factor, showing significant area and seasonal variations. The mean annual rainfall is 1524mm with a minimum of 1143mm and maximum of 2184mm. There is a distinct dry season running from January to May, followed by a wet season in May to December. Temperature is relatively constant, with an average annual range of 24.4°C in January to 26.4°C in June.

Eighty-six per cent of the land is currently used for agriculture, of which more than 90% is under sugar cane production. The farming system could be classified as a 'Peasant' and 'Plantation' system. Plantation, historically, has been identified with a marked concentration of land ownership, allocating their resources into the development of export crop, mainly Sugar Cane. However, in the last decade, plantations have increasingly diversified production to include food crops, especially vegetables.

Fruit production in Barbados has been of a scattered nature, with backyard production being dominant. The main fruits are: Barbados Cherries, Avocadoes, Mangoes, Citrus, Papaya, Breadfruits, Coconuts and Bananas. More recently, fruit crops research and propagation have taken on a new level of importance, due to the fact government recognizes the potential of fruits in the island as an alternative in the diversification from Sugar Cane.

Commercial fruit production, being a relatively new agricultural activity, face a number of organizational and technical problems that are needed to be solved. Among them are: Production Management, Pest and Diseases Control, Marketing System, Processing and Technology Transfer. These seminars and workshops deal with most of these problems and, strategies were discussed for circumventing them.

THE EDITORS

ACKNOWLEDGEMENT

We wish to thank the various organizing committees of the event for their efforts in making it successful.

Special thanks to the Ministry of Agriculture, Food and Consumer Affairs (MAFCA) and the Inter-American Institute for Cooperation on Agriculture (IICA) for sponsoring the event. Also to the technical and support staff of both organizations who assisted in one way or other, in its planning and execution.

Our appreciation is extended to the Barbados Nutrition Centre and its staff for the invaluable support given.

A number of private sector organizations have assisted by displaying their products. These are: The Pine Hill Dairy, T. Geddes Grant (Barbados) Limited, DaCosta & Musson Agricultural Division, Bajanne Producers, 4-H Movement, Plantations Limited and Alstons Engineering Limited; to them we are very grateful.

INTRODUCTORY REMARKS
by
MICHAEL J. MORAN, DIRECTOR, IICA OFFICE IN BARBADOS

Mr. Chairman, Honourable Minister, ladies and gentlemen. I am indeed pleased to make a few remarks on this occasion of the "Fruit Crop Show and Seminar".

The Inter-American Institute for Cooperation on Agriculture (IICA) is presently cooperating with the Ministry of Agriculture, Food and Consumer Affairs in the development of Fruit Crops.

This is an important event. It represents a check-point in the process of developing a Fruit Crop Agribusiness from cultivar to consumer for small farmer and larger enterprises alike.

This event does not substitute the hard work in the field, from nursery to commercial application to marketing the produce for final consumption. It rather compliments and provides a practical forum for discussion, observation and learning about the problem, advances and opportunities in Fruit Crop Production and Marketing in Barbados.

There are many problems still to overcome, primarily in the areas of operational techniques and management levels. Significant progress has been made however, such as the following:

- The limiting problems for Fruit Crop Production have been identified.

- Technicians, Nursery Personnel and Fruit Farmers are being trained on plant propagation techniques, nursery management, and orchards management and development.

- More than fifty (50) new fruit cultivars have been introduced from very reliable sources and propagated.

- Nursery plant production are expected to increase from the 7000 plants output in April 1983 to a projected 35,000 plants by April 1985.

- Data gathering, and monitoring and evaluation on Fruit Crop Development has began.

Fruit Crop Development is important for several reasons:

- Important source of nutritional value,

- It's potential import on savings of foreign exchange,

- Income generation, opportunities, and

- Development of new agro-industry - both cottage industry and larger scale processing.

The domestic, tourist and extra-regional markets offer challenging opportunities. The export market demands top quality, which is generally not the case in the local market, top quality consciousness among producers and laborers is not easily obtained in the short run.

As you can see, managers, technicians, producers, farm input suppliers and public officials are all involved in this event. In practice,the same cooperation is required for an efficient Fruit Production and Marketing System to develop.

Your active participation in this event is most welcome, that is one of it's main goals. The second is to present practical hands-on information through seminars, displays and close interaction among participants in this event.

Private and public cooperation and close communication between managers, technician, foreman and laborer are essential for the system to work effectively and efficiently to produce the expected results of all involved. We hope you find this event most informative and the displays useful to your interest.

ADDRESS

by

DR. the Honourable R.L. CHELTENHAM

MINISTER OF AGRICULTURE, FOOD AND CONSUMER AFFAIRS

Mr. Moran, distinguished Guests, Seminar Participants, Ladies and Gentlemen:

It gives me great pleasure to welcome you to this first ever Fruit Crop Show and Seminar sponsored jointly by the Inter-American Institute for Cooperation on Agriculture and my Ministry. The purpose of these events is to make farming community and the general public familiar with fruit crop production in Barbados and the associated problems.

Many of you will recall that soon after taking up this portfolio I directed that the production of fruit should be emphasized. At that time, nearly all of our pawpaw trees were dead due to a complex of virus diseases. Fruit production was limited to a haphazard individualistic type of planting. Even within my Ministry, no organized arrangements existed for fruit production or research to identify types of fruit which could be grown in commercial quantities. The extent of the Ministry's involvement in the growing of fruit was the supply of seedlings to interested persons on and an ad hoc basis.

Until then and indeed, up to now, production originated mainly from volunteer trees and there is still no true estimate of local fruit production but it is felt that about 9 000 tonnes are grown every year or some 60% of our domestic requirements. Demand is supplemented by imported fruit. In 1970, the bill was 3 million dollars. By 1982 it had tripled to nearly 10 million dollars.

I resolved to change that situation and sought technical assistance from the European Economic Community and the Inter-American Institute for Cooperation on Agriculture in order to overcome deficiences in planning and execution and with a view to getting the fruit growing

programme launched.

The Scotland District has been identified for special treatment in our fruit development effort. The area has been singled out for special incentives and farmers in that area who plant not less than 50 trees in one location can get a rebate of $3.00 per tree in each of the two years following the planting.

We recognised that there are many constraints to increased fruit production in Barbados but we are determined to overcome them. In the meantime, we have set ourselves a number of goals for the fruit industry. These include:-

(a) the encouragement of commercial fruit production;

(b) the identification and securing of export markets for selected fruit (Cherries, pawpaws);

(c) increasing the consumption of local fruits;

(d) improving the production efficiency of the fruit industry; and

(e) the initiation of a viable processing industry based on local raw materials.

Attainment of these goals is impossible without planning and the development of information and marketing systems. It is in these areas that the expertise of IICA has been invaluable and with its resident coordinator Dr. Moran, my Ministry has started an exercise with the following aims. Firstly, to develop a comprehensive programme for fruit development; secondly, to gather and disseminate basic information about fruit growing and, thirdly, to assist in the planning exercise.

To move forward at this time, we have to strengthen research into fruit production, processing and marketing. We must also examine the possibilities for getting credit to achieve increased output in the sub-sector especially through the development of commercial orchards. Our efforts are being concentrated on the production of mangoes, pawpaws, avocadoes, cherries, passion fruit, limes, grapefruits, guavas, pineapples, and sour sops.

In the long run, through our fruit programmes, we plan to achieve the following objectives:-

- a further diversification of our agricultural production which will improve the structure of agriculture generally;

- an improvement in land use and reduction of soil erosion through long term tree crop production;

- an increase in the market supply from local production thereby substituting imports and creating a base for export promotion and agro-industrial development;

- the creation of new and long term job opportunities in the rural areas;

- an improvement in the standard of living of agricultural communities by the creation of income generation opportunities.

My Ministry has pioneered the planting of over twenty (20) acres of cherries on lands of the Barbados Agricultural Development Corporation at Haggatts. These orchards when fully rehabilitated will provide a selection of heavy bearing and high flavour clones rich in vitamin C from which additional planting material will be taken. Cherries grown in Barbados are in great demand, and markets in the

United States of America and Japan have not only been identified but shipments have already been made to them. We have recently decided to put in an additional hundred (100) acres in cherries.

With the assistance of the European Development Fund (EDF), limes and mangoes have been planted in the Back River Area of the Scotland District, while a pineapple nursery has been established in the East River area. Once reliable sources of water can be established, the growing of cherries, mangoes, limes and grapefruits will be extended to the Lower Back River, Bruce Vale and Haggatts areas.

This briefly outlines our aims and objectives as far as fruit production is concerned. But it would be remiss of me if I did not record the invaluable contribution made by IICA in connection with the production of pawpaws. Because of its efforts, we in Barbados will soon have pawpaws on our tables again and we are leading this region in the work to rehabilitate the pawpaw. I would like to thank publicly IICA and especially its expert Dr. Marte for their outstanding work.

This Show is aimed at you the farmers and would-be fruit farmers. Seminars and Round-Tables have been organized to give you the opportunity to discuss matters of mutual concern and to hear from experts their views on such questions as the protection of Papaya and citrus from virus diseases and the major problems of fruit production. You will also see demonstrations of plant propagation techniques, spraying and the use of heavy equipment. I commend this work to you and hope that you pay particular attention not only to the displays, but also to the various seminar discussions and round-tables that have been organized for the next few days. Your active participation is vital for by so doing you will be contributing your own experiences to the pool of knowledge which we are gradually collecting about fruit production.

I am impressed with the programme that has been prepared and wish to congratulate the organizers and all those who have been involved in planning this Show. I hope it will be the first in a series which will improve in every respect as time passes. I trust too that

you will have a successful show and, that as a result of these seminars and discussions your task as fruit producers will be easier. In this regard I am to announce that a reduction in the fees charged for fruit trees purchased from the Ministry's nursery at Haggatts in St. Andrew is under consideration and a decision will be made shortly.

I now have great pleasure in declaring open this Fruit Crop Show. This is but the first of many such demonstrations and seminars on an area of the greatest importance to Barbados.

PROTECTING PAPAYA AND CITRUS
FROM VIRUS DISEASES

*** S E M I N A R ***

CHAIRMAN — **J.P.W. JEFFERS**
Deputy Chief Agricultural Officer, MAFCA

SPEAKERS — **OMER S.L. THOMAS**
Virologist/Pathologist, MAFCA

"Nature of Viruses, their properties and transmission appertaining to papaya and Citrus"

AND

"Sympotomatology, Economics and Control of Virus Diseases"

RAFAEL MARTE
Fruit Specialist, IICA

"Virus and Virus-like Diseases of Papaya and Citrus"

AND

"Identification of Casual Agents: Diagnosis"

* * *

THE NATURE OF VIRUSES, THEIR PROPERTIES AND TRANSMISSION APPERTAINING TO PAPAYA AND CITRUS

by

OMER S. LLOYD THOMAS

Virologist/Pathologist

Senior Agricultural Officer

ABSTRACT: Virus diseases of plants were known long before the discovery of the bacteria. They are obligately parasitic biological entities operating at the molecular level. Viruses are not motile and hence rely entirely on passive means for transmitting infection from cell to cell. During their extra-cellular existence, virus particles are exposed to environmental cues which may be hostile to their survival as infectious agents. Despite their simple structure and limited genome size, the papaya and citrus viruses have shown considerable versatility in overcoming these hazards. Because the viruses are submicroscopic, their presence in the field can only be revealed by symptomatology. Their nomenclature is determined by these symptoms. Papaya ring spot, papaya mosaic, citrus exocortis and xyloporosis are some names. The importance of symptoms has increased since it became known that viruses are polycistronic. Identification of viruses is for most of the times a biochemical analysis. Physiochemical determination and serology are more often used than EM. Properties of papaya and citrus viruses do not vary widely from other plant viruses, The virions possess only one type of nucleic acid, they are unable to grow, no genetic information is present for the synthesis of the Lipman system. These properties, being absent in other agents are characteristic of viruses. Virus diseases are the most important plant diseases since they cause great loss to crop growers. No direct method for controlling virus diseases exists. Methods of control are indirect and involve principles of Thermotherapy, Oil Sprays, Vector Control and Irradiation.

* * * PART I * * *

THE NATURE, PROPERTIES AND TRANSMISSION OF VIRUSES

I. INTRODUCTION

The viruses first studied by man were those that caused diseases of man, his animals and his plants, This anthropocentricity of interest has continued so that our knowledge of any particular virus is usually directly correlated to its economic importance to man.

Virus diseases are among the greatest threats to the fruit development program in Barbados. They have wiped out the papaya crop already and will again flare-up, if carefully guided prophylactic programs are not put in place.

More than a dozen virus diseases affect citrus in different parts of the world (Klotz 1973). Three of these virus diseases, namely, tristeza, psorosis and exocortis are known to occur in some places within the Caribbean Region (Hosein 1961).

The papaya is afflicted by some sap transmissible virus diseases (Smith 1972). Whether or not the viruses afflict papaya or citrus, they have similar characteristics and properties. They possess only one type of nucleic acid, either deoxyribonucleic acid (DNA) or ribose nucleic acid (RNA) (Pennington 1975). They are reproduced from their sole nucleic acid, whereas other agents are reproduced from the integrated sum of their constituents. They are unable to grow or to undergo binary fission. Few viruses, if any, code for RNA. No oxydative phosphorylation is carried out. They make use of ribose of the host cells - this is absolute parasitism. Since the turn of the 20th century, the work started by Leoffler and Frosch in 1983 and Beijerink in 1968 and others has shown the differences between viruses and other pathogens.

Viruses differ from all microbes like bacteria rickettsiae and chlamydiae, in their chemical compostion and mode of replication. The nucleic acid function as a genome supplying the genetic information required for the synthesis of viral proteins, and it is exactly replicated during viral multiplication (Bennett Fenner and Gibbs 1973).

RNA polymerase and other enzymes of nucleic acid metabolism have been found in some of the viruses of citrus and papaya that replicate in the cytoplasm and contain double-stranded RNA. The polymerase is needed in all such viruses to produce at least the earliest viral messenger RNA molecules in the cytoplasm of infected cells in the papaya and citrus plants.

The viruses causing diseases in citrus are exocortis, citrus greening virus, impietratura, citrus leaf curl virus, leaf mottle virus, tristeza virus, vein enation virus, xyloporosis, psorosis, yellow vein and ringspot virus (Klotz 1973). These viruses are transmitted either by vectors or grafting and in one case by seed (Childs, J.F.L. 1956).

The papaya is afflicted by about four virus diseases (Smith 1972). They are papaya distortion ringspot virus, mild mosaic, mosaic, and ringspot viruses and are transmitted by either sap, seed or vector (Smith 1972).

Plant virology will notice that there is no discussion of the ecology of many diseases usually thought to be caused by viruses, for example, all those transmitted by white fly. This is because plant pathologists have become more cautious about stating that a certain plant disease is caused by a virus since Doi et al (1967) showed that half of the plant 'virus' transmitted by leaf and plant hoppers were perhaps mycoplasma-like organism (MLO). In this article MLO in respect of papaya bunchy top disease will be discussed.

The associations between insects and plant diseases have been recognised for more than 70 years, but the transmission of autonomous pathogens by specific vectors has been much more difficult to establish. It is difficult even to decide which plant viruses were first known to be transmitted, when, and by whom. Doolittle and Walker (1928) in reporting the spread of virus diseases by vector said the cucumber mosaic virus is the first recognized virus known to be transmitted by aphids. These group of insects transmit most fruit crop diseases.

As modern physical and chemical techniques become available, electron microscopic studies revealed the details of the structure of the virus particles even for the smallest viruses. Because of their properties of antigenic homology, the principles of serology becomes an invaluable tool in virus identification.

Viruses are mainly identified by their properties, either

physicochemical or biological and certain properties are used in blue print (Englander and Epstein 1957). Dilution end points (Holmes 1929). Sedimentation properties (Anderson 1966). Electrophoretic mobility vanRegen Mortel (1966) among others.

These properties are not all known for some of the citrus and papaya viruses.

2. NATURE OF VIRUSES

Where do viruses belong in the biological world? What are their closest relatives? Many research virologists and molecular biologists are agreed that viruses are not small cells. They are basically elements of genetic material which possess an evolutionary history of their own because, intrinsically, they have the ability to mediate their own transfer from one host to another.

Viruses are endowed with genetic continuity and mutability and consist of sets of genes working in concert to make more virus. Their genetic material is chemically akin to that of all cells, even though in many viruses it consists of RNA, a coded polymer that in the evolution of cells has been relegated to a subordinate position, serving as a delegate bearer rather than a primary repository of genetic messages (Luria and Darnell 1968).

The physical integration of some viruses into the chromosomes of the host has only demonstrated for certain groups, but examples of virus that have become cell bound or helper-dependent on another virus for replication, and the rous sarcoma virus, dependent on helper viruses for maturation. Other viruses illustrate a situation where irreversible loss of independence is the regular outcome of the process by which they reach a 'modus vivendi'; the converted cells that has the viral genome are no longer capable of producing virions.

Some authors claim that only one avenue of evolutionary history has been followed by viruses, that is, from the entire cell of individual

cell components or precellular or acellular forms of genetic material; others claim that there are no 'a priori' reason to assume that all viruses have originated in the same way.

There are theories which indicate that viruses are regressed parasites. A case has been made for an origin of viruses by an extreme process of regressive evolution (Green 1935, Burnet 1945).

3. PROPERTIES OF PAPAYA AND CITRUS VIRUSES

The general properties of the citrus and papaya viruses are similar in some respects, but vary widely in others. Their properties in plant sap differ for each virus (Smith 1972). Their purifications, host ranges, sizes, morphologies and general physicochemical properties also differ.

It is not practical at this stage to outline the differences for each one of the viruses of citrus and papaya because very little information is available but Table 1 will attempt to compare some of those on which information is available.

The properties of these viruses like others are usually put into three major groups, viz: physicochemical, biological and host range symptomatology.

The total characterization of the viruses of papaya and citrus is not complete, there are many more properties that are to be brought to light.

Host range symptomatology is the only property which is minimally worked out for nearly all the viruses of these two fruit crops. Biological properties in respect of longevity in vitro, thermal inactivation point, dilution end point and cytopathic reaction are not recorded. However, the architecture of the viruses are almost always known. This is made possible through the use of the electron microscope.

.e 1: Viruses that affect Papaya and Citrus and their method of transmission

Virus	Transmission	Nature	Vectors
AYA			
tortion Ringspot	Aphid	Stylet Borne	Various sap
f Reduction	Mechanical/Aphid	Stylet Borne	Myzus persical
gspot	Mechanical/Aphid		Myzus persical Aphis gossyppii
aic			
rus			
llow vein	Dodder		
TRUS			
ocortis	Mechanical/Graft-ing Dodder		
loporosis	Budding & Graft-ing		
orosis	Grafting (root & patch)		
isteza	Aphids		Several spp.
trange Stunt	Dodder/Mechanical		
af curl	Budding		
af mottle	Psyllip		Diaphorina citri

Sedimentation coefficients extinction coefficients, stability, byrofringence and electrophoritic mobility are some physicochemical properties that could be used in characterization.

Citrus tristeza virus are semipersistent and as such according to Sylvester (1956) resemble non-persistent viruses in transmission properties because they do not have a latent period in the vector and so do not survive in aphid when they molt. The CTV can be readily detected in phloem tissues of the citrus plant (Price 1966, Esau 1967, Esau and Cronshaw 1967).

3.1 COMPOSITION

The virus particles consist of a nucleic acid genome that is surrounded by proteinaceous shell (Luria and Darnell 1953). One citrus disease that is caused by virus-like particles is the exocortis disease. The causative agent is a naked RNA with low molecular weight and is referred to as viroid (Semancik 1972).

The genomes of these fruit crop viruses consist of RNA which may be single stranded or double stranded and either linear or cyclic.

The nucleoprotein complexes of most of them are tubular, where the nucleic acid are surrounded by helically arranged protein subunits, and some are surrounded by protein subunits arranged as an icosahedral shell and are said to be isometric.

Because of the relatively few principles governing the assembly of macromolecular structures, the morphology of the viruses falls into a rather limited range of shapes and forms. This restricts, but does not nullify the usefulness of virion morphology as a major criterion of classifying the papaya and citrus viruses. Finer criteria, however, are required to establish similarities that may reflect genetic homologies, criteria based on the chemical and serological studies of these particles as well as on

the natural history of the virus-host interactions.

4. TRANSMISSION OF VIRUSES

Viruses are not motile and hence they rely entirely on passive means for the transmission of infection from plant to plant. Leaf hoppers (cicadellidae) and plant hopper (delphacidae) are second only to aphids in importance as vectors of plant pathogenic viruses, and also transmit diseases associated with mycoplasma-like organisms (MLOs) in phloem tissues.

Plant viruses are transmitted by aphids in two quite different ways. Some viruses are carried by aphids for only a limited period. Other viruses are translocated after they have been ingested, passed through the vectors body and add to the saliva. The aphid remains infective for a long period of its life, and does not loose its infectivity upon molting.

Circulative and propagative viruses will be ingested while the vector is feeding on an infected plant non-persistent and semi-persistent viruses can be brought into crops by alate aphids. The spread of these viruses within the crops can then lead to high incidences of infection.

The general transmission of viruses of citrus and papaya takes place in the following ways:

1. vectors
2. mechanical
3. asexual propagation practices
4. seeds
5. phanerogram

Many viruses are spread by vectors which feed on or parasitize plants. The vectors are chiefly insects, but some mites, nematodes, fungi and parasitic flowering plants are involved. Other methods of

transmission are by seed, vegetation propagation of infected plants, sap inoculation and grafting.

4.1 INSECT TRANSMISSION

Only a few viruses are transmitted by biting insects, - beetles, grasshoppers and earwigs - in a mechanical fashion, the virus contaminating the mouth parts are being introduced into the plant by the insect while it is feeding.

Most viruses show varying degrees of specificity toward their vectors. Some are transmitted by several or many species of, for example, aphids whereas others are transmitted by only one vector, although other possible vectors exist. Some vectors transmit only one virus or a few (Nishi 1969), others transmit many and the aphid Myzus persicae is notorious for its ability to transmit some fifty viruses. (Nishi 1969).

Viruses have been classifled in various ways according to their vector transmission characteristics (K.M. Smith 1972). They can be grouped as non-persistent or persistent, or as circulative or propagative.

According to Dradley (1964), non-persistent viruses remain transmissible by the vector for only a limited time, often less than one hour, but sometimes for several hours. They are acquired after a very short feeding period, usually less than a minute, and become infective immediately after feeding.

Many viruses are easily sap transmissible, have aphid vectors, and are thought to be carried near the tip of the insects' stylet. Aphids and other members of the hemiptera feed by means of these stylets which penetrate the plant, the feeding process involve the injection of saliva into the plant and the removal of sap from it. Nishi (1969) said it is possible that stylet borne viruses are acquired mainly from the epidermis than from the phloem, and

their transmission is sometimes described as mechanical. Some of these viruses remain infective within the vector for several hours and have been termed semi-persistent. With persistent viruses, the vector remains infective for days or weeks, often for life. Many of the viruses transmitted by leaf hoppers, white flies and thrips and some of those transmitted by aphids fall into this category.

Aphids are the most frequent vectors of plant viruses and they transmit a large number, over one hundred and sixty viruses are transmitted (Tarr 1972).

After aphids, leaf hoppers transmit the largest number of viruses (about sixty-five), but some of these are probably mycoplasma-like organisms. About one hundred species of leaf hoppers are reported to transmit these agents (Tarr 1972).

There are many diseases ascribed to viruses - more than half of those recorded (Gibbs 1969) - for which no vectors are known. Neither have all these diseases been proved to be caused by viruses, although some are. Many are graft transmissible and some can be transmitted by sap inoculation, but it is conceivable that other agents are responsible for some of these diseases.

4.2 PARASITIC ANGIOSPERM

Some viruses can be transmitted from an infected plant to a healthy one by means of dodder (cuscuta sp.) which parasitize both plant, thus establishing a bridge between them (Hosford 1967).

4.3 SEED TRANSMISSION

Since there are no vascular connections between the embryo and the parent plant, seed transmission of viruses restricted to the vascular tract is unlikely, and it is significant that most seed

borne viruses are able to invade parenchymateous tissues. Seed borne viruses are carried either in the seed coat or in the embryo.

The percentage infection of seeds varies greatly with the virus and the species of host plant involved, and on the resistance of the plant to the virus.

The percentage of infected seedlings obtained on planting seed from infected plants varies greatly being as low as 1 - 5% with some viruses - host combinations and approaching 100% in others (Bennett 1969).

Seed transmission of virus can be important in two ways. First, although the percentage of infected seeds may be small it may be large enough to produce infected seedlings evenly spread throughout the crop area and, if the virus is one which spreads rapidly, this can result in early and wide spread infection of fields leading to heavy crop loss. Secondly, virus infected seeds are frequently normal in appearance and are thus unlikely to be detected by plant quarantine inspectors.

4.4 GRAFTING, BUDDING AND OTHER VEGETATIVE PROPAGATION

Grafting and budding are important in spreading systemic viruses of horticultural plants, particularly perennial fruit crops which are propagated in such ways, and the use of infected root stocks, scions or buds, and the infected nursery stock can be a very effective way of spreading viruses. Such propagating material may carry a latent virus as in the example of the tristeza disease of citrus in which sour orange root stocks are killed by a virus present in the sweet orange scions which are grafted into them. Vegetative propagation of crop plants carrying systemic viruses - by tubers, bulbs, cuttings and so on - results in extensive spread of the viruses which thus become more than

often, destructive in plants so propagated.

4.5 MECHANICAL TRANSMISSION

Contact transmission can spread viruses in the field, for example, by virus-containing leaves or even roots of an infected plant rubbing against those of a healthy plant, by the use of virus contaminated implements (pruning knives. Example: the citrus exocortis disease) or by virus carried on the hands or clothing or introduced into, and spread through, the field by ploughs, and other field implements. Yarwood (1957) and Fulton (1966) describe other aspects of mechanical transmission.

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* * * PART II * * *

SYMPTOMATOLOGY, ECONOMICS AND CONTROL OF VIRUS DISEASES

I. INTRODUCTION

When it is remembered that there are more than three hundred different viruses, not counting strains, which affect plants, it is not surprising that this multiplicity is reflected in an equally varied response by the host.

Abnormalities develop in all parts of infected plants, not only externally but internally as well, and I shall deal with these in two categories:

As a rule it is in the foliage of a plant that the most noticeable symptoms develop, and the effects of different viruses on the leaves take many forms. First, there is the large group of mosaic diseases. This name was originated by Mayer in 1882 to describe the mottling of the leaves of the tobacco plants infected by the first virus to be discovered now known as tobacco mosaic virus (TMV).

Some viruses which cause a mosaic disease on one host gives rise to an entirely different type of symptom on another. Examples of this are the so called 'ringspots'. The rings formed on the leaves may be single or several concentrically situated and there is usually a central spot. An example of this is the distortion ringspot of the papaya.

Ring - and - line pattern or oak leaf designs are common in some mosaic-type diseases. Clearing of the veins of young leaves is a common first symptom of infection with mosaic diseases - this is a transitory symptom and disappears after a few days.

There are many other leaf abnormalities caused by virus infections which could be mentioned only in respect of papaya and citrus as we go on. The fruits show large watersoaked concentric rings. The stems

also show a variety of symptoms. The internode length may be reduced or the number of stems greatly increased. In some tree infections, the bark may be cracked or cankered or scaled away as in the exocortis disease of citrus.

Root symptoms have been less studied than symptoms in other parts of virus-affected plants, but certain abnormalities are known. Death of roots occurs in the citrus Tristeza disease.

Internal symptoms can be observed because various changes are made in the histology of virus-infect leaves. The most interesting internal symptoms are the so called 'intracellular inclusions'. These intracellular inclusions occur only in plants affected with a virus and so can be of diagnostic value. Their absence, however, does not mean that viruses are not present.

There are two main types of inclusions, crystalline and amorphous.

Virus diseases have such diverse effects on fruit trees that the economic loss they cause is difficult to estimate. Most virus diseases affect the growth and productivity of the trees and some reduce fruit size and color - factors of paramount importance in some markets and of less significance in others.

Citrus viruses cause severe economic loss in many countries. Tristeza, the most serious of the diseases, made useless, more than 6,000,000 trees within 12 years, in Soa Paulo (Bennette & Costa 1949). Papaya fruits, not being practical to produce cause large expenditure to import this fruit.

It must be recognized that in the absence of commercially suitable antiviral chemicals direct control of virus diseases is not yet possible. The management of virus disease aimed at encouraging the plants and discouraging the viruses therefore, would be a continuing battle. Breeding for resistance has provided some notable successes. Even in situations where the source of resistance is not available, it is possible

to obtain virus-free seeds and vegetative stocks. Although, the control of insects as vectors has always been more difficult than their control as pests, the use of systemic insecticides, holds much promise for several viruses. In the end, the need for strict quarantine against viruses and vectors need not be over emphasized.

Few virus diseases kill plants, but they can harm them in many ways and decrease the amount of food, fibres, flowers, etc. they produce. Unless viruses are controlled it is impossible to grow many crop plants satisfactorily. The value of the crop determines how much can be spent on treatments to decrease virus spread.

Many of these plant viruses have a complex disease cycle, involving at least the spread of the virus from an infected plant to a vector and back again to a susceptible host plant, and the aim of control measures is to attack the vulnerable place in such a disease cycle. Many methods have been used to break disease cycles and control virus spread, but not all are completely successful, and some have actually increased disease spread (Broadbent 1957). Control measures are often aimed at the virus vectors, which, as plant parasites, should be controlled anyway as they cause loss when they feed irrespective of whether they are transmitting viruses.

The methods used to control invertebrates acting as vectors of plant viruses differ little from those used to control them as pests. However, their efficiency in those two roles will be different as, for example, pests only cause feeding damage when present in large numbers, whereas when acting as vectors they may be few, yet cause much damage. A particular method may kill enough of the population of a particular vector to stop it damaging a crop directly, yet leave more than enough individuals to spread virus to all plants in a crop. Also, although most of the methods devised to control crop pests are also used against virus vectors, a few of the techniques are just not applicable. Example, the use of sex attractant or the release of sterile males would never succeed against aphids, which reproduce asexually throughout most of the year.

2. SYMPTOMATOLOGY OF VIRUS DISEASES

Disease symptoms are the effects of the viruses on growth and development of plants and other organisms. They may be more sharply defined as any perceptible change in the plant body or its functions, indicating a disturbance in the normal course of the physiological process.

The importance of symptoms has increased since it became known that genetically, viruses are polycistronic and that only part of the genetic information they contain refers to the amino acid configuration of virus protein and thus to such intrinsic characteristics as particles size, morphology and serological activity.

Since viruses are capable of changing almost any organ, influencing almost any function, symptoms determine the nature and extent of virus damage in crop production.

Diseases do not just occur they consist of a sequence of various stages in the course of their development. The course of a disease is characterized by a sequence of symptoms.

Local symptoms occur at or close to the locus or site where the virus has entered. Where the distinct area of diseased tissue becomes visible is the lesion (Local lesion). Some plants are local lesion hosts for some viruses and these local lesions occur mainly with mechanical inoculation and sometimes with vector inoculation.

Systemic symptoms usually the virus becomes systemic on reaching the vascular bundle and moves rapidly with the sap stream in the phloem towards the growing parts of the plant. In the previously healthy parts it causes systemic symptoms.

Because of the nature of viruses, diseases start with biochemical and metabolic changes. But most of these changes are hard to detect and usually have no diagnostic value.

After the immediate disturbance of cell metabolism, symptoms usually appear inside the cells and tissues of the plant as anatomical deviations. These finally result in macroscopically visible symptoms which fall into two categories:

(a) Abnormalities more directly resulting from abnormal cells and tissues;

(eg.) (i) growth reduction
(ii) color deviation
(iii) water deficiency
(iv) necrosis.

(b) Those abnormalities due to abberrant development of cells and tissues;

(eg.) (i) abnormal cork formation - citrus psorosis
(ii) malformations

2.1 BIOCHEMICAL AND METABOLIC CHANGES

Pathogenesis with virus is a genetic process because from the moment of the infection, metabolism of the plant is no longer entirely governed by its genetic system alone. This is because the genetic information encoded in the virus' nucleic acid interferes, leading to disturbances.

1. Redox potential in plant sap is lower than normal
2. Electric conductivity higher
3. Alkaloid content change
4. Photosynthesis is reduced
5. Respiration often is increased
6. Increased polythenoloxidase activity
7. Polymerization of phenolic compounds such as the amino acids typosine resulting in polyphenol deviatives like melanins and quinines, leads to a shift in light absomption from ultraviolet

to visible wavelengths, hence the violet and black colors.

8. Hormonal disturbances are evident
9. Decrease in chlorophyll content leading to chlorosis and yellowing.

2.2. ANATOMICAL CHANGES

i. The excessive formation of callose in the stem (eg.) this forms in the early stages of phloem degradation in oranges with tristeza disease (Batjer & Schneider 1960);

ii. Gummosis - The production of yellow orange or reddish-brown gum-like substance, often preceeding or proceeding necrosis and degradation of various tissues.

The gum is generally considered to be a decomposition product of carbohydrates, especially starch, moving into the tracheal elements. This kind of gumming occurs in citrus psorosis disease (Fawcett & Bitancourt 1943). Excessive Tylosis - The formation of outgrowths or tylosis from adjacent parenchyma into woody vessels entering through the pits and swelling into thin-walled bladders in the lumen of the vessels and blocking them. This leads to growth reduction and wilting.
Hyperplacia - The abnormal increase in number of cells leading to malformation of organs.
Proliferation - When hyperplacia is unlimited as in the case of tumors.
Hypertrophy - An unusual enlargement of both cell and organ.

2.3 GROWTH REDUCTION

Many viruses cause a growth reduction similar in proportion in all organs, so that the plants remain morphologically almost normal. The terms dwarfing and stunting are used in this case. Growth reduction is not always evenly distributed. This is illustrated in a later stage of development of bunchy top disease in other crops.

2.4 COLOR DEVIATIONS

Changes in color, very commonly in virus diseased plants, are the first symptoms that have been associated with virus infection, though they are not always the most conspicious. Most of the color deviations are in the chlorophyll - containing outer layers of the plant and therefore, the disorders are essentially the same for leaves, young stems and fruits.

The color deviations are:

(i) reddening
(ii) purpling
(iii) browning
(iv) blackening
(v) bronzing
(vi) Yellowing

(a) chlorosis
(a1) edge chlorosis
(a2) vein chlorisis

(b) vein clearing
(c) vein banding
(d) Interveinal mosaic

There are color deviations in stems, leaves, fruits, flowers and seeds.

2.5 NECROSIS

Loss of water and various degenerative changes leading to death of cells and tissues that do not directly kill the whole plant, is necrosis.

Necrosis occurs in leaves, in stems, fruits and seeds.

3. ECONOMIC IMPORTANCE OF VIRUS DISEASES

Virus diseases have such diverse effects on fruit trees that the economic loss they cause is difficult to estimate. Most virus diseases affect the growth and productivity of the tree, however, and some (eg. proliferation) also reduce fruit size and color - factors of paramount importance in some market place.

By impeding the growth rate, some viruses considerably delay the production of economic quantities of fruits by young trees that are infected when planted, but once the trees have attained the optimum size for their allotted space, viruses that reduce their growth may have no appreciable effect on yield per acre.

In attempting to estimate the economic effects of virus diseases of fruit trees, one must consider four points of paramount importance:

1. Each fruit tree consists of two different varieties or species:

   (a) The root stock; and

   (b) the scion.

2. Varieties differ markedly in their reaction to infection by a single virus.

3. Viruses occur in a range of strains, often varying from virulent to those causing no symptoms.

4. Viruses may 'interact', that is, one virus may greatly influence the effect to another in the same plant. The influence may be synergestic and increase the severity of symptoms or it may be protective.

These four facts influence the result of virus infection in a particular tree to the extent that no prediction can be made with any

certainty, unless the identity of the scion variety and root stock, the strain of the virus with which one is concerned, and the extent of latent infection with other viruses are known.

Whilst we cannot at present estimate financially, the losses caused by virus infection of fruit trees in general, it is possible to group them according to the type of damage they cause (Table I).

Three billion dollars a year is the title of a leading article by Jessie Wood in the United States Department of Agriculture year book for 1953, which contain accounts of several hundred diseases attacking food and fibre crops, about a quarter of them of viral origin.

Citrus tristeza virus caused the loss of 7 million orange trees in the state of Sao Paulo, Brazil, alone, and has attacked millions of others in tropical and subtropical countries.

Tropical fruit production has been threatened by many devastating virus diseases. The citrus crop alone is afflicted by more than a dozen of them (Klotz 1973). The papaya and many others all have their fair share of virus diseases. It was suggested by plant pathologists that the increase in destructions of plant virus diseases is caused by development of agricultural enterprises, with movement of plants and plant products about the World.

Table 1 SOME VIRUS DISEASES GROUPED ACCORDING TO SEVERITY AND PREVALENCE IN ORCHARDS IN THE WEST INDIES

	A	B	C	D
Citrus	Tristeza Psorosis Exocortis Xyloporosis			Greening
Papaya	Bunchy Top Mosaic	Distortion Ringspot Papaya Ringspot		Leaf Reduction

(A) Disease of local importance which would cause several losses if became prevalent.
(B) Disease that probably reduce yield by 20% or more and are already prevalent.
(C) Diseases that affect only a few varieties.
(D) Latent infections with unknown effect.

4. CONTROL OF VIRUS DISEASES

There are various methods of approach to the problem of the control of plant virus diseases. They are not all applicable in the same way to the various diseases. These methods can be roughly classified under the following headings:

1. Controlling Primary Spread (preventing the introduction of virus)
   (a) elimination of the sources of virus infection
   (b) avoiding the vectors
   (c) breeding resistant varieties of crops
   (d) special methods of propagation
   (e) quarantine and certification
   (f) virus-free seed and planting material

2. Controlling Secondary Spread
   (a) direct attack on the vectors
   (b) cure of virus infected plants

To these we could add the 'vaccination' of a plant with an avirulent or masked strain of a virus which thereby sometimes immunizes the plant against a more severe strain of the same virus. This method is at present limited in application and is largely academic.

Figure 1. Diagramatically outline the various methods for disease control.

4.1 CONTROLLING PRIMARY SPREAD

4.1.1 Elimination of the Source of Virus Infection: One way this can be done is by modifying the farming methods. This is relatively inexpensive.

4.1.1.1 Crop rotation: Fields may contain virus-infected plants or viruliferous vectors and these must be destroyed before a crop is planted.

4.1.1.2 Volunteer Crops and Infected Plant Debri: Virus infected plant material remaining in a field after crop harvest or crop removal may carry inoculum to other crops, and infected plants may resist for several

years. If volunteer papaya plants emerge vegetatively in fields after a new crop is planted the probability of being an inoculum source is high. These volunteer plants should be removed from the fields although they look healthy.

4.1.1.3 Infected Weeds and Weed Seeds: Almost all viruses that infect crop plants also have weed hosts which may show no symptoms and some viruses are seed-borne in weeds. Weed control may also be important to limit the spread of air-borne viruses.

4.1.2 Quarantine and Certification;: It is very difficult to detect viruses in seeds or planting material as they rarely show symptoms. Even when growing plants are imported from another country, they often lack leaves (eg. young fruit trees). Therefore the plants should be grown in quarantine in vector-free conditions and checked for virus infection. Plants may be held in quarantine in the importing country, or sometimes in an intermediate country. Tristeza virus of citrus trees is controlled in Argentina and some citrus growing countries in the World by a certification scheme for imported budwood.

4.1.3 Virus-Free Seed and Planting Material: Only a few viruses are transmitted through the seeds of infected plants. To ensure that planting material is virus-free, sap from sample leaves should be inoculated to test plants that produce characteristic symptoms when infected with the viruses suspected to be present, or serological tests made.

4.1.4 Special Methods of Propagation: The special methods of propagation are the meristem culture and heat

treatment. Plants that are vegetatively propagated, can sometimes be freed from virus by heat treatment or by growing plants from their apical meristems or shoot tips (Kassanis 1950).

Often heat treatment and meristem tip culture methods are combined and tips are cultured from heat treated plants. Obviously, the successful application of these techniques to field problems depends on keeping the stocks virus-free. This can only be done by efficient nucellar stocks or budwood schemes. This is mostly done with citrus.

4.1.5 Avoiding the Vectors: One way of doing this is chemical control of vectors at source. Although many immigrant vectors can be killed by treating the crop, most pesticides do not act sufficiently quickly to prevent infection of a plant by a vector already carrying virus. Better control may be achieved by treating the source of the disease, if it is known.

4.1.6 Breeding Resistant Varieties: This is a promising method of control and it involves the production of virus immune or resistant varieties or cultivars of plants. This is a long term method and the plant breeder is the key person in this respect.

4.2 CONTROLLING SECONDARY SPREAD

This type of control aims at preventing the spread of the virus within the crop. Virus spread within the field can be decreased by many agronomic, chemical or biological means.

4.2.1 Direct Attack on the Vectors: The use of pesticide granules is practical in long term perennial crops than spray machines applying chemicals on a biweekly basis.

4.2.2 Cure of Infected Plants: Heat therapy was developed by Kunkel (1936) who subjected tree crops infected with virus to temperatures of 35°C for two weeks or more. The cure was proven by grafting scions from treated trees to stocks from virus-free trees and no disease developed. This method is not widespread for large orchard trees.

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VIRUS AND VIRUS-LIKE DISEASES OF PAPAYA (CARICA PAPAYA L) AND CITRUS (CITRUS spp)

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ABSTRACT: Citrus and Papayas are two potential crops for Barbados. The cultivation of these crops are threatened by virus and virus-like diseases. Infection by viruses and related pathogen is receiving increasing recognition as a limiting factor in the productivity of tree crops. This paper discusses the virus and virus-like diseases which affect Papayas and Citrus in most areas of the World where these crops are cultivated commercially. Their symptoms, transmissions and other methods of diagnosis are discussed, together with specific methods of control and preventions.

INTRODUCTION

Citrus are only second to Bananas in importance of Fruit cultivation around the World. Today they can be found growing in a wide range of climates that go from subtropical condition, where Orange and Mandarin attain the best qualities, to the tropical condition where Grapefruits, Pummelos and Limes do their best.

The Rutaceae family to which citrus belong is a broad family containing seven (7) subfamilies. Only the Aurantioideae in which citrus are included is composed of:

> 2 Tribes, 6 subtribes, 9 subtribal groups, 33 genera, 203 species and 38 Botanical varieties.

One of the most outstanding characteristics, almost "unique" in the plant kingdom, is that all of its members are compatible for cross pollination and grafting. This characteristic is the major reason why many artificial and natural hybrids among genera and species of the sub-family today exist. But this compatibility does not stop at the boundary of the subfamily Aurantioideae, since many of its members are

compatible with members of other subfamilies of the Rutaceae. "The list can go on forever."

The advantage of being graft compatible is that many rootstocks could be, and have been selected to solve specific problems (such as adaptability to different soils and climate, resistance or tolerance to virus, diseases and pests and the influence in the quality and the productivity of the top scion-cultivar).

Papaya, on the other hand, is native to the tropical America but because of its easy propagation and the organoleptic characteristic of its fruit, papayas are today found in all tropical and some subtropical region of the World.

The precocity of this crop, the escalated production of the plant, the rapid popularity of the papaya fruit and, of course, the rapid and easy propagation (by seeds) are the main factors of the rapid dissemination of this fruit around the World.

The Papaya belongs to the family Caricaceae and to the genera carica which contain 21 species. Only three (3) of those species are economically important. They are:

a) Carica papaya the Common papaya
b) Carica candemarcensis. The Papaya of high elevation 1500 to 2500mt.
c) Carica monoica. The Papaya of the Amazon which grow under conditions of very high pluviometry (over 3500mm/year).

Contrary to the Citrus, the Papayas are cross incompatible even at the specie level. This makes it so difficult to put together the quality found in the Carica papaya fruit, with the resistance to known problems (such as bunchy top), found in other species of the same genera Carica.

For the cultivation of these two groups of fruits (Citrus and Papayas) viruses and virus-like problems are of major importance. In some areas they are the limiting factor to grow the crop. Several billions of trees die each year because of virus and virus-like diseases. Barbados already has the fate to test this fact, since in a matter of less than a year, the Papaya crop, which was one of the most popular and widely cultivated Fruit in the Island, was practically wiped out entirely by the "Bunchy Top" disease.

* * * PART I * * *

1. VIRUS AND VIRUS-LIKE DISEASES OF CITRUS

Among the most serious problems affecting the production of citrus Worldwide, the viruses and mycoplasma-like organisms are probably at the top in importance. The whole citrus industries have come close to extinction several times, because of virus diseases.

Psorosis was the first citrus disease shown to be caused by a virus (1933), and since then more than 20 virus and virus-like diseases of citrus have been recognized.

In this paper our discussion is more concentrated on the four (4) most important viruses affecting citrus production in almost all citrus areas around the World.

1.1 TRISTEZA

Without any doubt, tristeza is one of the most serious diseases which affect citrus. Tristeza means 'Sadness' in Spanish, and there was not a name more suitable for this disease. Even when there is some disagreement over its definition, tristeza is a complex of strains and components. Several strains of the Citrus Tristeza Virus (CTV) have been recognized. The T_1 strain causes a very mild damage while the damage caused by the T_3 is severe. But still, there are some questions about the tristeza

complex in whether it consists of different strains of the same virus, or of two distinct viruses.

There are three major disease symptoms of the tristeza:

a. Tristeza decline: Caused by the starvation of the roots because the sieves tubes necrosis below the bud union. Wilting and often rapid death of the infected trees are the typical symptoms.

b. Stem pitting: Especially found more pronounced in Grape fruits. Two important symptoms are vein clearing in the young leaves and pit lesions in the vascular tissue.

c. Seedling Yellow: Caused the stunting and chlorosis of citrus (Sour Orange, Grapefruit, Lemon and Citron) seedlings.

1.1.1 Transmission

The Citrus Tristeza Virus (CTV) is transmitted by vectors and by grafting but not through seeds. Several Aphids are known to transmit tristeza. The most effective one is toxoptera citricidus k., but also CTV is transmitted by Aphis gossypi G., A. spiraecola P., and Toxoptera aurantii B. The difference in efficiency of the vectors, may be responsible in part, for the difference of tristeza spreading, in the different regions of the World where it occurs. In some areas, while Citrus are still not affected by tristeza, the virus has been shown to be present (South Texas, Mexico and Central America).

The tristeza decline is a problem that occur only when trees are budded onto susceptible rootstocks. So the use of resistant rootstock is the more effective means of control (Further details in PART II).

Viruses in general are recognizable by the symptoms they develop on the plant in the field. Some plants however, may be carrying the virus without symptoms expression. That is why the use of indicator plants is so important. West Indian lime (Citrus aurantifolia) is the indicator used for citrus tristeza virus. The test take from one (1) to six (6) months.

Serological methods have been developed for the identification of viruses. The ELISA (Enzyme-Linked Inmuno-absorbent Assay) method permits the identification of citrus tristeza virus in only two (2) days.

1.2 PSOROSIS

Psorosis has been found in all major citrus areas of the World. The name of Psorosis was applied to a group of diseases which exhibit different symptoms but have in common a type of vein flecking chlorosis in immature leaves.

Psorosis A, Psorosis B, Blind Pocket, Concave gum, Crinkly leaf, infectious variegation and satsuma dwarf have been included in the Psorosis complex. However some investigators include only the first four because crinkly leaf, infectious variegation and satsuma dwarf can be mechanically transmitted while the others do not.

Psorosis causes decline of trees on almost all rootstocks and, although leaf symptoms appear earlier, there is little effect until the plant is over six years old. Psorosis is the only citrus virus known, where seed transmission have been shown. No vector has

been reported to transmit the virus and only three of the types are mechanically transmitted (Crinkly leaf, infectious variegation and satsuma dwarf). The common way of transmission is by grafting when using infected scions.

Main symptoms differ with the type of Psorosis:

1.2.1 Psorosis A produce bark lesions on the trunk and limbs. Here the bark comes off in dry irregular flakes. Gum may be present on the edge of the lesions and theyoung xylem.

1.2.2 Psorosis B similar but more extensive symptoms than in psorosis A. Also produce symptoms on the fruit (rings of sunken tissues on the rind).

1.2.3 Blind Pocket two forms are known:

i) Narrow, lense-shaped vertical depression in the trunk with gum layer underneath

ii) Concavities accompanied by psorosis-like eruptions.

1.2.4. Concave Gum Recent studies suggested not to include this disease in the psorosis complex but this has not been definitely substantiated.

Concave gum causes pockets which are longer, wider and shallower than those of blind pocket.

1.2.5. Crinkly leaf and infectious variegation:
Both are caused by strains of the citrus infectious variegation virus. The blades of mature leaves show warping and pocketing on single branch or whole trees. The fruit is often, but not always coarse, rough and misshaped. Chlorotic spots appear on all or part of the leaf blade.

1.2.6. Satsuma Dwarf Narrow boat shaped leaf. Trees are dwarfed with a bushy look.
Indicator plants are the most useful method for the identification of this virus disease. Sweet orange seedlings are used for the general identification of psorosis, but each type could be screened with other indicators (Eureka Lemon, Satsuma Mandarine, Mexican Lime, Peas, Beans, Cow Peas).

1.3 EXOCORTIS

This disease is caused by a "Viroid" (Free RNA without protein coat) and even when found Worldwide rarely kills the trees. Trees on susceptible stocks such as Trifoliate orange and its hybrids may be severely affected. The trunks below the bud union and the crown roots of these susceptible stocks, show vertical crack, gumming and scaling of the bark. Depending on the strain of the virus, trees can be slightly dwarfed to severe bark scaling and stunted.

Exocortis is transmitted mechanically and by grafting. Virus free material is essential.

Indexing of Exocortis is done rapidly and efficiently with some clones of Etrog citron (USDES 60-13, Arizona 861)

1.4 XYLOPOROSIS

Also known as "Cachesia" is a bud transmissible citrus virus, which attack the stem, bark and wood of citrus plants. The primary symptoms are gum impregnation of the phloem and pitting of the cambial face of the wood, with corresponding pegging of the bark. Other symptoms are chlorotic and sparse foliage, retarded growth etc.

Xyloporosis is not transmitted by vector, seeds nor mechanical means. It is only transmitted by grafting. The use of clean material is the best way to avoid the disease. Indicator plants are 'Orlando tangelo' and more recently 'Parson's special mandarine' is used.

1.5 LESS IMPORTANT VIRUSES

1.5.1 Impietratura: Symptoms similar to boron deficiency. All species are susceptible in various degree. Only graft transmissible. Grapefruit on sour orange is the indicator plant.

1.5.2 Cristacortis: Graft transmissible. Cause stem pitting. Symptoms are similar to Xyloporosis but pegs are larger. Orlando tangelo and Sour orange are the indicator plants.

1.6 VIRUS-LIKE DISEASES OF CITRUS

In this group "Stubborn" and "Greening" are the most important diseases. They cause very similar symptoms.

Stubborn is caused by a mycoplama like organism which is a wall-free procaryote: Spiroplasma citri. Greening is caused by a mycoplasm like organism which is a walled procaryote.

In general the principal symptoms of both are stunting, reduced yields and poor fruit quality.

2. VIRUS AND VIRUS-LIKE DISEASES OF PAPAYAS

The first report of a virus in papaya was made in Jamaica in 1930 by Mr. F.E.V. SMITH who reported the following:

> "Throughout the Island, papaws are subject to a disease but this trouble is most noticeable on the Liguanea Plain. The plants are attacked at all ages, but more often the symptoms do not appear until the tree is about reaching the bearing stage. The terminal leaves as they emerge from the bud are yellow and frequently mottled while their size gradually becomes reduced until nothing but a pencil point is left. By the time this stage is reached the larger leaves hang down and gradual death is the result. Usually some adventitious buds lower on the stem start into growth,but the majority of these suffer the same fate, and strong growth is never regained. While root attack is suggested by symptoms, it has not been possible to associate the symptoms with unhealthy root system and failure to find any organism in the tissues coupled with the mottling suggest that it is a virus disease. It has not been found that the disease is carried in the seed and other methods of transmission of a possible virus are being investigated".

The same year CIFERRI, reported a mosaic disease of papaya in Dominican Republic. The next year (1931) COOK reported a similar problem in Puerto Rico and he wrote the following:

> "What appears to be a virus disease of Carica papaya L. attacked the plants in the Station grounds a few years ago but the gardener destroyed the plants before the writer could make a study of them. This or a similar disease was later described by Dr. R. Ciferri of Santo Domingo as "curly leaf" but he was uncertain as to the cause. My histological studies indicate that it is a virus disease. The young leaves become more or less curled and in severe cases, this curling persists throughout the life of the plant. The lower leaves become yellow and fall. One or both symptoms may appear on the plants. Some times all the older leaves fall, leaving a cluster or rosette of leaves at the apex. In several cases the fruits are reduced in number and size".

Subsequent reports came from Edwards, Larter and Martyn in Jamaica (1931), Ho and Li in China (1936), Stell and Baker in Trinidad (1937 and 1939), Acuna and Zayas in Cuba (1940), Thownsend and Andrews in Florida (1940) and many other places around the World, where papaya was growing commercially.

Virus and virus like diseases have for long been recognized as a major limiting factors for the commercial production of papaya World wide.

Many names have been given to problems caused by virus and virus like diseases in papayas and, confusion trying to describe specific differences among some of them still today exist. Some of these names are:

Bunchy Top, Cotorro, Curly leaf, Mosaic, Mild Mosaic, Dieback, Ringspot, Distortion Ringspot, Faint Mottle, Spotted Wilt, Yellow Crinckle, etc.

Most of the reports in the Caribbean refer to the occurrence of Bunchy Top, Papaya Mosaic and Distortion Ringspot. While Florida reported mild mosaic, Faint Mottle and Distortion Ringspot as major or minor virus problems of papaya. Bunchy top is not known to occur in Florida while Mild mosaic virus has only been reported in Florida.

2.1 BUNCHY TOP

Without any doubt, Bunchy Top is a major disease of papaya wherever it occurs. It seems also that Bunchy top occur wherever the only vector confirmed (Empoasca papayae Oman) to transmit it, is present. There are some reports however, that suggest the possiblilty of other Empoasca species such as E.dilitaria being a vector of bunchy top in Cuba.

The Caribbean, (Cuba, Dominican Republic, Haiti, Jamaica, Puerto Rico and Barbados) have reported the highest damage from Bunchy Top disease. In this area, Bunchy top is the major limiting factor to growing papaya commercially.

Bunchy Top was once confused with many other virus and non virus diseases. Today we know it is cause by a mycoplasma and among the specific characteristic for its identification from other similar problems are:

1. Bunchy Top affects only Carica papaya (Don't have other hosts)
2. The latex don't flow from affected plants.
3. It is only trasmitted by Empoasca papayae,and possible E. dilitaria and E. stevensii.
4. It is not mechanically or seed transmitted.
5. Not as transmissible.

Bunchy top symptoms may be confused with that caused by other viruses such as the Papaya Mosaic Virus and Distortion Ringspot Virus. In general plants can be attacked at any stage of development but often the symptoms become more evident when the tree is bearing fruits.

Young leaves are curled at the top, yellow mottle spots are noticeable when the young leaves are faced to the sunlight, which become more and more apparent as the disease progress. Sunken greasy spots may appear at the end of the primary Axis. The growing point is reduced as well as the leaves emerging from it, until this growing point practically disappear. By this time old leaves hang down and gradually die. The disease symptoms always move from the top to the bottom and it seems the causal agent follow the same pattern. Normally adventitious buds develop lower in the stem and sometimes these buds may grow to produce a fair crop. In fact, one common practice, is to cut down the tree when the first symptoms appear, to allow for the development of one or two adventitious buds from the bottom.

2.2 PAPAYA MOSAIC VIRUS

The Papaya Mosaic Virus is also a major problem of papaya when ever it occurs. Unlike Bunchy Top, this virus is transmitted by several vectors, most of which are aphids. Among them the most important are Aphid spiraecola, Myzus persicae and Toxoptera aurantii.

This virus can be transmitted mechanically and by grafting. It is not transmitted by seeds. Several plants other than Carica papaya are reported as hosts of the Papaya Mosaic Virus. This virus stunts the plants, cause yellow mottling and distortion of the leaves. The plant eventually dies.

2.3 DISTORTION RINGSPOT VIRUS (DRV)

Distortion Ringspot is the most serious virus disease of Papaya in Florida and other subtropical areas. However it also affects papaya in the tropic. The virus has vectors which transmit it from plant to plants in a very effective and rapid way. The most important is Myzus persicae. Canover in Florida reported that Aphis spiraecola, Amphorophora sanchi and Macrosiphum ambrosiae were unsuccessful to transmit the virus (DRV) in several attempts. However other Aphids such as Aphis gossypii, Glover have been successful in other studies.

Other than by vector, the virus can be mechanically transmitted to host plants and also by grafting. Transmission by seed have not been reported.

The Distortion Ringspot Virus has the characteristics of a typical non persistent (stylet-borne) aphid-borne virus.

There is much variation on the symptoms from plant, to plant but in general the most recognized symptoms are the following:

Younger leaves show vein clearing followed by chlorosis of the crown. Blistering and severe narrowing and distortion of one or more leaf lobes develop. A greasy-appearing streak on petiole and stem follow, and fruits are affected by greasy-appearing spots, ring and C-shaped marking. Over a period of several weeks petiole become shorter, plant growth is retarded and fruit set is sharply reduced or ceased. The earlier the plant become infected the more dramatic the effect in the plants. The expression of symptoms in the field is more noticeable in cool weather than in hot weather. The same thing can be said about the virulence.

Even when Papaya is the only naturally occurring host, experimentally, the virus has been transmitted to several plants of the Chenopodiaceae and Cucurbitaceae families. At least three other species of Carica are host of the virus (C.cauliflora, C. goudotiana, C.monoica.)

2.4 MILD MOSAIC (MMV) AND FAINT MOTTLE RINGSPOT VIRUSES (FMRV)

They are two virus disease of Papaya of minor importance. The first one (MM) has only been reported in Florida and the second (FMR) has very similar symptoms to Distortion Ringspot (DR). In fact, in some stages they cannot be differentiated. In chrony stages, distortion ringspot (DR) is differentiated from FMR, by the distorted foliage and crusty grey coloured fruit symptoms, whereas FMR tends to recover and to produce inconspicuous symptoms. Also FMR is most readily recognized than DR in hot weather, while DR is more common In cool climate. They are identical in host range and aphids transmission, physical

properties and in some aspects in symptoms. That is why some researchers have suggested the possibilities they are different strains of the same virus.

Mild mosaic is not transmitted by Aphids and differ from them in physical properties and host range.

2.5 OTHER VIRUSES

Other viruses which have been reported to afflict Papaya are, Spotted Wilt virus, Tobacco Ringspot Virus and Yellow Crinkle Virus. None of them are so important to Papaya as the other viruses and virus-like diseases described.

3. CITRUS AND PAYAYA VIRUS AND VIRUS-LIKE DISEASES IN BARBADOS

3.1 CITRUS

Several pathologist-virologist visiting the island have suggested the possibility that tristeza is present in Barbados. But their statements were based on symptoms observed, and not on a serious study with indicator plants or other more accurate methods. Specifically, a decline on lime trees at bearing stage, observed through out the island is a reason for their conjecture. Moreover, known vectors of Citrus Tristeza Virus are confirmed to be present in Barbados. They are Toxoptera aurantii A.gossypii G. and A. spiraecola P.

Early introduction of citrus plant material from abroad was not always from a reliable virus-free source such as a Budwood Registration and Certification Programme. Also it is confirmed that private individuals have made their own introduction of plants or plant material. This situation, plus the fact that Psorosis, Exocortis and Xyloporosis are spread almost Worldwide, indicates

the strong possibility of these viruses being present in Barbados. If that is so, why is it that their effects are not noticeable?

Sour Orange (seville) is the only rootstock commercially used in Barbados. This stock is susceptible to CTV but not to Psorosis, Exocortis nor Xyloporosis. This is the main reason why symptoms are not noticeable at this point. Also, the Citrus Industry in Barbados is not yet developed. Only few commercial Orchards exist but the threat is a potential problem.

The Fruit Crop Development Project (MAFCA-IICA)has introduced most of the Indicator Plants for the Indexing of these viruses. Details of this Programme are given in PART II, the section of control of virus diseases.

3.2 PAPAYA

C. Weir, E. Tai and Cynthia Weir in their Book "Fruit Tree Crop Production in the Caribbean Region" reported Papaya Mosaic Virus as the most serious disease of Papaya in the West Indies. However, reports from Puerto Rico , Dominican Republic, Haiti, Jamaica and Cuba confirm Bunchy Top as the most serious disease of Papaya for those regions. This statement has now been proved for Barbados too.

S. Haque in a visit to Barbados reported to have seen clear symptoms of bunchy Top disease on Pawpaw Plants. However the same report pointed out he could not confirm Bunchy Top as the cause of so many Pawpaw plants which die from the observed disease. It is obvious that he based his observations on symptoms on affected plants, and no further tests were carried out.

In 1983 the Fruit Crop Development Project (MAFCA/IICA) in a joint effort with the Ministry of Agriculture of the Dominican Republic and the Institut Fur Virus Krankheiten Der Pflanzen in

Germany started a study to see if Papaya Mosaic Virus or the Bunchy Top diseases were responsible for the death of so many Pawpaw Plants in Barbados.

Vegetative material from affected plants were collected in the summer of 1983 from ten (10) different locations.

These materials were sent to Dominican Republic and Germany where they were submitted to indexing with indicator plants to immuno-electron-mycroscopical test and to electron microscope observations. The results from these studies were that mechanical transmission were not possible in several attempts at both places (Dominican Republic and Germany). The studies show no virus particle in the samples but particle of a mycoplasma like organism were observed.

Based on these tests and since we know Papaya Mosaic Virus is readily mechanically transmitted to these plants, we supported the confirmation of Bunchy Top as the causal agent of the disease problems of Pawpaw in Barbados. Moreover, the symptoms observed respond to that reported by Bunchy Top in other Areas especially the test of the Latex which does not flow out when the plant is affected. Further test such as transmission with vectors and grafting are being carried out.

The suspicions of a complex of virus and virus-like diseases as a major problem of Pawpaw in Barbados is not discounted, neither does the possible presence of other viruses. Since the sample were taken during the summer (to reduce the chance of contamination with Distortion Ringspot Virus if present) the test should be repeated, sampling late in Autumn and/or the Winter. During these seasons Distortion Ringspot Virus symptoms are more readily observed in the hot areas of the (tropics) and it seems that the virulence of the virus is greater.

* * * * PART II * * * *

I. IDENTIFICATION OF CAUSAL AGENTS: DIAGNOSIS

The method mostly used for the diagnosis of the causal agent when dealing with virus and virus-like diseases of Citrus and Papayas are:

- Symptomatology
- Chemical
- Inclusions (Paracrystals)
- Electron Microscopy
- Electrophoresis
- Culturing
- Transmission
- Serology
- Indicator Plants

1.1 SYMPTOMATOLOGY, as it is clear, the identification of the organism is done by observing the symptoms caused on the plants affected.

1.2. CHEMICAL METHODS are used to detect marked components characteristic of certain diseases. This method has been successful with Tristeza Exocortis and greening. The absence of starch in the root of citrus as determined by the Ionide test, have been used as a preliminary indicator of Tristeza.

1.3 INCLUSIONS: The aggregation of particle from the virus can be observed as paracrystal under light microscope. This technique is limited to few viruses at present.

1.4 ELECTRON MICROPSCOPE: This method is useful when the causal agent has been characterized. The presence of the virus particles, their shapes and sizes are determined by this method. Tristeza infected trees have been located by this method.

1.5 TRANSMISSION Method is well known for most Virus and Virus-like Diseases of Citrus and Papaya. The screening of these methods is used in the Diagnosis of the Causal Agent.

The Methods of transmission are:

a) Vectors
b) Grafting
c) Mechanical Inoculation
d) Seed

1.6 SEROLOGY

Serology is also a useful diagnostic tool, when the virus has been purified and antisera have been produced. Until recently, antisera have been produced for Tristeza, Satsuma Dwarf, Stubborn, Crinkly Leaf and Leaf rugose virus.

The ELISA (enzyme Linked immuno-absorbent Assay) is the most rapid method for the Diagnosis of citrus Tristeza Virus. In simple terms, the principle of the ELISA procedure is as follows (Fig.1):

a) The specific antibody is absorbed by a microtiter plate. WASH.

b) The test sample containing the Virus is added. WASH.

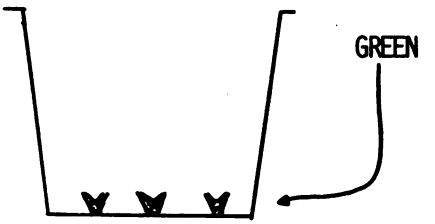
c) The Enzyme-labelled with specific antibody is added. WASH.

d) The Enzyme Substrate is added.

e) The color intensity which is proportional to the Virus concentration is measured.

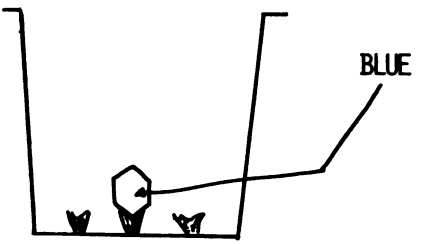
Fig. 1 ESCHEMATIC PRINCIPLE OF THE ELISA PROCEDURE

1. SPECIFIC ANTIBODY ABSOBED TO PLATE.



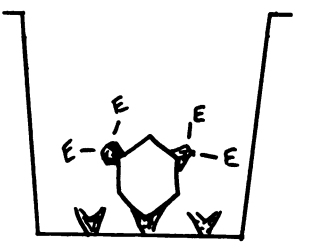
WASH

2. ADD TEST SAMPLE CONTAINING VIRUS



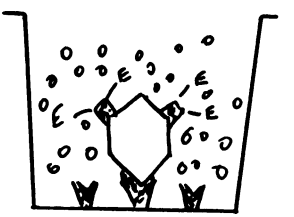
WASH

3. ADD ENZYME LABELLED SPECIFIC ANTIBODY



WASH

4. ADD ENZYME SUBSTRATE



5. MEASURE COLOR INTENSITY (PROPOTIONAL TO VIRUS CONCENTRATION.

By this method Citrus Tristeza Virus can be detected in two days. The Elisa method has several modification. Some of them are the Elisa Sandwich, the double Sandwich and the "Bead" ELISA.

The "Bead" ELISA is a modification that have special application when using few sample. The equipment used in this method is less specific, and the microtiter plates are substituted by PLASTIC "beads".

1.7 INDICATOR PLANTS

The indexing of Virus and Virus-like disease by the use of the indicator plants is today one of the most practical and more used method for the diagnosis of the causal agent. These plants show recognized symptoms when inoculated with the suspected problem. The time and the temperatures are two important factors in this test. TABLE 1 presents the Indicator Plants used for each Virus, the symptoms expected, the optimal temperature and the Incubation Period.

Table 1. INDICATOR PLANTS AND SYMPTOMS PRODUCED ON THEM BY THE PRINCIPAL VIRUS AND MYCOPLASMALIKE AGENTS*

Disease	Indicator Plants	Symptoms on Indicator Plants	Optimal Temperature (°F)	Incubation Period
Blind Pocket (see also psorosis)	Mandarin, sweet orange, lemon	Leaf flecking and/or vein clearing.	65–78	4–8 weeks
Cachexia-Xyloporosis		Gum in Parsons Special near union and point of cutback; pits in wood and gum in bark of long-term indicators.	80–95	1 year on Parsons Special; 2 years or more on others.
Citrange Stunt (see also tatter leaf)	Troyer, Carrizo, or Rusk citrange	Distortion and blotching of young leaves and twigs. Later symptoms are zigzag growth of branches and wood pitting.	65–78	4–8 weeks
Concave Gum	Dweet tangor, mandarin, sweet orange	Oak-leaf pattern and flecks in young leaves.	65–78	5–10 weeks
Crinkly Leaf (see also infectious variegation)	Citron, mandarin; sweet orange, sour orange, lemon	Crinkling of leaves, leaf flecking.	65–78	3–6 weeks
Cristacortis	Orlando tangelo, sour orange, sweet orange	Concave gum or psorosis-like leaf symptoms may appear but are not diagnostic. Pitting and gumming of stems of Orlando and sour orange in later stages.	moderate	10 months or more: leaf symptoms sooner
Dweet Mottle	Dweet tangor	Psorosis-like mottle on leaves.	65–78	6–9 weeks
Exocortis	Etrog citron (Arizona 861; USDCS 60–13; some others)	Leaf and stem epinasty: cracking of midvein; browning of underside of veins; stunting, blotching and cracking of stem; wrinkling and browning of petiole; browning of petiole; browning of leaf tip.	80–95	3–16 weeks
Greening	Sweet orange, tangelo	Stunting, leaf blotching and chlorosis.	cool type 65–75 warm type 70–95	4–12 weeks

*From - The Citrus Industry. Vol. 1V: 205 - 207. Reuther W., E. Calavan and G. Carman Editors 362p.

(cont.) Indicators Plants .....

Disease	Indicator Plants	Symptoms on Indicator Plants	Optimal Temperature (°F)	Incubation Period
Hassaku Dwarf (see also tristeza)	*Citrus obocoidea* and Mexican lime	Small upfolded leaves, vein clearing.	— —	
Impietratura	Grapefruit, sweet orange	Hard, gummy deposits in rind and core of fruit; psorosis-like leaf symptoms may occur but are insufficient for diagnosis.	— —	Leaf symptoms may appear in a few months; one year or more for fruit symptoms.
Infectious Variegation (see also crinkly leaf)	Citron, mandarin, sweet orange, sour orange, and lemon	Leaf flecking, speckling, crinkling, variegation, and distortion.	65–75	3–8 weeks
Leaf Curl	Caipira sweet orange	Extreme curling of leaves, stunting.	— —	
Psorosis	Sweet orange, mandarin, Mexican lime, Dweet tangor, citron	Clear flecks along veinlets; sometimes ring-like patterns on mature leaves; rapid dieback of new growth (shock) usually followed by recovery.	65–78	4–8 weeks
Ring spot	Lemon, Rough lemon, sour orange, sweet orange	Yellowish rings with green islands on some leaves; sometimes vein clearing and stem lesions.	65–80	4–12 weeks
Satsuma Dwarf	White sesame, Satisfaction kidney bean, and Blackeye cowpea by sap inoculation. Satsuma for long-term test outdoors.	Necrotic spots and streaks from sap inoculation (see text); leaves bent downward, boat-shaped or spoon-shaped leaf symptoms in long-term test on Satsuma.	Cool to moderate	— —

(cont.) Indicators Plants

Seedling Yellows (see also tristeza)	Lemon, sour orange, grapefruit, Mexican lime, *C. excelsa*	Stunting and yellowing of sour orange, grapefruit, *C. excelsa*, and lemon; stem pitting of Mexican lime; corky veins may develop late on Mexican lime.	65–80	4–12 weeks
Stem Pitting (see also tristeza)	Mexican lime and grapefruit; long-term test on grapefruit needed for stem pitting diagnosis.	Pitting of the stem (delayed in grapefruit), vein clearing of leaves of Mexican lime.	65–80	8–16 weeks; 2 years or longer in grapefruit
Stubborn	Sweet orange, tangelo	Stunting and leaf mottle, leaves smaller than normal, shortened leaf internodes.	80–92	4–12 weeks
Tatter Leaf (see also citrange stunt)	*Citrus excelsa*	Blotching, vein chlorosis and distortion of leaves, ragged edges on some leaves.	65–78	4–8 weeks
Tristeza	Mexican lime; *Citrus macrophylla*, *C. excelsa*.	Veinlet clearing in young leaves; stem pitting.	65–78	3–24 weeks
Vein Enation, Woody Gall	Mexican lime, *C. volkameriana*. Rough lemon, sour orange, and Rangpur lime	Enations on underside of veinlets of Mexican lime and sour orange; galls on trunks of *C. volkameriana*. Rough lemon, Rangpur lime, and Mexican lime.	65–85	4–12 weeks for vein enations; often longer for woody galls
Yellow Vein	Mexican lime, Rough lemon, Etrog citron, *C. macrophylla*	Bright yellow veins in leaves; yellow blotches on stems.	65–80	2–8 weeks

2. THE CONTROL OR PREVENTION OF VIRUS AND VIRUS-LIKE DISEASES

2.1 QUARANTINE PROGRAMME

Quarantine is not new. In our Region (under-developed countries) the availability of trained personnel and facilities are the major limitation faced in trying to avoid the introduction of Pest and Diseases from one country to another. This situation is aggravated by the fact people often use considerable ingenuity to circumvent quarantine measures.

2.2 INSECT CONTROL

Many viruses are transmitted by Vectors. The establishment and follow-up of an effective spray programme is favourable to reduce the spread of these viruses. The eradication of virus-vectors, although have been successful in some areas, is expensive and often the effects are temporary.

2.3 OIL SPRAY

Oil Spray has been used to wash out the stylet of vector when the virus dealing with it is non persistent. The oil spray form a film layer at the surface of the leaves which wash out the Virus from the stylet of Sucking Insect Vectors.

2.4 CHEMOTHERAPY

The use of certain product to treat affected trees have been investigated to certain extent. Tetracycline have caused temporary remission of Greening Symptoms in Citrus. Also some curative effect has been noticed in Papaya against Bunchy Top. But the expense is prohibitive for commercial orchard.

2.5 CROSS-PROTECTION

The inoculation of trees with a mild strains of virus to protect them against more virulent strains (like the vaccination of animals) have been studied with good promising results. Cross-protection appears to be specially useful in protecting plants from virulent forms of citrus tristeza virus. The inoculation of stock Scion combination has also been studied to dwarf citrus trees.

2.6 APOMITIC EMBRYONY

Apomixis is the reproduction of a plant without any form of sexual union. Nucellar embryos are those apomictic embryos that develop from the nucellus. The main characteristic is that they are 'True to Type' and also virus-free, since Virus do not develop in very young meristematic tissues, and seed transmission is very rare. But these trees propagated from these seedlings show characteristics of juvenility (vigorous growth, thorniness and slowness, to come bearing), which is the main disadvantage of this method. However the method has been very useful in citrus to reproduce Virus-free material when a Potential Plant (with good characteristics) was affected by Virus.

2.7 HEAT

Heat has been used to eliminate or inactivate virus and virus-like diseases on citrus plants. Tristeza, Psorosis and Exocortis could be inactivated but attempt to destroy Xyloporosis have been unsuccessful. The base of this method is to find the temperature, where at a given time it will inactivate the virus without damaging the tissues of the plant.

Hot water has not been effective in the control of viruses. However, the use of hot air in chambers where the temperature is uniformly controlled, is commercially used today to inactivate these

viruses.

2.8 MERISTEM CULTURE

Tissue culture is one of the most revolutionary field in Agriculture. The production of virus free material by the induction of callus and shoots from meristems, and even from part of a cell, is used commercially in many crops. This method of propagation has been of great help to Horticulturist, Pathologists, Virologists and even breeders.

In Papaya for instance, Anther and embryo culture have been used in Florida to avoid the problems of cross compatibility among certain species of Carica and combine characteristic of quality with resistance to Distortion Ringspot Virus.

Meristem culture has long been used in citrus also.

2.9 MICROGRAFTING (Shoot tip grafting in VITRO)

The juvenility problem of the use of apomitic embryos gave rise to an input to find alternative method that could be used to produce Virus Free Plants, "True to Type" and to overcome juvenility. The Shoot tip grafting in vitro has been one of the most successful. This method is today used in most of the programmes to produce Virus-Free Plants of citrus.

The method consist of germinating seeds under very aseptic conditions. After disinfected in a 0.5% Sodium Hypochlorite solution seeds are germinated in vitro using a plant cell culture salt solution (Murashige and Skoog) solidified with 1% DIFCO BACTO-AGAR. A Shoot tip excised from the prospect tree is then sterilized and a 0.15mm long tip is placed onto the decapitated Rootstock Seedling, The procedure is conducted in an air chamber to avoid contamination.

This method is being improved each day and without doubt it is to become the leading method to produce Virus Free Plants.

2.10 SELECTION AND BREEDING

The selection of plants for given characteristics, is one of the oldest method used to improve production and obtain resistance to soil and disease problems, etc. This method is as old as the agriculture itself. However, sometime it is difficult to maintain the selection of a given character without loosing potential in others. The method of grafting and other vegetative methods help a lot to improve the selection of trees since the clonal propagation avoid the segregation common in sexual reproduction.

The selection of tolerant plants to virus and viruslike diseases has been tried for a long time in most of the citrus and papayas areas of the world. In citrus the main effort is to find Resistant Rootstocks while in Papayas the selection produce plants in their own roots.

Improvements are continuous and as a result of them, several of the virus and virus-like diseases of citrus are today reduced to the minimum effect.

In Papaya the process has been slower. May be, due to the fact that most of the resistance characters are found in Carica species which are not cross-compatible with Carica papaya and that selected specific genotype could be lost if propagated by seed.

However, a revolutionary method to produce hoploid plants from Anther culture, which then can be treated so as to become diploid has been developed. The Diploids breed true since they were truly homozygous.

Also Embryo culture has been used to overcome the problem of incompatibility between Carica papaya and Carica spp.

Specifically CANOVER and LITZ used this method to transfer resistance to Distortion Ringspot Virus found in certain Carica spp to Carica papaya.

2.11 RESISTANT ROOTSTOCK

Budding and grafting has long been used in Vegetative propagation for their advantage in combing characteristics of two different plants without the problem of segregation.

Citrus is probably the crop in which most study has been conducted in Rootstock Scion Relationship. Citrus Rootstock has been selected, tested and used for their resistance to given Diseases and soil problems. Also for the overall influence on the performance of the top cultivar budded on them.

TABLE 2 presents the overall performance of the most used Citrus Rootstock in relation to Tristeza, Exocortis, Xylopososis, Gummosis Drought condition, soil type and quality of the fruit produced.

2.12 BUDWOOD REGISTRATION AND CERTIFICATION PROGRAMME

The establishment of a Budwood Registration and Certification Programme to avoid or to reduce the problem of Virus and Virus-like diseases of citrus has been the classical and at the same time the modern approach.

In this programme, all the different methods for the control and prevention as well as the Diagnostic method for Virus and Virus-like diseases can be combined. The effect of such a programme is gradual in places where a well developed Citrus Industry exist but definitely it is effective, specially in young and

primordial Citrus industry such as the one in Barbados. In the former old orchards are removed and certified trees are planted or replaced. In the latest, the Citrus Orchard established could be from Virus Free certified plants from the very beginning.

TABLE 2: PERFORMANCE OF CITRUS ROOTSTOCKS (SALIBE, A.A. 1977)

ROOTSTOCK	TRISTEZA	EXOCORTIS	XYLOPOROSIS	RESISTANCE TO GUMMOSIS	RESISTANCE TO DROUGHT	INDICATED FOR SOILS	INDICATED FOR SPECIES	QUALITY OF THE FRUIT
SOUR ORANGE	S	T	T	H	M	HEAVY	ALL	H
SWINGLE CITRUMELO	R	S	T	H	M	LIGHT & HEAVY	ALL BUT LEMONS	H
CARRIZO CITRANGE	R	S	T	H	L	LIGHT & HEAVY	ALL BUT Eureka lemons	H
CARRIZO MORTON	T*	S	T	H	L	LIGHT & HEAVY	ALL	H
CITRUS VOLKAMERIANA	T	T	M	M	H	LIGHT & HEAVY	ALL BUT SOME ORANGES	L
ROUGH LEMON	T	T	T	L	M	LIGHT	ALL BUT SOME ORANGES	L
RANGPUR LIME	T	S	S	L	H	LIGHT	ALL	L-M
SUNKI MANDARIN	T	T	T	M	M-H	LIGHT & MEDIUM	ALL	M
CLEOPATRA MANDARIN	T	T	S	M	L	LIGHT & MEDIUM	ALL BUT LATE ORANGES	M
ORLANDO TANGELO	T	T	S	M	L	LIGHT & MEDIUM	ALL	M
CITRUS TAIWANICA	T*	T	T	M	L	LIGHT & MEDIUM	ALL	M
SWEET ORANGE	T	T	T	L	L	LIGHT	ALL	M

* SHOW WOOD PITTING

LEGEND: S = SUSCEPTIBLE H = HIGH
T = TOLERABLE M = MEDIUM
R = RESISTANCE L = LOW

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MAJOR PROBLEMS ON FRUIT CROP PRODUCTION IN BARBADOS

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CHAIRMAN EDWARD CUMBERBATCH

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Senior Agricultural Assistant, MAFCA

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CMSR S.L. THOMAS
Virologist/Pathologist, MAFCA

"Fruit Crop Diseases in Barbados"

MICHAEL J. MORAN
Marketing Specialist, IICA

"Fruit Crop Marketing in Barbados"

AGRONOMIC PROBLEMS OF FRUIT PRODUCTION IN BARBADOS

by

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ABSTRACT: In times past fruit trees production in Barbados was a very haphazard affair and no special attention was given to them. Since there were no organized cultivation these problems went unnoticed As fruit tree cultivation become more organized many problems are apparent. This paper deals with the agronomic problems affecting fruit production, particularly those found in the nursery and in the fields. Improper nursery practices can have a concommitant effect in the future orchards. Field problems are related to soil management, such as pruning, training and providing windbreakers.

1. INTRODUCTION

In the past, fruit tree production in Barbados was very limited. There was no systematic approach to the production of fruit. Data on investments and returns was non-existent, as such, there were no records to use as standards.

Now, with more and more attention and effort being put into the systematic development of orchards, problems are more apparent. These problems are many and varied, and affect not only the farmer but also the researcher and extension agents.

This paper seeks to focus on the problems related to management, both in the nursery and in the field, under conditions which are applicable to Barbados.

2. NURSERY MANAGEMENT

Formerly, farmers or householders had to rely on their own selection of fruit species and/or cultivars. Selection would be based on

either flavour, sugar content, external quality, length of time to maturity or any other characteristic which suited the farmer.

However, with the modern methods of plants breeding (developing new species cultivars) and vegetative propagation, this haphazard system was greatly replaced. Government began the production of fruit trees using modern and updated techniques, such as: Mist propagation for the rooting of cuttings, Micro-propagation, Tissue culture etc.

Some of the nursery related problems are:-

- Inadequate scion/rootstock relationship studies; e.g. Sour Orange (Citrus aurantium) has been the main rootstock over the years. Studies suggest that some of the newer rootstocks should be evaluated.

- Indiscriminate selection of scion material;

- Insanitary propagating practices;

- The spread of virus diseases.

Present nursery work in Barbados has three main objectives:

i. the production of quality plants;

ii. the production of enough plants to replace old plantings and establish new ones and also making the plants available at attractive prices to the consumer while reducing high Government subsidies.

iii. the constant look for species and/or cultivars which are high yielders, have good export potential and which

exhibit a high degree of tolerance and/or resistance to pests and diseases.

In addition to the above there is the need for staff, at all levels, to be trained in modern nursery management and propagation techniques.

3. PLANTING

3.1 PLANTING SYSTEM

3.1.1 Back-yard System

Small farmers and householders have evolved what is known as the "back-yard" system. "The system where fruit trees are grown in a disorganized condition around the house." It was established in several ways:

- The small farmer or householder would buy a fruit and if it tasted good would either grow it in a pot or box and then plant in the back-yard or just simply throw the seeds in the back-yard.

- A neighbour who had more seedlings than desired would distribute to friends.

- If the tree could be propagated by cuttings, a piece would be broken off and stuck into the ground.

- In a few cases, e.g. plum, a branch was used as a fence post but caught root and flourished.

- More recently, especially when Government sold plants for $1.00/plant, a householder, who originally had $10.00 to buy two (2) plants realised he could buy ten

(10). He did so. The result: an area of maybe 18m x 8m (144 sq. m.) which should hold three (3) plants at a 7.5m x 7.5m spacing is now holding as many as ten (10) plants or more.

What happens?

Competition

(a) For light - results in tall spindly plants with poor lateral branching.

(b) For nutrients - results in poor performance, high susceptibility to disease and pests, etc.

(c) For water - without which, vital processes slow down.

Transmissions of pests and diseases from plant to plant are made easier.

Destruction of flowers, leaves and young fruits occurs when limbs and branches of one tree knock off that of others.

Aesthetics beauty of a well laid orchard is absent.

3.1.2 Standard System

This system was used mainly by plantations. More

recently small farmers who wished to make fruit growing a commercial venture also adopted the practice. It follows a square or rectangular pattern with various basic spacing depending on the size of the tree.

- Small Fruit Trees - usually occupied a spacing of 5m x 5m e.g.West Indian Lime, Barbados Cherry, Dunks, Guava etc.

- Medium Sized Fruit Trees are spaced between 6.5m x 6.5m to 8m x 8m e.g. Grapefruit, Orange, Lemon, Julie Mango, etc.

- Large Sized Fruit Trees are spaced at approximately $10^{(+)}$m x $10^{(+)}$m e.g Imperial Mango, etc., Avocado, Breadfruit, Breadnut, Coconut, etc.

Sometimes the above spacings created problems such as:

- After a few years trees overlapped, hence blossoms were knocked off. Also, there can be easier transmission of pests and diseases.

- The use of machinery can be severely restricted.

- The movement of workers is hampered.

3.2 WINDBREAKS

The mean annual wind velocity is 4.5m/sec. ranging from 3.5m/sec. in October to 5.9m/sec. in June. This can be a significant drawback to fruit production. The wind:

- knocks off blossoms,

- dries out the soil,

- destroys leaves,

- aids in the transmission of diseases

- and carry salt mist or deposit.

Therefore the use of windbreaks is important. Windbreak by definition is anything that modifies the flow of wind. For example:

- A building to the windward side of a tree.

- Another tree(s).

- Fences with or without vines on them.

- Netting, e.g. saran.

Not all fruit trees need a windbreak. Some fruit trees are themselves very tolerant of moderately strong winds, e.g. Barbados cherry, mango, jamoon, etc. They can also be used as windbreaks.

4. ORCHARD MANAGEMENT

Whereas nursery management is the prime consideration of the Government and a few private nursery operators, orchard management concerns all growers of fruit trees. The aim of both is to produce enough fruit to satisfy household demands and to have a surplus.

The agronomic aspect of orchard management to be discussed include: Soil and water management, pruning and weed control.

4.1. SOIL MANAGEMENT

The soils of Barbados are predominantly shallow. However, the underlying parent rock (coral) is relatively soft and crumbly, and provides, for the most part, excellent drainage. Unfortunately the coral limestone releases much calcium ions, which at high levels raises the pH and makes other necessary elements become unavailable. Hence, management of soil for fruit production must seek to correct these problems. Other soil problems existing in the Scotland District are:

- Highly erodable soils (sands and clays)
- Excesses of oil and salt.
- Poor drainage.
- Unreliable water availability.

Different techniques of soil management are indicated for this type of region. However, several species have proven to be adaptable to harsh conditions, e.g. Cashew (Anacardium occidentale L.) Mango (Mangigera indica L) Barbados Cherry (Malphigia glabra L) Fat Pork (Chrysobalanus icaco) and guava (Psidium guajava L)

Small farmers in the past were never very serious fruit growers, but in the "back-yard" situations they cultivated fruits such as golden apple (Spondias sp) Citrus (Citrus spp), coconut,(cocos nucifuava) and breadfruit (Artocarpus communis). Bananas (musa spp) were usually intercropped with sugar cane or planted on the hedge row.

Fruit growing by small farmers was more pronounced in areas such as Dunscombe, Porey Spring, Welchman Hall, Sugar Hill, Chimborazo, Horsehill. It is to be noted, that these places are located on the fringes of the Scotland District, where lands are marginal but rainfall is usually adequate.

Householders in urban and suburban areas encounter situations where trees were planted in subsoil because top soil was removed to allow for building. Also the grass that are lawns were used to beautify the houses competes severely with trees for water and nutrients.

4.2 PRUNING

Pruning in fruit trees is done for three basic reasons: Production, Framework, Maintenance.

In Barbados pruning is done mainly for maintenance; that is the removal of dead, damaged or diseased branches. For some crops such as Avocadoes only maintenance pruning is required. But for others such as Grapes, Framework and Production pruning are essential.

Pruning is an art and require certain skill and practice. The use of proper tools is important. However, wrong tools are frequently used by householders. The use of cutlass instead of pruning shears; pruning knife and saw can lead to jagged cracks which do not heal smoothly and provide hiding places for ants and other pests. Moisture seeps into these cracks which creates a fertile breeding ground for the various pathogenic fungi.

The portion of the limb to be cut should extend well into the non-diseased or damaged part of the limb. The cut

should be made at a bud or young twig and should slant away from the bud. There should be no jagged edges and the cut should be treated with a fungicidal paste. One week later paint with tree seal.

4.3 IRRIGATION

Many of the orchards relied on natural irrigation (rainfall). However, recently, with the move to a more sophisticated fruit orchard programme, there has been a corresponding shift towards providing a reliable supply of water. Thus, we observe that there are quite a few orchards with trickle irrigation.

Trickle irrigation has brought its own set of problems, namely:

- It is relatively expensive to establish.
- Clogging may occur.
- Malfunctioning of equipment may occur which results in overwetting of some areas.
- Damage by machinery to the irrigation lines.

The problem of moisture availability shows up also with back-yard farmers who do not realize, the importance of a steady supply of water to fruit trees, especially when in a fruiting stage.

4.4 WEED CONTROL

Many farmers do not seem aware of the danger of weeds. Weeds serve as reservoirs of many plant pathogens -

bacterial, fungal and viral, e.g. wild cucurbits transmit virus to bananas, etc. Pondgrass is a reservoir for some nematode species. The list is endless.

For the most part trees are left to compete with a wide range of weeds especially the true grasses and climbers. In many cases it has been observed, that these weeds are more successful than the trees in the competition for water, light and nutrients.

Climbers that compete for light and nutrients are mainly cow itch, hog vine and monkey cucumber of the leguminoseae, convolvulaceae and cucurbitaceae families respectively.

Weed control may be by three basic methods of a combination of all three: Chemical, Mechanical, and Manual.

Each system has its drawbacks: The danger of toxicity to plants and animals, e.g. persistence of the chemical, and harmful side effects; Machinery tends to cause physical damage and soil compaction. Manual control is an expensive user of labour.

Good weed control should go hand-in-hand with the establishment of a good ground cover - preferably a leguminous crop. A good ground cover is one which will not compete for light, nutrients and water, is not an alternate host for pests and is easy to maintain, e.g. Centrosema pubescens.

5. CONCLUSION

In conclusion, I would like to say that in spite of all of these problems the situation is not without hope.

There is already a concentrated effort to raise the standard of fruit tree production in Barbados.

The fruit tree industry is benefiting from the vast amount of research that has gone into vegetables in terms of pesticides, fertilizers and so on.

The knowledge of land cultivation and management has increased tremendously. Farmers are quite familiar with compound and single nutrient fertilisers. They better understand the use of organic matter.

The Ministry of Agriculture, Food and Consumer Affairs in conjunction with other international agencies especially IICA is extending fruit production capabilities by increasing training of staff in matters relating to fruit production and the introduction of better selections of fruit species and/or cultivars.

Now that these problems are being dealt with, the future of a viable fruit production system in Barbados appears promising.

PESTS OF ORCHARD CROPS IN BARBADOS

by

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ABSTRACT: All fruit trees in Barbados are attacked at one stage or another by a wide range of invertebrate and vertebrate pests. The major pests are insects, but mites, millepedes, snails, slugs and birds are also important, particularly in fruits. The symptoms or direct damage resulting from pest attacks can be used as indicators of their presence because the organisms are not always conspicuous. Damage to fruit trees is either associated with sucking or chewing type organisms. With the former e.g. aphids, curling and wilting of leaves are the most obvious symptoms but the plant may be killed if large populations are involved. With chewing types, portions of plant tissue are removed. Whatever the mode of feeding, great losses can result from such pest attacks and in many instances, control measures have to be implemented.

1. INTRODUCTION

A wide range of vertebrate and invertebrate pests are associated with orchard crops in Barbados. These pests include insects, mites, millipedes, slugs, snails and birds. Insects are by far the most dominant of these pests and the level of damage caused by any pest species varies considerable from year to year.

1.1 INSECTS

The insects which attack fruit trees are broadly classified as either suckers or chewers. The type of damage which they cause is directly related to these methods of feeding and the structure of the feeding mechanisms.

1.1.1 Suckers

Sucking insects possess mouthparts which are fitted with long needle-like tubes or stylets which are used for

sucking plant juices. Because of their feeding structures, sucking insects tend to feed on or near leaf veins in which the flow of fluids is greatest and closest to the surface. Stylets are inserted into the veins and plant sap which is normally transferred to aerial plant parts are drawn into the insect's mouth. Such feeding activity causes leaves so affected to wrinkle, yellow, wilt and eventually fall prematurely. Young plants can even be killed. The period taken for symptoms to show up is influenced by the number of sucking insects feeding on the plants. Because of the ease with which this food is obtained, sucking insects develop quite rapidly. A complete life cycle can be completed in just a couple of weeks. Additionally, particularly with plant lice or aphids, the life cycle may be shortened to further capitalise on the food supply. The egg stage is usually eliminated and live young are produced directly from female adults. Females do not have to mate to produce offspring. This adaptation of sucking insects so as to exploit their food source is of major consequences to the host plant which is affected considerably.

Sucking insects also produce a sweet substance called honeydew. This is loved by ants which feed on it and are often present in large numbers on leaves which are attacked. Of greater concern, however, is the black sooty mold fungus which grows on this sugary medium. The fungus covers the leaves and reduces the photosynthetic activity of the plant.

Although leaves are the main target of sucking insects, young stems, flowers and fruits may also be affected. Aphids, scales, mealy bugs and thrips are the major sucking insects which attack these plant parts. Most of the adult sucking insects will develop wings and thus fly from heavily infested or unthrifty plants to new vigorous ones. This not only guarantees their survival but increases their pest potential. Scale insects seldom produce wings and tend to

remain almost immobile on stems or leaves on which they feed.

Because these insects are so small, (most of them being barely visible to the naked eye) one does not easily recognize their presence. Additionally, they prefer to feed on the young soft terminal leaves and buds which are often out of one's reach in fruit trees, and this increases the difficulty of detecting damage. However, excessive feeding will cause severe distortion of the leaves. The leaves will wrinkle and buckle in a very irregular pattern. Examinations of the lower leaf surface will usually indicate that sucking insects are present. Because all life cycle feeding stages of these insects are suckers then the entire life cycle can be spent on a single area of the plant.

Damage on fruit is usually associated with discoloration of the skin. Sucking insects are also transmitters of virus diseases.

1.1.2 Chewers

In chewing insects the mouthparts are comprised of a pair of chewing structures or mandibles. These are very hard and possess sharp rows of teeth. By moving the mandibles in synchrony, portions of the plant tissue are completely removed. Such damage can be very extensive, particularly in insects which lay eggs in batches. Army worms fall into this category. When such larvae are allowed to feed unchecked, then only leaf veins may remain.

The powerful mouth parts of chewing insects have enabled them to explore areas which are unsuitable for the sucking types. Some of these insects have become borers. They tunnel into roots and stems or gird them. The effect of this method of feeding on the plant, particularly the borers is often most devastating. The plants so affected may show

symptoms similar to those exhibited by sucking insects, leaves wilt but without the wrinkling associated with suckers, stems and branches may be killed. With heavy attacks trees may die in a couple weeks after the first symptoms appear. The major chewing insects are moth larvae, beetles, termites and leaf miner larvae.

1.2 MITES

These small organisms are quite similar to the sucking insects both in size, feeding structures and damage levels. The symptoms are also identical. They are mainly restricted to leaves and fruits. On the latter they may cause severe discolouration.

1.3 MILLEPEDES

Although millepedes are often regarded as feeders on decaying vegetable matter, they have been known to cause considerable damage to fruits and leaves. They are chewers and will cause extensive leaf damage. Their greatest damage is however to fruit into which they will tunnel. They tend to feed in groups.

1.4 SLUGS AND SNAILS

These mulluscs, particularly slugs, are very serious pests on fruit trees, particularly citrus. They seldom feed on fruits. The damage is of the chewing type. Slugs leave a slime trail as they move. In sunlight, the dry trail glistens, and this feature is quite diagnostic of the presence of these pests. This mullusc is soft bodied and hence quite prone to dessication. Their activity is thus primarily nocturnal or during rainy cool days. They lay eggs in batches in the soil and are very voracious foliage feeders. Slugs will also remove bark from citrus trees thus killing them.

Snails are less a problem since their numbers are often small.

They will however attach themselves to fruits on which they feed and chew holes. These fruits are unmarketable.

1.5 BIRDS

The only birds which are regarded as pests on fruits in Barbados are the ground sparrows. These are general pests and will pick holes in both young and ripe fruit. The damage is worst in dry seasons when seeds and insects, the preferred food of these birds are in short supply.

2. PAPAYA (Carica papaya L.)

Many pests (Table I) attack pawpaws, but only a few of them are of major importance. Although the lists of pests are quite long, many of them are restricted to minor pest status because of the influence of natural enemies and other controlling factors. Some of the sucking insects, particularly leafhoppers and aphids, can cause serious mechanical damage as well as transmit some of the most serious diseases of pawpaws e.g. bunchy top disease.

TABLE I: PESTS ASSOCIATED WITH PAWPAWS IN BARBADOS

Sucking types		
Aphids	-	Myzus persicae and other unidentified aphids
Bugs	-	Nezara viridula, stink bug
Leafhoppers	-	Empoasca papayae
		Empoasca sp
Mealybug	-	Pseudococcus sp
White fly	-	Dialeuroides sp
Scales	-	Unidentified assorted types
Mites	-	Tetranychus urticae, red spider mite
Thrips	-	Thrips tabaci, onion thrips
Chewing types		
Moths	-	Heliothis zea, corn earworm
		Spodoptera sp, armyworms
Birds	-	Brown sparrow, Loxigilla noctus
		Yellow sparrow, Coereba flaveola

The young leaves curl and turn yellow when under attack by these sucking insects. The insects are mostly confined to the underside of the leaves and will be easily overlooked if the leaves are not examined carefully. Very heavy attacks can result in the death of young plants. Large quantities of honeydew may be produced and sooty mould may cover the entire leaf surface thus reducing the photosynthetic capacity of the plant with the consequential reduction in fruit yield.

The onion thrips, in addition to its sucking method of feeding also possesses mouthparts which allows it to scrape off tissue. If the fruit is attacked by this insect the skin is bronzed thus affecting its market value. Birds will feed on both young and mature fruits.

2.1 CONTROL

Because the majority of pests of pawpaw are minor, control programmes have never been pursued on a regular basis. However, leafhoppers can cause serious problems both from the mechanical damage resulting from their feeding activity and the virus diseases which they transmit. Many natural enemies, mainly ladybird beetles and aphid lions, keep other potential pests in check. When insecticides have to be applied, these should be used selectively, and special care should be taken to cover the undersides of the leaves as these could be folded over to protect the offending insect pest.

Most contact insecticides will give excellent control of leafhoppers. Among the most popular are the synthetic pyrethroids, Decis, Ambush, Sherpac, Belmark and organophosphates like Malathion.

3. MANGO (mangifera indica))

Most of the insect and mite problems of mangoes are confined to the leaves. Again sucking insects are the major pests associated with this plant (Table 2).

TABLE 2. Pests associated with mangoes in Barbados.

Sucking types	
Mealy bugs	*Pseudococcus* sp
White flies	*Dialeuroides* sp
Scales	unidentified assorted species
Thrips	*Selonothrips rubrocintus*, *Thrips tabacci*
Mites	unidentified
Chewing types	
Moth	unidentified boring cossidae
Birds	Brown sparrow, *Loxigilla noctus*
	Yellow sparrow, *Coereba flaveola*

3.1 SUCKING INSECTS

All of the sucking insects are soft bodied and prefer to feed on the leaves. Unlike pawpaws, whiteflies are a very serious problem and are responsible for the premature falling of leaves. The fragile adults with white powdered scales and the creamish nymphs feed along the veins of leaves usually on the undersurface, close to the midribs. Although the adults are good flyers they tend to remain on the same leaf unless disturbed. Leaves that are so affected will fall. Because the leaves are much tougher than leaves of pawpaws, the degree of wrinkling is far less in mangoes.

Scales and thrips are two sucking insects which may cause serious damage to mangoes. The scale, particularly the aggregating snow scales are almost immobile once they have started to feed and will also kill leaves and small stems of mango plants.

Thrips will attack both leaves and fruits and produce the bronzing colour which will reduce the attractiveness of the fruit, thus lowering its market value.

The generally small size of these soft bodied insects makes detection very difficult.

Mites also cause leaf and fruit discoloration. Fruits may have rusty skins as a result of excessive feeding.

3.2 CHEWING INSECTS

Chewing insects do not seem to cause too much damage to mangoes. However, in the last few years a cossid-moth larva has been causing increasing concern. The larva of this moth tunnels into stems and often damages the conducting channels thus disrupting the flow of nutrients through the plant. When this occurs the affected portions of the stem dies. This pest is found in increasing numbers but the reason for its pest status is not presently clear. It may be a recent introduction to the island.

Although no other chewing type insects are found in large enough numbers of mangoes to be regarded as pests, one insect has been collected from mangoes imported from St. Lucia and Martinique. This seed weevil, Sternochetus mangiferae, has never been recorded from the Western Hemisphere previously, but is a major pest of mangoes in Africa, Asia and Australia, and it poses a serious threat to the mango industry. In the region at present mangoes are banned from both St. Lucia and Martinique and every effort is being made to prevent its introduction.

Recent local surveys have indicated that it is not present here.

The adult weevil lays eggs below the skin of the young fruit.

The larva hatches and travels into the seed where all further development occurs. The infested fruit may fall prematurely, but if the fruit matures, the seed is completely destroyed. The tunnel created by the small larva closes as the fruit matures.

Mangoes, particularly ripe ones, are a favourite of birds, and damage can be quite extensive if fruits are allowed to ripen on the trees.

3.3 CONTROL

Mango insects seem to be less well controlled by natural enemies than the pawpaw insects. This may be attributed to the frequent use of chemicals against both insect and disease organisms which seriously affect mangoes.

The sucking insects are quite easily controlled by the same chemicals recommended for pawpaw insects. Mites are best controlled with an acaricide like Kelthane (dicofol).

The chewing insects present a more difficult problem. Chemicals are useless against the insect once it enters the stems in the coxid larva; or the seed, in the case of the seed weevil. Good management practices are the best controls coupled with selected resistant or tolerant varieties. If chemical control is to be effective then the timing has to be so well synchronised with the lifecycles of the two insects that adults are attacked before they have an opportunity to lay their eggs. For the mango seed weevil, irradiation has been suggested as a possible treatment of affected fruit, but this is still very experimental. Perhaps for coxid larvae, cutting off and burning affected branches may assist control. For mango weevil total destruction of fruit and seeds for a year or two is a possibility, particularly in small isolated orchards.

4. AVOCADO (Persea americana M)

Both leaves and fruits of avocado are attacked by insect pests. Like mangoes, the height of the trees makes it rather difficult to examine the plants closely for pest damage. As a result pest damage often reaches a fairly advanced stage before symptoms are recognized and treatment started.

The major pests on avocado are listed in Table III.

Table 3. Pests associated with avocado in Barbados.

Sucking types		
White fly	-	*Trialeurodes* sp
Scales	-	unidentified
Thrips	-	*Selonothrips rubrocinctus*
Mites	-	unidentified
Chewing types		
Moth	-	boring larvae (cossidae)
Termites	-	*Nasutitermes* sp
		Cryptotermes sp

Of the insects listed above thrips are by far the most serious pest. These small frill-winged insects are barely visible to the naked eye. The female adult which is usually black, inserts small eggs into the leaf tissue. Small nymphs hatch in about 3-5 days and begin to feed on the leaf tissue, sucking juices as well as rasping tissue away. Populations increase rapidly and the affected leaves become bronze-coloured. Leaves are quite tough and attacks are not confined to the younger leaves alone. Many leaves will fall prematurely. The fruits are also very severly attacked, and their epidermis badly bronzed. Such fruits are almost unmarketable, although the fruit quality seems to be unaffected. White flies can also be found in large

numbers but these are usually of minor importance.

One chewing insect and a cossid moth has presently been found on avocado. It appears to be the same insect which affects mangoes.

Termites are a very serious problem in avocadoes. Most damage occurs either on the roots or inside the pith of the trunk. The centre of the trunk becomes hollow as termites pass from roots to stem. Once the conducting systems in the plant are destroyed the leaves and fruits dry and death follows quickly.

4.1 CONTROL

Thrips on avocado are not effectively controlled by natural enemies and insecticidal applications are often required. Refined oils like Triona or Albolinum, synthetic pyrethroids e.g. Sherpac, Decis and most organophosphates and carbamates, particularly systemic ones will give good control. Although plants can tolerate much leaf loss with little apparent effect on fruit yield, direct feeding on the fruits should be discouraged.

5. BARBADOS CHERRY (Malpighia glabra)

No other organisms besides a few insects achieve pest status on cherries in Barbados. Of these, white flies and scale insects are the most serious. These sucking insects feed on both stems and leaves. The closeness of the leaf canopy provides the ideal environment for population build up. Large quantities of honeydew are produced and the sooty mould fungus covers most of the leaves.

This often gives the foliage a black appearance and drastically reduces the pathosynthetic ability of the plant. Ants are associated with the insects but are not pests.

Studies conducted in the Ministry of Agriculture's Entomology section, have shown that ladybird beetles and other natural controlling agents are able to keep sucking insect populations under excellent

control strategies.

However, if the pest build up is too rapid to be controlled by the biological agents, then chemical insecticides with either systemic or contact action will give effective control. These chemicals are already discussed.

Termite control is rather difficult since their presence is not often detected until the plant shows symptoms of withering. By then treatment is useless. If detected earlier, some measure of control can be achieved by using insecticides like Dursban, Diazinon and Furadan.

6. CITRUS (Citrus spp.)

The many types of citrus grown in Barbados are subjected to a very wide range of pests (Table 4). Most of the insects and mites associated with citrus have been known to cause serious losses, and often achieve pest status. The aphids and thrips are primarily associated with young terminal leaves and blossoms. The aphids increase very rapidly in numbers and cause severe distortion of the young leaves. Such distortions may be so severe that the plant may be severely stunted or leaves fall prematurely. Although thrips will feed on leaves, they tend to prefer to attack blossoms. Such attacks will result in the shedding of many of these blossoms, with the consequential reduction of fruit formation. It has also been suggested that these insects, when present in limited numbers may be beneficial to the plant in that they serve to reduce the fruit load of the plant thus greatly improving the size and overall yield of the crop. However, because these insects do breed so rapidly, populations tend to get quickly out of control.

TABLE 4. PESTS ATTACKING CITRUS IN BARBADOS

Sucking types		
Scales	-	Cottony-cushion scale - *Icerya purchasi*
		Black scale - *Sassetia oleae*
		Citrus snowscale - *Anaspis citri*
		Other unidentified scales
Aphids	-	melon aphid - *Myzus persicae*
		cotton aphid - *Aphis gossypii*
		Black citrus aphid - *Toxoptera* sp.
Thrips	-	flower thrips - *Frankliniella* sp
Mites	-	citrus rust mite
		citrus red mite - *Panonychus citri*
Mealy bugs	-	*Pseudococcus citri*
White flies	-	*Dialeurodes citrifolia*
Chewing types		
Beetles	-	sugar cane root borer - *Diaprepes abbreviatus*
Moth	-	cossid stem borer
Termites	-	*Nasutitermes* sp
		Cryptotermes sp
Slugs	-	unidentified sp
Birds	-	ground sparrow - *Loxigilla noctis*
		yellow sparrow - *Coereba flaveola*

Scales and mealy bugs also pose very serious problems for citrus growers. Large scales, like the cottony cushion scale, attack stems and are often present along the entire stem. Stems and branches can be killed, particularly in dry conditions, when plants are under water stress. Sooty mould is quite common in citrus as well.

Mites can not only cause severe damage and shedding of leaves, but their attacks on citrus fruits discolour the skin. The fruits may either fall prematurely or remain attached to the plant, but the skin turns rusty. Such fruits when mature are not marketable.

The chewing insects make a very significant contribution to the pest problems affecting citrus.

During the last year or so, there has been increased incidence of borer damage by a coxid moth on stems of citrus. Larvae tunnel into stems, killing large portions of the plant. This insect is found on a much larger scale in avocado.

The sugar cane root borer is another chewing insect which feeds on citrus. The adult striped beetles feed on citrus leaves, cutting out irregular portions. The damage can be quite extensive when populations are high. The female lays batches of eggs between two leaves or between the folded blades of the single leaf. A batch may comprise as many as 250 eggs. The larva hatches in about 1 week and falls to the soil where it burrows and feeds on the root system, for about nine (9) months. The grub girds the root system, removing the vascular system in the process. When this damage is extensive, the plant will die. Because all of the attack is occurring in the soil, it is impossible to determine the extent of the damage. The first symptoms that are observed are the wilting of leaves. This spreads rapidly and all leaves will dry and fruits will eventually fall. Once this stage is reached there is no control which can halt the process, and death of the plant follows shortly.

Termites are also very serious pests of citrus. Although they do not often attack healthy plants; the presence of dried branches or plant material in close proximity to the trees will encourage transfer of the insect to healthy plants. Most of the feeding will be concentrated away from view and the symptoms as expressed on the plant will be quite similar to those for sugar cane root borer.

Snails and slugs are also quite common pests of citrus. Their damage is similar to that of chewing insects. However, slime trails which shine in sunlight are diagnostic of slug damage.

Ground sparrows are a pest of citrus fruit. Damage is most severe during dry seasons when the preferred foods are in limited supply.

6.1 CONTROL

Pesticides form the most popular method of defence against insects, mites and slugs which attack citrus. There is however, need for restraint in the present use of these chemicals, so as to allow the natural enemy complex of parasite and predators to exert their effect. So far such constraint is lacking and as a direct consequence there is almost a continuance of pest problems.

Many of the sucking insect problems can be controlled with minimal assistance from pesticides. Ladybird beetles, aphid lions and other predators should be encouraged and chemicals should only be used if natural biological agents are ineffective. If damage by sucking insects become intolerable, then many of the synthetic pyrethroids and other contact organic poisons available locally will give excellent control. These pesticides would also control leafminers; which are only a problem when insecticides overused, kills the naturally controlling agents.

The other chewing insects are most difficult to control. As most of the damaging stages occur within the stem or in the soil, then detection is difficult. Application of chemicals to reach these targets is almost impossible. For the mothborer, good management is perhaps more important than chemical treatments. Chemicals should be directed to foliage if there is evidence of presence of adults. All dried portions of stem should be removed from the plant and burnt as these are likely to contain developing life stages.

Adult rootborer beetles may also be killed with chemicals. Although, soil treatment, if properly applied, could give some control, but is rather expensive since the area to be covered is quite large. Systemic soil chemicals like Furadan and Mocap, as well as other soil chemicals like Diazinon can be used. For foliage treatment, any contact or systemic poison sprayed onto foliage will give adequate control.

FRUIT CROP DISEASES IN BARBADOS

by

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ABSTRACT: A number of diseases are known to occur on major fruit crops in the Caribbean area. In Barbados the occurrence of very serious diseases are low to non-existent. The common diseases known occur at relatively high frequences. The fruit crops are afflicted by diseases and disorders of fungal, bacterial, mycoplasmal and virus origins, also toxicogenic arthropods and those due to hunger. Fungal diseases are the most common known, but the virus and mycoplasma diseases are most dangerous and important. Few cases of bacterial diseases and phytotoxemias are known, but hunger signs are a wide spread phenomenon. The major symptoms expressions range from simple leaf spots to death of the plant. The major fruit crop diseases are the papaya bunchy top and virus disease complex, antrachnose of most fruits, tree die backs and hunger signs, sooty mold complex. Recently golden apple pan-gumming disease has taken the spotlight.

I. INTRODUCTION

Fruits grown in Barbados are important entities in human nutrition as a source of vitamin and minerals and to a lesser extent of energy, protein, cellulose and polysaccharide carbohydrates. This common source of nutrition is under constant threat by the numerous diseases the plants are exposed to.

The major fruit crops grown in Barbados are citrus, papaya, mango, avocado and cherries. There are many other minor fruits cultivated but not in organized orchards. Whether of major or minor importance all the fruit trees are constantly threatened by diseases.

The major diseases recorded are of virus aetiology and the most common ones found are of fungus caused and are hunger signs (deficiency of nutrients) bacterial diseases of fruit trees in Barbados are not known.

Leaf diseases of the fruit trees are the most common problems reported and these are mainly of the sooty mold complex, leaf spots, blight necrosis and chlorosis. Some leaf necrosis and chlorosis are mainly due to poor nutrition, and general unthriftiness is due to mal agronomic practices which is a concommitant effect of the widespread paucity of knowledge in respect of cultural practices. Most of the disease conditions reported have in some way affected the productive capacity of the fruit trees. It is however a common place practice for trees to be neglected by small and sometimes large growers.

Another area of concern in respect of fruit crop pathology is post harvest irregularities. This area accounts for more than 50% of the reported problems. Too often growers suffer great loss of fruit during storage. These storage losses occur because of poor handling and harvesting practices and improper pre-harvest care. Some of the post harvest problems reported to the Plant Pathology Laboratory are directly due to mechanical damages sustained during harvest while others are directly pathologically related.

Post harvest conditions in avocado, mango and papaya can cause serious losses in monetary terms.

The pathogens mainly responsible for these fruit diseases are colletotrichum, phytophthora and glomerella. Work in Barbados in respect of minimizing post harvest losses in papaya is currently being pursued by Inter-American Institute for Cooperation on Agriculture (IICA) and Ministry of Agriculture Pathology Department.

Production of fruit crops in Barbados is for the most part from backyard or small scale cultivation of improved types. Although some pests and disease problems have been identified, no estimation of the seriousness of infection and infestation under orchard conditions has been possible in Barbados so far, except, perhaps for papaya. The storage and shelf life of individual varieties are being studied, also strategy to extend the shelf lives. As stated earlier, experiments with

papaya are currently being conducted.

AVOCADO (Persea americana)

Little work has been done in the Caribbean on the development of root stock resistant to or tolerant of Phytophthora root rot. Two major problems of avocado cultivation in the wet and warm conditions are antrachnose, and scab (Sphaceloma perseae). They have been researched in other parts of the Caribbean and their control methods using well timed fungicidal sprays is widely accepted.

GUAVA (Psidium guajava)

Unlike most of the major fruits, the guava is afflicted by few diseases especially Colletotrichum sp. Post harvest loss is still one of the major problems.

The sooty mold complex and hunger signs are the most common generalized symptoms on the growing plant.

MANGO (Mangifera indica)

Fruit setting remains a problem in the production of mangoes. This phenomenon may be a consequence of one of a multiplicity of factors. These factors are the primary irregularities facing the crop during culture. Disease including antrachnose, die back and wither tip are all with us in varying levels of occurrence.

A phenomenon not understood by growers is the non-pathological occurrence of chlorotic and necrotic manifestations. This is conjectured to be due to antrachnose and or tear stain caused by colletotrichum. Hot water treatment of these conditions are attempted elsewhere.

PAPAYA (Carica papaya)

Over the past few years, the papaya production suffered a set

back because of disease problems. The crop is known to be afflicted by diseases such as root and collar rot, curly leaf, mosaic-like, bunchy top and distortion ring spots. An important post harvest occurrence commonly found is the fruit spotting syndrome. There are various vectors known to transmit the virus diseases in papaya.

Like most other fruits, sooty mold complex, hunger signs and leaf spots are common in papaya.

Research on storage and ripening of the papaya fruit have not resulted in significanly improved methods for the control of post harvest diseases or the extension of fruit storage life (Wilson L.A. 1980). But presently, storage and ripening experiments are being conducted here in Barbados by the Pathology Department of the Ministry of Agriculture and the Inter-American Institute for Cooperation on Agriculture, where nine varieties are used in experimentation.

Different treatments administration were investigated in respect of post harvest loss using gramma radiation were reported by Jiravatana et al (1970) Ible, (1976). They used Giberellic Acid and temperature to determine the rate of ripening of solo cultivar.

2. SOME COMMON AND IMPORTANT DISEASES OCCURING IN BARBADOS

It is impractical to give the long list of all the diseases occurring on fruit crops in Barbados. However it has been instructive for me to base important diseases on symptomatology and it seems there are about fourteen (14) different symptom categories. The ones here are the more common, and with each are examples of the genera of the biotic or abiotic caused agents.

2.1 ROOT DISEASES, SUBTERRANEAN ROTS AND SYSTEMIC INFECTIONS OF FRUIT CROPS

Above ground, the Herbaceous crops show wilt, and the trees become chlorotic, wilt and collapse. Some of the common casual

Biotic factors are -

(a) Fusarium Sp (b) Rosellinia Sp
(c) Armilaria Sp (d) Phytophthora Sp
(e) Fomes Sp (f) Xanthomonas Sp

Abiotic Agents are: Poor Nutrition Poor Water Relations
Excess Line in Soil, Shallow Soil
Poor Drainage.

2.2 TREE DIE-BACK (DYING TWIGS AND BRANCH ENDS)

Biotic agents associated are: Botryodiplodia(Diplodia) Colletotrichum (Gloeosporium) Botrytis, Fusarium, Glomerella and, Phomopsis.

The Abiotic agents are: Salt Spray (Hypertonic Exposures)
Mechanical Injuries.

2.3 COMMON LEAF SPOTS

Circumscribed Leaf Lesions from species of such Fungus Parasites as: Cercospora, Alternaria, Septoria, Phyllosticta, Colletotrichum

2.4 SURFACE GROWTH PARASITISM (MILDEWS AND SOOTY MOLD)

These are three kinds:-

(a) Powdery - which is a whitish superficial growth on the adaxial leaf surface caused by Oidium Spp.

(b) Downy - these parasites are less superficial, exhibiting velvety growth on the leaf abaxial surface and caused by such Fungi as Peronospora.

(c) Sooty Mold - caused by Fungi such as Meliola aphanostigue

2.5 BARK AND TRUNK LESIONS AND GUMMING

These are sometimes caused by viruses and also some like phytophthora.

2.6 FRUIT SPOTS

Caused by species of Cercospora, Colletotrichum septoria, among others.

Some diseases that occur on fruit crops are not all common to each variety. The following paragraphs will attempt to highlight the difference of pathological occurrences within species and also their major problems.

3. PAPAYA DISEASES IN BARBADOS

Leaves, fruit stems and roots of the papaya plants are afflicted by diseases. These are of various aetiologies viz: bacteria, fungi, virus, mycoplasma (MLO), physiogenic, hunger and physiological. Of these major diseases listed in Table 1, the bunchy top disease, distortion ring spot virus conditions and the fruit rot are the most serious one.

Virus

Distortion ring spots - P D R S V

Mosaic - P M V

Hunger

Pan appendige Chlorosis - Lime induced

Interveinal Necrosis - Micro nutrients

TABLE 1: THE COMMON DISEASES OF PAPAYA IN BARBADOS

FUNGUS	
Antrachnose	Colletotrichum sp
Fruit Rot	Colletotrichum sp
Mildew	Oidium sp
Sooty Mold	Asterina sp
	Phaeodimeriella sp
Target Spot	Cercospora sp
Root Rot	Phytophthora sp
Fruit Rot	Phytophthora sp
MYCOPLASMA	
Bunchy Top	MLO
VIRUS	
Distortion Ring Spot	Papaya Distortion Ring Spot Virus
Mosaic	Papaya Mosaic Virus
HUNGER	
General Chlorosis	Lime Induced
Intervienal Necrosis	Micronutrient Difficiency
PHYSIOLOGICAL	
Shoe String Manifestation	Hormone Imbalance due to Exposure to Herbicide (2, 4-D)
Leathery & Leaf Roll	Hormone Imbalance due to Exposure to Herbicide (2, 4-D)

Physiological

Shoestring manifestations - Hormone damage on leaves 2, 4-D herbicide. The disease most frequently occurring are the hunger signs, the virus disease bunchy top and fruit rot. Post harvest fruit rot has very significant occurrence in a number of varieties.

3.1 CONTROL

The diseases of this crop cannot all be controlled by standard direct methods. The Bunchy Top and Ring Spot diseases can only be realistically controlled by the introduction of disease tolerant cultivars. Proper field management and infection prophylaxis are key factors to the control of these diseases.

The fungal diseases can be directly controlled by the proper field management and infection prophylaxis are key factors to the control of these diseases.

The fungal diseases can be directly controlled by the properly selected and well timed applications of fungicides in an integrated pest management programme.

4. CITRUS DISEASES

More than a dozen virus diseases affect citrus in different parts of the world. Three of these virus diseases may be present in Barbados viz - tristeza, psorosis and exocortis. An indexing programme is currently on the way to confirm these diseases.

Tristeza is the most destructive of the citrus virus disease. The disease expresses itself on certain root scion combination, while other combinations are known to be resistant or tolerant.

Sour orange is the only rootstock used in Barbados (Barker).

The combination of this with sweet orange scion produce susceptible reactions. These diseases are carried through budwood material (Smith 1972) and by aphids (Costa 1951).

It is evident that the use of certified disease free budwood material is the key to the management of virus diseases of citrus. Work on the budwood certification programme in Barbados is in progress.

Other diseases of citrus are equally as important as the virus diseases, but not as dangerous. Most of these diseases are of fungal, aetiology, but hunger signs are widespread in Barbados. Table 2 outlines the different categories of diseases that are prevalent.

TABLE 2: COMMON DISEASES OF CITRUS IN BARBADOS

FUNGUS	
Leaf Spotting	Curvularia sp
Wither Tip	Colletotrichum sp
Damping Off	Phytophthora sp
Seedling Tip Blight	Phytophthora sp
Scab	Elsinoe fawcettii
Foot Rot Gummosis	Phytophthora sp
Melanose	Diaporthe citri
Fruit Rot	Penicillium sp
Stem End Rot	Diplodia sp
Greasy Spot	Mycosphaerella sp
Sooty Mold One or More of:	Aithaloderma sp
	Phaeosaccardinula sp
	Capnodium sp
	Meliola sp
HUNGER SIGNS	
Vien & General Chlorosis	General Starvation
Foliocellosis	Zin Deficiency
Bronzing	Manganese Deficiency
Intervienal Chlorosis	Iron Deficiency
Exanthemia	Copper Deficiency
VIRUS	
Psorosis	Citrus Psorosis Virus
Xyloporosis	Xyloporosis Virus

5. MANGO DISEASES

The diseases of mango are few, but when they flare up they inflict severe damages on the fruit, blossoms and leaves. The major diseases known to occur here are outlined in Table 3.

5.1 CONTROL

The control of the papaya and mango diseases caused by fungi are similar. The proper use of suitable Fungicides and good field management will reduce the occurrence of the diseases.

It should be noted that spraying should commence at blossom time and continued on a regular basis until the mature green stage of the fruits.

6. AVOCADO DISEASES

Fruit fall, foot rot and antractnose are the major diseases found. Few cases of scab and sooty mold occur. These diseases are mainly controlled by the use of Fungicides and the maintenance of proper nutrition and good field management. Table 4 outlines the common diseases of Avocado.

One of the major problems of avocado cultivation is the occurrence of foot and root rots in the nurseries. IICA, improved technique now in application is to circumvent those rots in the nursery.

6.1 GENERAL APPROACHES TO CONTROL

The approaches to control depends largely on the intensity of agricultural production needs. Also, on the education of the farming community.

TABLE 3: MANGO DISEASES IN BARBADOS

Anthracnose	Glomerella cingulata
Mildew	Oidium sp
Sooty Mold	Aithalodesma sp
	Antennularia sp
	Melioloa sp
	Trichothallus sp
Fruit Rot	Colletotrichum sp
Tear Stain	Colletotrichum sp
Blossom Blight	Colletotrichum sp
Leaf Spot	Colletotrichum sp

TABLE 4: COMMON DISEASES OF AVOCADO

DISEASE	PRESUMED CASUAL AGENT
FRUIT DISEASE	
Anthracnose	Glomerella cingulata
Fruit Rot	Glomerella cingulata
Scab	Sphaceloma perseae
Fruit Rot	Botryodiplodia sp
LEAF DISEASE	
Alga Rust	Cephaleuros sp
Leaf Spot	Cercospora sp
Anthracnose	Glomerella cingulata
Sooty Mold	Asteridiella perseae
Scab	Sphaceloma perseae
ROOT DISEASE	
Root Rot	Phytophthora sp
Collar Rot	Phytophthora sp

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FRUIT CROP MARKETING IN BARBADOS

by
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ABSTRACT: The Fruit Crop Production marketing system in Barbados is undergoing the pains of a new industry. This subsector requires greater planning and coordination than generally needed for other crops. This paper focuses on fruit crop marketing in Barbados and recognizes this non-traditional fruit system is complex and risky. Key practical problems related to marketing at the pre-harvest and post harvest levels are discussed and operational techniques are suggested. Some of the areas covered are production programming, financing control and buyer-seller arrangements. The author has drawn on his experience in Barbados, and other countries and a review of past studies carried out in Barbados. A systems approach to solving fruit crop marketing problems is stressed. A suggestion is made to better utilize existing training and educational institutions to fill the gaps in developing human resource skills at the management, technical foreman and labor levels.

1. INTRODUCTION

Within the last few years, fruit crop development in Barbados has taken on a new meaning and renewed sense of priority.

The Agricultural Sector Plan 1983-88 specifically states the following objectives for the fruit sub-sector:

- To encourage more extensive commercial fruit production.
- To increase the consumption of locally producted fruit.
- To improve production efficiency in fruit industry.

The Plan further points out that export opportunities for fruit will be carefully investigated and exploited whenever feasible. In turn, the plan views marketing as a major constraint since there is no organized fruit marketing system.

Barbados is laying the framework to boost fruit crop output with different on-going and proposed projects financed by: The European Economic Community (EEC), the European Development Fund (EDF), the Inter American Development Bank (IDB), the World Bank and the Inter-American Institute for Cooperation on Agriculture (IICA).

The Government is providing approximately US$47 million for Agriculture over the period 1983-88 for farm input supplies, extension of irrigation systems, agronomic research on fruit crops and cultivation practices for increased production[1/].

2. OVERVIEW OF THE SYSTEM

The overview that one is left with after examining the various projects, facilities and institutional arrangements in Barbados is one of a new agribusiness undergoing the pains of birth. Volumes are relatively low, products very perishable and farmers are just beginning to adjust to new varieties, management practices and new technology. All these factors make the marketing system a complex and risky one.

In 1983, Barbados consumed approximately 12,000-15000 tons of fruit or approximately 94-115 pounds per capita [2/]. Domestic production represents about 45 - 60 depending on what data you use. Most of the fruit is grown on thousands of small backyard orchards. One estimate indicated that about 80% of all householders producing fruit do so only for their own use.

1/ GIS Monitor. Vol. 2, No. 2. June 1984.

2/ Reliable information on fruit production, marketing and consumption Barbados is very tenuous at best.

Additionally there are small plantations with orchards of 0.5 to 1 acre producing fruit for commercial purposes.

There is some evidence that the demand for fresh and processed fruit could strengthen in three markets: domestic,which has a relatively low per capita consumption of fruit; tourist industry, and the extra-regional export market. Domestic fruit market appears to offer the best potential short-run opportunities which could save a substantial part of the ϕ600 tons of fresh and processed fruit imported in 1982 valued at US$6.7 million (BDS$13.4 million)[1/].

The production and marketing systems that has evolved to move the thousands of tons of domestic and imported fruits from farm to consumers each year is complex, highly fractionated, and traditional. It is composed of a large number of relatively small units at all levels of the system and characterized by widely diffused decision making throughout the system on the basis of highly imperfect market information.

Because of the diverse nature of the system, it is difficult to summarize the behaviour of the Barbados fruit production- marketing system. It is marked by great diversity and apparently little effective coordination. Some remanent of vertical coordination seem to have evolved between some hotels, restaurants and selected growers.

1/ MAFCA/Planning Unit in cooperation with IICA Aggregated Numerical Information on Food Imports, Exports and Re-Exports by Division of S.I.T.C (1980-84). Bridgetown, Barbados. October 1984.

Apart from direct consumption at the back yard orchard level, the marketing system consists of the following channels 1/:

2.1 Hawkers:

The traditional hawkers or hucksters market an estimated 40% of all fruit production. Many operate throughout the Island and buy for cash at the farm gate and do their own marketing.

2.2 Wholesalers

Complementing the traditional hawker systems are a significant number of small scale fruit and vegetable wholesalers. They are active in the hotel and restaurant trade operating out of small vans, buying produce directly from farmers, importers and selling to hotels, restaurants, and other retail institutions.

2.3 Supermarkets

The supermarket sector in Barbados is well developed in comparison with other countries of the Eastern Caribbean Area. There are about 150 including small village 'Supermarkets'. They normally buy directly from producers and market and estimated 30% of fruit availability.

1/ See Lohoar, Production and Marketing Handbook for Horticultural Crops in Barbados. IICA, Bridgetown, December 1981. pp 3-5.

2.4 Barbados Agricultural Society Marketing Arm (BAS)-ACTCO

This institution is a retail and "wholesale" fruit and vegetable outlet. The wholesale operation is more of a retail-wholesale "bulk-breaking" activity. Refrigeration facilities are available and a wide range of good quality vegetables and fruits are sold retail to the public and wholesale to the hotels and restaurant businesses.

2.5 Hotels and Restaurants

The tourist industry is well developed in Barbados which has had a pull effect in developing a substantial number of good quality restaurants which also cater to residents. In 1983-84 season there were nearly 328,000 visitors who stayed an average of approximately 9 days.

2.6 Barbados Marketing Corporation (BMC)

This institution is not a major force in the market for most crops since it handles less than 10% of total out-put. In the case of fruit, it is estimated at about 7%.

3. PROBLEMS AND OPERATIONAL TECHNIQUES

This summary presentation does not list all the problems in the Barbados Fruit Marketing System, but rather sets only those believed to have a clearly significant impact on the performance of this commodity subgroup.

The relative criticalness of the problem in Barbados is difficult to assess precisely due to lack of reliable information. In one sense, all are critical because weakness in one part of the system will deliberate the functioning of the total system. However, the weakness of one firm, farm system or distribution of a specific commodity may not be a problem of another given the diversity of the commodities produced and

marketed. For example, the series of problems in the production stage (insufficient soil analysis, inadequate variety and seed selection etc.) combined to adversely affect field and exportable yields of the crop. Several projects studied in Central America showed 37-70% of the produce was rejected even before reaching the packing house for export.

Several general problem areas identified in Barbados Food Marketing System which were commonly stated in the numerous studies are the following:

- Reorganization and/or redefinition of marketing management and the role of Government Marketing Organizations.

- Lack of trained human resources in Agribusiness and Economic incentive.
- Off-season production during the months of July through December.

- Deficient production - marketing intelligence system. The BMC/BASIS is presently trying to fill this void.

- Absence of a systems approach to fruit production and marketing.

- Faulty coordination and organization among system participants especially small farmers and hucksters trade.

- Lack of knowledge of proper operating techniques.

The alternative solutions to these very general production-marketing problems have been articulated before, but too often they have been acted upon.

One important consideration to overcome this difficulty is to identify key centre-points than have a "pull effect" for improving the

marketing systems. Selected producers, (large and small), small traders and middle-level marketing entrepreneurs represent points of entre with growth potential. Investment in improving the human resource capacity is basic for sustaining marketing developments. One thing is to invest in "brick and motar" but it is quite another challenge to make this capital infrastructure investment to work in favour of farmers, hawkers, processors and consumers.

The following problems and specific operational techniques are put forth as concrete example from lessons learned based on project evaluations and field experience in selected Central American and Caribbean Countries.

TABLE I

FRUIT MARKETING PROBLEMS AND SUGGEST OPERATING TECHNIQUES

PROBLEM	OPERATING TECHNIQUES	MARKETING IMPLICATION
Inadequate variety Selection	Understanding of requirements imposed by each stage in the total system: Agronomic, perishability, fragility, lost, appearance. Improve seedselection and continuous experimentation.	Seeds/Plants should be chosen to meet market requirements.
Excessive disease and insect damage.	Information on availability, cost and effectiveness of agrochemicals, on-going research on actual insects and plant diseases problems, skills in application techniques of Agrochemicals, pest management systems, cultural and biological controls.	Influence adversely the quality and the market values of the product, and increase post harvest losses. Major consideration for export products to, or transit through a country with stringent phytosanitary regulations.
Erroneous timing of land preparation.	Need to plan production schedule to match market and agronomic conditions.	Increase chance of obtaining higher prices and marketing greater percentage of crop.
Delayed financing.	Production programming consistent with financing availability - banks sensitive to timely funding at reasonable rates of interest.	Particularly important to new and small exporters at pre-tender and post-tender stages, pre-shipment and post-shipment stages.
Excessive need for close supervision of worker.	Development of worker and foreman training programs and motivation systems plus detailed work procedure plan.	Takes time from marketing management function. Increase cost which is frequently passed on to consumers.
Insufficient capability of farm/foreman personnel to absorb technical assistance.	Simplification of task and procedures, greater understanding of potential utility of modern technology, effective demonstrations of practical utility.	Complicates entire marketing production system and reduces producers profit margin right by reduction in marketable crop or high labour cost low production.

FRUIT MARKETING PROBLEMS AND SUGGEST OPERATING TECHNIQUES cont'd

PROBLEM	OPERATING TECHNIQUES	MARKETING IMPLICATION
Insufficient/incorrect technical assistance to farm personnel.	Marketing/extension in-service training and demonstrations, - choice of varieties, picking, packing, storage, disease and pest control. Coordination of producer -Technical assistance efforts and avoid unnecessary duplication and farm confusion from conflicting advice.	Increase cost/risk in marketing the products.
Improper harvesting and field selection (see Annex I for a list of common handling mistakes).	Coordination of overall production, harvesting and packaging schedules with market conditions, quality control and materials of fruit for harvesting in function of market requirements.	Degree of ripeness when harvest especially important for storage and transporting post harvest losses.
Rough handling and faulty storage at the farm level.	Design and use of appropriate field and storage bases to reduce damage.	Bears directly on the market quality - price and acceptability.
Defective packing.	Knowledge of market packing requirements and alternative packing techniques can be improved at little cost or interference with established marketing practises in most cases.	Post harvesting methods are responsible for much re-storage. Packages must meet specific product and market needs.
Damage from inadequate refrigeration.	Knowledge of refrigeration requirements of fruits and skills in temperature control and storage techniques, equipment, maintenance skills.	Reduce losses and preserve quality critical in tropical climates.
Damage in farm-to-plant transport.	Scheduling and conditioning of transport vehicles, storing procedures in transport vehicles. Increase capacity utilization.	Integral link with marketing chain and strategic implications for cost.
Inadequacy of transport availability and frequency.	Production - transportation coordination scheduling techniques.	Directly affects marketing cost, quality of the products and loss of market.
Difficulty in locating buyers.	Information on location, credit worthiness and product line and interest.	
	Information on structure and dynamic of marketing systems.	Implications obvious.

FRUIT MARKETING PROBLEMS AND SUGGEST OPERATING TECHNIQUES cont'd

PROBLEM	OPERATING TECHNIQUES	MARKETING IMPLICATION
Disadvantageous contracts with buyers.	Information on structure and dynamics of the marketing system and knowledge of alternative contractual arrangments and better negotiating skills. Farmer organizations.	Bargaining power in the market places.
Small local market .	Analysis of local consumer habits and demand and opportunities for processing and exporting.	A major marketing problem confronting small countries. Effect domestic demand for non-exportable surplus is insignificant compared to the potential available supply of seconds.
Organization of raw material supplies for processing.	Consider semi-processed fruit, i.e. concentrates but capital investment is high.	Extend useful life of surplus procedure and reduce volume to facilitate transport.
Lack of organization among small producers.	Assembly centers located in selected cities. Market oriented organizational schemes Cost-sharing transportation services.	Reduces bargaining power in the market. Limits input purchases at lower prices.

The above table does indicate special consideration need to be made for export market requirements. It should be further stressed that Extra-Regional Markets such as the United States, Canada and Europe pose major problems for the Barbados emerging fruit production-marketing system, i.e. limited production capacity, quality control, contract arrangements, timely information, appropriate varieties, handling, packing, and transportation.

Besides looking at operating techniques for fruit production-marketing as a system, there is a need to develop specific skills through training and education at the managerial, technician, foreman and labour levels.

Barbados has the basis for a "Skill Development and Training Delivery System". The interaction among the institutions involved may be perceived as sporadic and unsystematic at the present time. A major challenge is to direct this existing resource base to address specific operational problems facing the fruit production-marketing and the agricultural business in which it operates.

Some examples are the following: Barbados Institute of Management and Productivity, Private Consultant Firms i.e. Systems, Barbados Community College, Private Sector Agribusiness (National and Foreign) Selected Farms, Government Research and Extension, Banks, BAS/ACTCO, International Organizations, Shipping Companies, Brokers, BASIS - Information.

4. CONCLUSION

The absence of systematic planning in most development projects aimed at improving the production and marketing of fruits is notorious particularly for export markets. Given the characteristics of the fruit industry, high product perishability, seasonal market, variable weather conditions, high quality requirements, long farm-to-consumer distance, and very limited transportation service, the need for planning and

coordination of all the components of the commodity systems is critical.

The outlook for fruit production-marketing development is mixture of promising opportunities and tenacious obstacle. Difficulties will continue to challenge this new industry, but with experience and improved manpower, sufficient advancement can be made. Management education will play a key role in developing the human resources needed to make Barbados a competitive participant in the fruit export marketing system.

Private and public cooperation and close communication between managers, technician, foreman and labourer are essential for the system to work effectively and efficiently to produce the expected results of all involved. A high risk business requires a high degree of coordination and information and the necessary infrastructure.

4.1 CONCERNS FOR IMMEDIATE ACTIONS

a) Commercial Application - cost of production and marketing and the probable net returns to producers.

b) Basic information on Consumer Consumption patterns, Marketing Channels, cost analysis and production data.

c) Development of monitoring and evaluation system for fruit crop development for planning and development of a dynamic agroindustry.

d) Continuous applied Research on situated market possibilities: domestic, intra-regional, extra-regional match with existing and potential supply characteristics and growth potential and competition for selected markets and comparative advantage.

COMMON HANDLING MISTAKES

- Harvesting of immature fruit.
- Leaving the fruit on the plant until it is overripe or oversized.
- Harvesting by pulling or twisting instead of using clippers or knives.
- Exposure of produce to the sun.
- Overheating of produce in bags (paper, plastic, jute).
- Overheating of produce during transport in non-ventilated vans or trucks.
- Harvesting during high temperatures.
- Storing produce at the wrong temperature or relative humidity.
- Mixing different types of produce with different temperature requirements.
- Leaving cold stores open.
- Packing and grading produce on the floor instead of using clean grading tables.
- Tight filling of cartons.
- Multiple handling resulting in mechanical damage, bruising,rotting and so on.
- Rough handling of produce and cartons.
- Treating perishables like general cargo.

SOURCE: BASIS Report October 1983

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THE IMPORTANCE OF FRUITS AS A MEANS OF IMPROVING NUTRITION

* C O N F E R E N C E S *

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"The Nutritive Value of Fruits"

M.E. NELSON and KAREN GRIFFITHS
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"Dietary Fibre in Fruits: Its Role in Human Nutrition"

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"Programmes to Increase the Consumption of Locally Produced Fruits"

* * *

THE NUTRITIVE VALUE OF FRUITS

by

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A fruit is the edible, more or less succulent product of a tree or plant consisting of the ripened seeds and adjacent tissues (McWilliams, 1974).

The soils and climatic conditions of the Caribbean region not excluding Barbados favour the growing of fruits, such as bananas, "figs" (Musa sp.), papayas and mangoes. Certain fruits such as apples (malus), apricots and peaches survive best in temperate regions such as North America.

Fruit may be divided into groups according to such differences as shapes, types and number of seeds and the part of the flower from where they develop:

1. Simple: Single ovary.

    1.1 Fleshy

        1.1.1 Drupe: Developed from superior ovary, regularly have one seed and the endocarp is a stone. e.g. mango, cherries.

        1.1.2 Berry: Developed from superior or inferior ovary; the pericorp is soft and usually have several seeds. e.g. Avocado pears, papaya, banana, guava, carambola.

        1.1.3 Pome: Walls developed from ovary and receptacle endocarp is hard or tough and contain several seeds. e.g. Pomerac.

1.2 Dry

Which could be dehiscent (e.g. Cocoa) or indehiscent.

2. Aggregate: Several to many adherent simple fruits, all derived single flower.
e.g. Raspberry and Blackberry.

3. Multiple: Derived from a cluster of flowers (inflorescence).

A brief look at the composition of fruits reveal that fruits in general contain a high percentage of water: muskmelons and watermelons are approximately 92% water; other fruits have a water content ranging between 80-90% and in dried fruits, water constitutes 25% by weight of the edible portion. Fruits are notably low in protein and fat, with the exception of the avocado pear which contains up to 28% fat.

Although the total amount of carbohydrate remains constant, the form varies with the maturity of the fruit. The starch content is relatively high in the immature fruit, but is very low in mature fruits, since a majority of this carbohydrate is converted to sugar as the fruit ripens. Various sugars are also found in fruits.

Fruits are so important that they form one of the six food groups needed for an adequate diet. They supply the body with vitamins, minerals and fibre which are vital for healthy living.

Fruits contribute appreciable amounts of the minerals, iron and calcium. Among the fruits richest in iron are dried fruits of all kinds, grapes and berries.

Calcium is found in small amounts in citrus fruits (the whole fruit contains twice the amount contained in an equal amount of juice). Sodium, magnesium and potassium, are almost present in varying amounts in most fruits.

Ripe fruits like vegetables contain indigestible cellulose which provides needed fibre or bulk in the diet. Fibre is particularly important because it aids in the elimination of waste from the body and so helps to prevent constipation. In addition fibre is believed to be important in the prevention of some gastrointestinal disorders, for example, cancer of the colon and the rectum. In addition the low caloric content of fruits and their effect on satiety makes them ideal for reducing diets.

Most fruits are excellent sources of vitamin C (Ascorbic Acid) which improves the absorption of iron in the body.

Since the body has limited abillty to store vitamin C, we need, therefore to include it in our diet everyday. When Barbadians think of fruit which would provide them with vitamin C, they immediately think of citrus fruits e.g. orange, lime, grapefruit and lemon but some locally grown fruits provide the body with even more vitamin C than citrus fruits. Locally grown fruits such as the West Indian cherry, guava, cashew and dunks are excellent sources of vitamin C (Fig. 1).

If we consider the cost of an orange and remember that the cherry pulp contains eighty (80) times more vitamin C than the orange pulp, this fruit should be given priority (Bannochie, 1966).

Besides the vitamin C content, cherry also contains other vitamins necessary for good health including the B vitamins - Riboflavin, Niacin and Thiamin.

In addition to the large amounts of vitamin C, local fruits are rich sources of vitamin A. Fruits that are yellow in colour such as the mango and pawpaw provide the body with vitamin A (Table 1). According to the recommended Dietary Allowance for the Caribbean, the adult male and female aged 20-39 require 750 R.E. of vitamin A and 30 mg. of vitamin C daily.

A medium sized pawpaw would supply the body with the entire day's requirements for vitamin A and over three times the daily requirement for vitamin C.

Local fruits can therefore make a significant contribution to the diet and should be used when in season. Fruits can be used in their natural state or squeezed to make nutritious and appetising drinks e.g. cherry, guava and mango.

Conservation of vitamin C is an important aspect to be considered in the preparation of fruits, as this vitamin is lost on exposure to air.

Following are some of the precautionary measures necessary to preserve the vitamin C content in fruits:

1. Wash thoroughly and remove blemishes.
2. Cut fruits shortly before serving, since this minimizes the oxidative loss of vitamin C.
3. Raw fruit may be chilled before serving.
4. Extract the juice from the fruits just before serving.
5. Cover fruit juices when chilling.
6. Serve different ways for variety (whole, sliced, diced, chopped) but be sure to cut only just before serving.

Fruits on the whole do not only taste good but their flavour, colour and texture add variety to any meal. Do you eat enough?

Fig. I: Comparison of Vitamin C Content in Local and Imported Fruits (in 3½ ozs of edible portion)

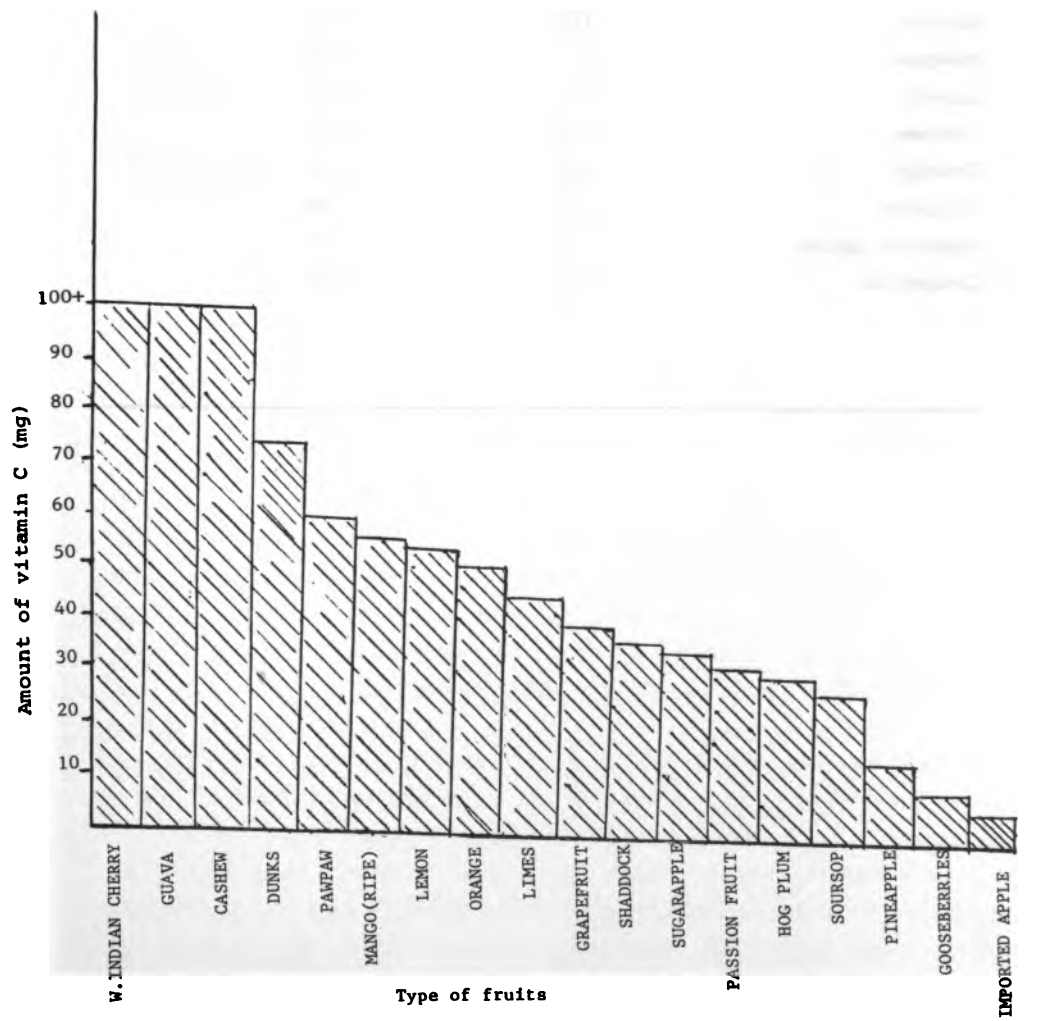

Table I: Comparison of Vitamin A and C content in Local and Imported Fruits (in 3½ ozs edible portion.)

Fruits	Vit: A R.E.	Vit: C mg.
Mango	210	53
Pawpaw	175	56
Guava	25	218
Cashew	40	219
Orange	20	50
Hogplum	25	28
Imported apple	5	6
Grapefruit	10	38

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DIETARY FIBRE IN FRUITS: ITS ROLE IN HUMAN NUTRITION

by

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I. INTRODUCTION

During recent years there has been considerable focus on the role of dietary fibre in human nutrition. Several countries have published guidelines for changes in the present diet including an increased consumption of dietary fibre. These guidelines have met with both criticism and support as the policy makers, the food industry, and the scientific community argued about the merits of dietary fibre.

The United States Senate Committee on Nutrition and Human Needs (1977) headed by Senator McGovern, enunciated seven (7) dietary goals for the United States. Foremost on the list was that the "American public increase carbohydrate consumption to account for 55 to 60 per cent of the total energy intake." It was recommended that the consumption of complex carbohydrates and naturally occurring sugars should be increased from about 28 to 48 per cent of energy intake. This goal when translated into practical terms would mean an increased consumption of fruits, vegetables and whole grain products. There would not only be an increased consumption of starch, but a concomitant increase in the dietary fibre intake.

More recently (1983) the National Advisory Committee on Nutrition Education (NACNE) made proposals for nutritional guidelines for health education in Britain. In this report there are five (5) recommendations, one of which being that "Dietary fibre should be increased from the present 20g to 25g in the 1980's and 30g in the long term; both cereal fibre and fruit and vegetable fibre should be

increased."

Is 30g of fibre as a national average intake a realistic goal? That is the question asked by many British dietitians and health professionals. The intake of cereal fibre depends very much on the choice of bread and the total energy intake. Intakes of greater than 27g of fibre are not achieved without either having an above average energy intake combined with using whole meal bread, or following idiosyncratic food habits such as bran supplements or large amounts of fruit. In practice to be able to achieve the recommended 30g of dietary fibre the contribution from fruits and vegetables becomes very important. Actual realisation of this goal depends on how far those who eat only white bread can have low fruit and vegetable intakes can be persuaded to change.

2. WHAT IS DIETARY FIBRE?

The term dietary fibre gained prominence in 1972 when Trowell postulated that dietary fibre was a protective factor in ischaemic heart disease. Trowell defined dietary fibre as "The skeletal remains of plant cells that are resistant to digestion by enzymes of man." (Trowell, 1974). In 1977, Trowell broadened the scope of his definition to include the undigested storage polysaccharides present within the contents of the cell wall, as well as undigested polysaccharides and lignin present in the cell wall. Using this definition, dietary fibre includes not only the cellulosic and non-cellulosic polysaccharides such as gums, mucilages and pectins but also the lignin which is present in the cell walls. Thus dietary fibre is not a single entity but a mixture of several different chemical structures combined in a complex physical structure - the plant cell wall.

3. DIETARY FIBRE - WHY ALL THE FUSS?

Much interest is being taken in the presence of dietary fibre in the human diet. The data from epidemiological studies suggests that

certain diseases (Table 1) are rare or relatively rare in countries where carbohydrate foods rich in fibre provide the staple diet. In contrast, these diseases are common where much of the carbohydrate foods are low in fibre but rich in starch and sugar.

Table 1: Some of the diseases attributed to a decreased fibre intake

Appendicitis	Constipation
Cancer of the colon	Cancer of the rectum
Diverticular disease	Irritable colon
Ulcerative colitis	Haemorrhoids
Hiatus hernia	Gallstones
Ischaemicheart disease	Pulmonary embolism
Diabetes mellitus	Obesity
Atherosclerosis	

4. THE NUTRITIONAL ROLE OF FRUITS

There is much accumulated evidence which suggests that the dietary fibre in cereals is not only better at resisting bacterial degradation and providing the best form of fibre for faecal bulking but that it also gives the best results in the treatment of diverticular disease. However, the dietary fibre content of fruits must not be ignored for it too, has a role to play in human nutrition. Figures 1 and 2 show the dietary fibre content of selected fresh tropical fruit and imported fruit.

Fruits supply degradable fibre materials which provide an energy substance for the growth of bacteria in the intestines. Fruits therefore contribute to faecal output by way of the increased faecal bulk as provided by the increase in bacterial population (Stephen, 1981).

It has also been demonstrated that one of the constituents of

Fig. 1: Dietary Fibre Content of Selected Tropical Fruits g/100g whole fruit

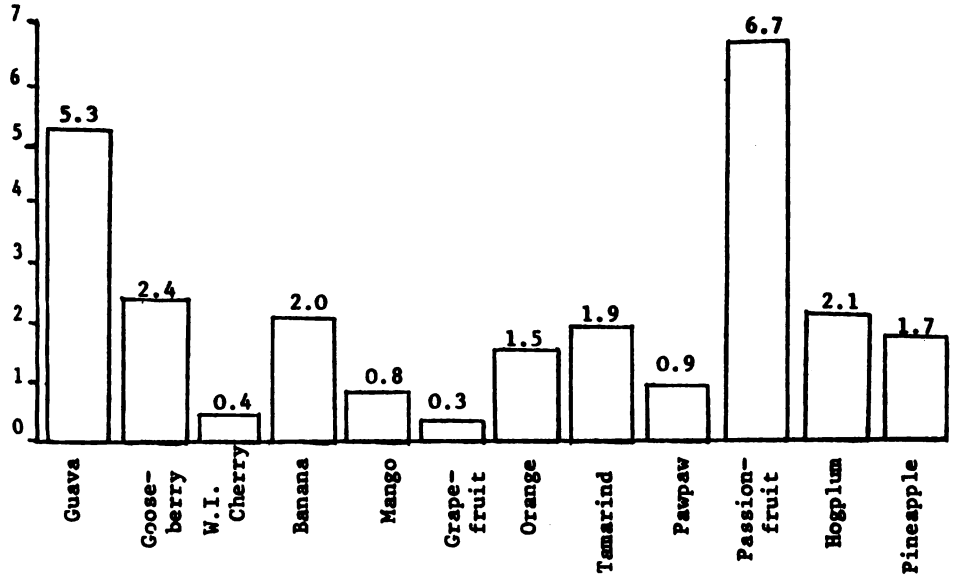
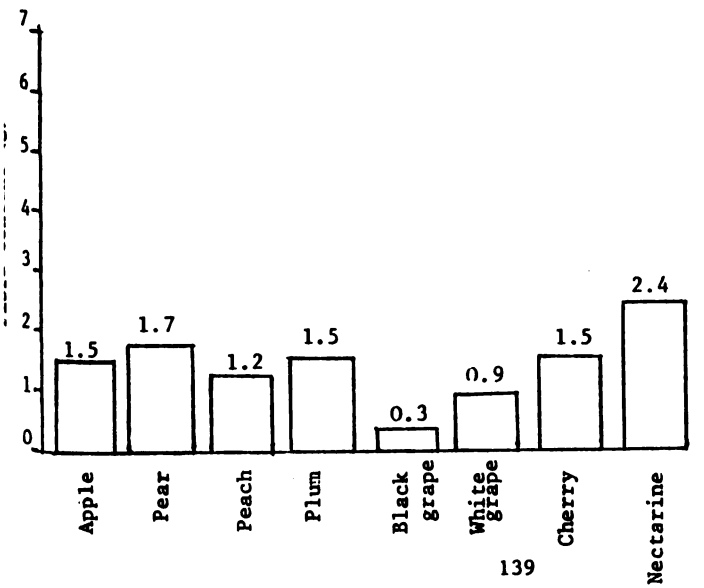


Fig. 2: Dietary Fibre Content of Selected Imported Non-tropical fruit (g/100g whole fruit)



fibre, pectin, found in the cell walls of fruits as the calcium and magnesium salts may have a role to play in the prevention and control of maturity onset diabetes, arteriosclerosis and coronary heart disease. Hayes (1977) and Jenkins et al (1976) reported that pectin can reduce the post prandial rise in glucose levels. Jenkins et al (1975) had earlier reported that pectin can reduce plasma cholesterol levels in normal subjects by 10-15 per cent. Truswell (1978) also demonstrated that pectin can reduce plasma cholesterol levels by a mean of 13 per cent. Thus by appropriate dietary supplementation the diabetic's plasma glucose and plasma lipids can be controlled.

Pectin is also one of several substances found to enhance faecal bile acid excretion. As its sodium salt, it forms insoluble complexes with heavy metals such as cadmium, and aids in their excretion. Addition of pectin to the diets also leads to increased faecal fat. (Kay and Truswell, 1977).

Although there is a suggestion that increased cereal and vegetable consumption will reduce mineral absorption, the added cereals and vegetables themselves increase the intake of minerals (e.g. trace elements) and thereby limit any deleterious effects on mineral status of the phytate or fibre associated with these foods (James 1980).

5. CONCLUSION

Implications for Use of Fruit in the Barbadian Diet.

Statistics published by the Chief Medical Officer of Health for 1982 showed that of all patients who visited the district outpatient clinics 15.1% were treated for diabetes mellitus and 22.1% were treated for diseases of the circulatory system. Statistics released, also show that of the ten (10) principal causes of death in the island, heart disease and diabetes mellitus were ranked No. 1 and No. 4 respectively. Interpretation of these statistics show that these two diseases are leading causes of morbidity and thus there is a need for a concerted effort to address these two diseases.

Since research has shown that the pectin in fruit can have a positive effect in lowering blood sugar levels and blood lipid levels, then one of the methods by which heart disease and diabetes mellitus can be tackled is to advise increased consumption of local fruits in these vulnerable groups. Increased consumption of fruit in other groups within the population is also desirous since pectin has also been shown to lower plasma cholesterol levels in normal subjects. Thus the pectin can have a prophylactic effect.

In the meantime, there is a need for more research to be done as regards the dietary fibre content of fruit in relation to some of the other diseases listed in Table 1.

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ASPECTS OF FRUIT CONSUMPTION IN A GROUP OF BARBADIAN WOMEN

by

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ABSTRACT: This paper examines the responses of 66 mothers (attending Child Health clinics at two Barbadian polyclinics) who were questioned about the types and frequency of fruits consumed, factors influencing the consumption of local and imported fruits and their perception of the nutritional importance of fruits in the diet. The study revealed that most of the fruits consumed were imported fruits and fruit juices. Local fruits when in season were used mainly for making drinks. Preference for certain fruits was the main factor influencing consumption. The women were cognizant of the importance of fruit for "good health".

1. INTRODUCTION

Good nutrition means that the body has been supplied with foods containing proper amounts of essential nutrients which have been utilised both in the maintenance and repair of tissues and supplying energy for normal body functions.

A nutritionally adequate diet is based on a wise selection of a variety of foods chosen from the following groups: Staples, legumes, dark green leafy and yellow vegetables, fruits, food from animals and fats and substitutes (C.F.N.I., 1980).

Fruits being one of the six food groups needed for adequate nutrition form a vital part of the diet that is needed for good health.

For good nutrition to occur the right foods have to be identified, selected, purchased or produced and prepared in ways which will

guarantee optimum nutrition.

However, many factors both social and economic influence the consumption of food (Obaid, 1982).

In Barbados, there is a high dependence on imported foods as source of nutrients and a high proportion of these imports come from outside the Caribbean region. Since the energy crisis of 1973-74, foreign exchange, inflation and balance of payment problems have increased. Hence the consumer spends more on food (Mayer, 1982).

The 1969 Food and Nutrition Survey showed that very small quantities of fruits were consumed in Barbados. The consumption of imported fruit items represented 1/3 of the total consumption of this food group.

More recently, a decrease in total supply of fruits in Barbados was suggested to have resulted from a decrease in imports (National Food and Nutrition Proposal, 1984). Hence this decrease in the supply of fruits may have many implications for the consumption of fruits and nutrition.

Until recently little study has been done to determine the dietary intake of fruit of people in Barbados. On comparing food consumption and vital statistics in Barbados with the more developed countries, the most important factor which stands out, is that the prevalence of obesity is high. A recent Nutrition Survey carried out in Barbados has shown that just over 44% of all women are obese i.e. 120% Wt/Ht (Nutrition Survey, 1981). Obesity, a serious health problem in Barbados at present may have resulted not solely however, from a greater consumption of high energy foods but also as a result of the less emphasis which is given to low calorie foods such as fruit. Therefore the role of fruit in the diet is a subject of much concern for the health personnel.

Since fruits are a good source of dietary fibre they are useful in the management of obesity through the effect on the "texture and palability, the energy density, the range of satiation, the extent of bulking and altered thernogenesis (Vahouny, 1982).

However, no discussion on local fruit promotion policy is complete without some reference to fruit consumption and the factors influencing consumption. To this end this study was undertaken. The objectives of this study were to determine the types and frequency of fruits consumed. To determine the factors that influence fruit consumption and to assess the subject's knowledge of the nutritional importance of fruits.

2. METHODS

Two polyclinics, Ladymeade situated in the South-West and Maurice Byer situated in the northern part of the island were selected. After permission was granted from the Senior Health Sisters, 66 mothers aged 20-30 years (35 from Maurice Byer and 31 from Ladymeade) attending two child health clinics were interviewed using a self administered and number questionnaire following a brief verbal instruction.

Information on types and frequency of fruits consumed and factors influencing fruit consumption was collected for both subsamples. The questionnaire also aimed to assess the subject's knowledge of the nutritional importance of fruits.

3. RESULTS

Information collected on the marital status of the women showed that most of the women were single 36 (54%) with 45 (68%) having between 1-2 children. All the women had some form of education. Most 41, (62%) had attended secondary school, while 22 (33%) and 3 (5%) had attended primary and tertiary institutions respectively.

3.1 FRUITS CONSUMED

Fig. 1 shows that most of the women bought oranges (40%); red apples (25%) and bananas (10%) most often, while fewer persons bought locally grown fruits. Half of the number of women in the sample (50%) said that they bought canned fruits such as peaches, pears and apricots at least once per week.

Table 1: Type of fruit juice bought most often

Fruit	Number	Percentage
Orange	53	54
Pineapple	33	33
Grapefruit	7	7
Fruit punch	6	6

Of the responses given for the type of fruit juices bought most often, 54% indicated orange juice and 33% pineapple juice. Responses indicated that fewer persons bought grapefruit and fruit punch.

Similar number of women, 33% often bought canned and both canned and box fruit juices.

All the women who said that they bought canned fruit juices did not own a refrigerator. Only 20% of the women bought fruit juice in the box.

3.2 LOCAL FRUIT CONSUMPTION

Of the 66 women interviewed, most of them (73%) said that they made drink from local fruits when they were in season.

Figure 2 shows the kinds of local fruits used for making drinks.

Golden apple, cherries and limes were the fruits mentioned by 32%, 23% and 15% of the women respectively as local fruits used for making drink.

Table 2: Frequency of fruits consumed most often

Frequency of consumption	Number	Percentage
Daily	32	48
Weekly	27	41
Other	7	11

A total of 66 women were interviewed.

Table 2 shows that less than half the number of women (48%) said that they ate fruits daily compared with 41% who mentioned that they ate fruits weekly. Fewer persons ate fruits less often.

3.3 PERCEPTION OF THE NUTRITIONAL IMPORTANCE OF FRUITS

When questioned about the importance of fruits nearly all of the women 77% were aware that fruits were needed in the diet.

TABLE 3: Responses Given on the Nutritional Importance of Fruits inthe Diet

PERCEPTION	NUMBER	PERCENTAGE
Good Health	18	27
Dietary Fibre	7	11
Vitamins	26	39
Don't know	15	23

Of the women who said the fruits were needed in the diet, 39% of them mentioned that fruits supplied the body with vitamins, while 27% said that fruits were needed for good health. Fewer persons mentioned fruits as a source of dietary fibre.

TABLE 4: Reasons Given for Buying Fruits ·

RESPONSES GIVEN	NUMBER	PERCENTAGE
Preferred	47	71
Nutrition	16	24
Available	2	3
Cheap	1	2

Although most women were aware of the nutritional importance of fruits the majority of them (71%) said that their preference influenced their buying of fruits, while 24% bought fruits because they were nutritious. 3% of the women mentioned availability, and 2% said that they bought fruits because they were cheap.

3.4 KINDS OF FRUITS MOST PREFERRED

Figure 3 shows the kind of fruits preferred by the women interviewed. Oranges, red apples, mangoes and bananas were the fruits mostly preferred by 30%, 17%, 14% and 11% of the women respectively.

Figure 4 shows the type of fruit trees grown in backyards.

Only 50% of the women interviewed said that they had fruit trees growing at home. Most of them 32% had golden apple trees, 14% bananas and similar number 10% of women mentioned pear and cherry trees.

TABLE 5 Place Where Fruits Are Purchased

PLACE	NUMBER	PERCENTAGE
Supermarket	40	61
Street Vendor	16	24
Both supermarket and Street Vendor	10	15

4. DISCUSSION

This study was largely concerned with the various aspects of fruit consumption in a group of Barbadian women.

Insufficient data on fruit consumption and the main allocated for conducting the study were the main limitations.

However, the findings of the current study revealed that more imported fruits, mainly red apples and oranges rather than locally grown fruits were consumed by these women. The high consumption of canned fruits such as peaches, pears and apricots, lend support to the great emphasis placed on imported fruits by these women.

It seems from the findings of the current study that while imported fruits are eaten as fresh fruits, most of the locally grown ones when consumed are made into drinks. Golden apples, cherries and limes were the most common fruits used for making drinks. It must be pointed out however, that the month of the year in which the study was carried out may influence the answers given as to the type of local fruits consumed.

The fact that imported fruits were not used for making drinks does suggest that people cannot afford to buy such fruits to make drinks. Most of the women who made drinks from fruits were those who had fruit trees growing at home or could get fruits from friends.

It would appear, from the results of the current study, that fruits do not form a main part of these women's diet since less than half the women interviewed (48%) consumed fruits daily. This finding may help explain the prevalence of obesity in Barbadian women.

Information gathered from obese clinic attenders showed that high calorie foods were often used as snacks. When a reducing diet was implemented these high calorie snacks were replaced by fruits which because of their lower calories content helped to promote weight loss.

In relation to fruits preferred, a greater number of people, 30%, and 17%, mentioned oranges and red apples respectively. It is possible that these fruits are considered superior to locally grown fruits, thus cultural factors, more so than economics, play a greater role in influencing consumption. The consumption of such fruits may reflect the fact that Barbadians aspire more towards North American standards.

Most women in the study (66%) bought fruits from the supermarket, and this finding is in keeping with that of the 1981 survey where 66% of the households were shown to buy food from the supermarket.

The availability of fruits may be the determining factor influencing fruit consumption since apples and oranges are the fruits found most often in supermarkets. Also, the way fruits are displayed in supermarkets may influence consumption. Imported fruits are usually displayed in attractive packages, whereas, this does not usually apply to local fruits. People with limited knowledge about the nutritive value of fruits tend to purchase the more attractive and expensive fruits.

Although most women were aware that fruits are important, they

lacked the knowledge of the nutritional value of specific fruits. Often, oranges are bought in place of cherries, although cherries contain 80 times more vitamin C than oranges and also cost less.

More canned fruit juices than box fruit juices were bought by these women. When asked for the reason why canned juices were preferred, the most frequent reply given was that the box juices were too sweet.

The availability of more unsweetened fruit juices in boxes may help to increase their consumption. When local fruits are plentiful, the lack of marketing facilities may explain the reason why very few people consume them.

More imported fruits than locally grown ones, are sold by street vendors. Also, it was mentioned by a few vendors interviewed, that greater profit is gained from the sale of the imported ones. Thus the availability of such fruits may influence people's taste for them and hence consumption.

It can be concluded that although most women were aware of the nutritional importance of fruits for good health, fruits did not form a main part of the diet of these women as has been indicated by the frequency of consumption of fruits.

Imported fruits especially red apples and oranges were bought most often. People's preference for fruits was the main factor influencing consumption. However, there is need for further research in this area.

Fig. I Types of fruits bought most often

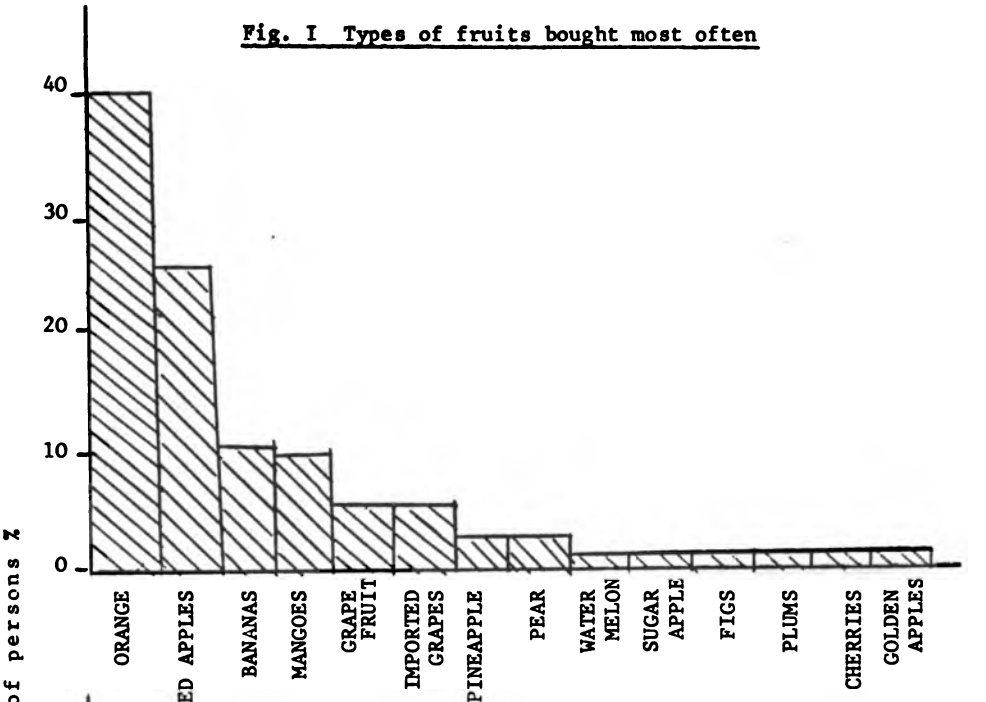


Fig. II Types of local fruits used for making drinks

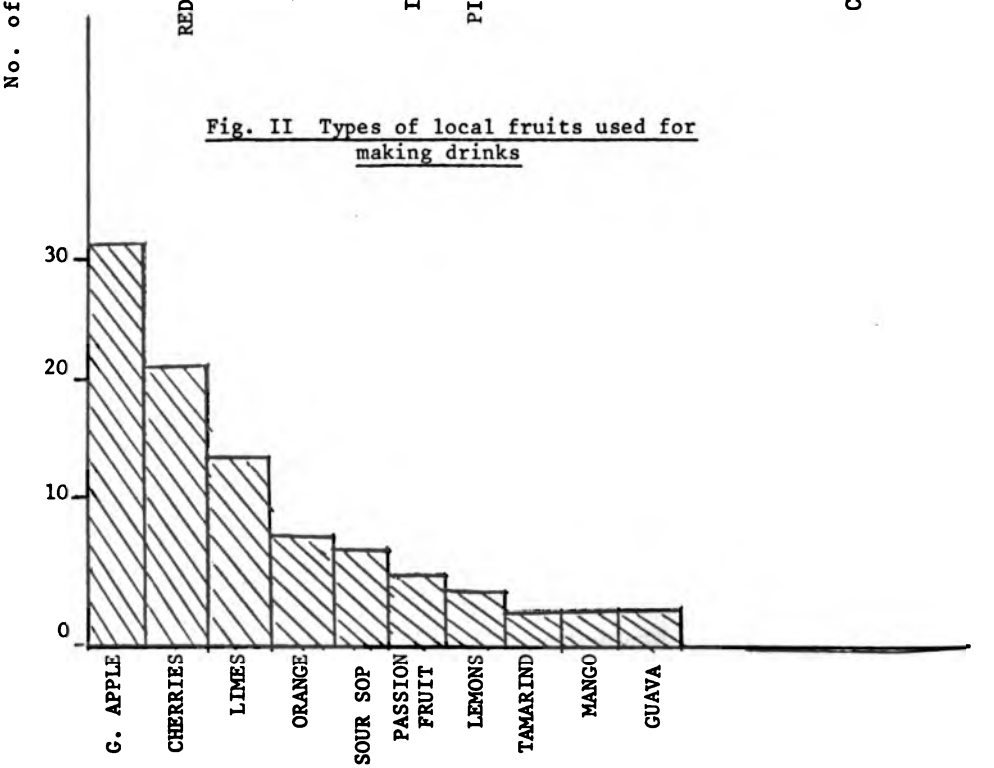


Fig. III Type of fruits liked Best

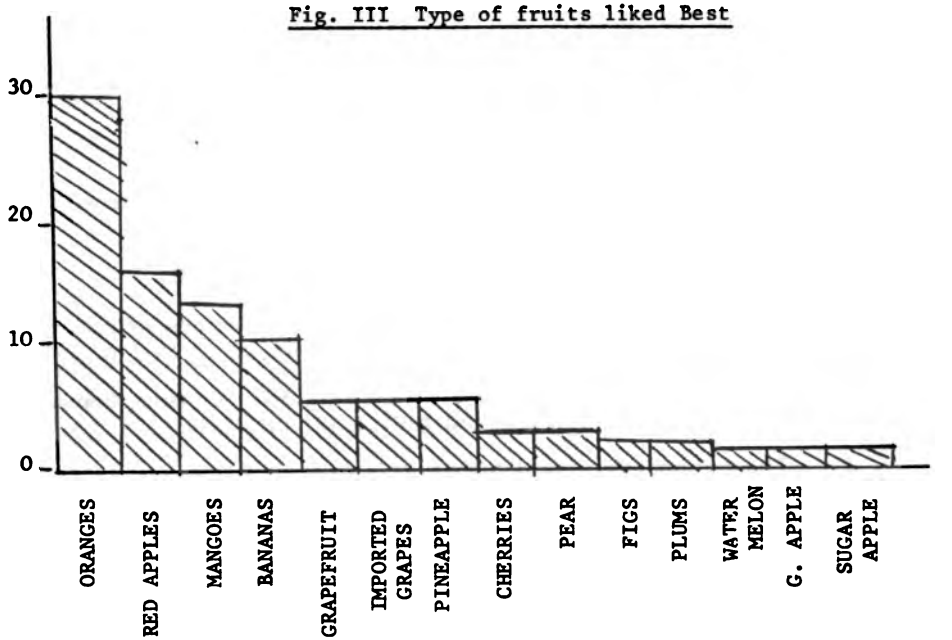
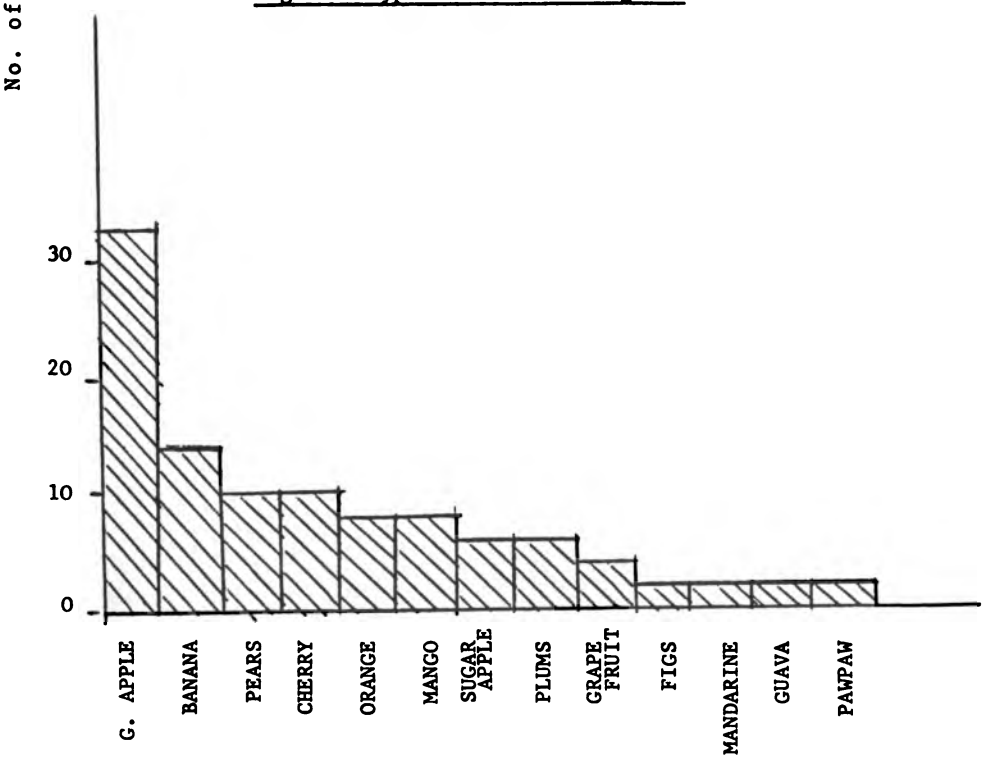


Fig. IV Type of fruit trees grown



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PROGRAMMES TO INCREASE THE CONSUMPTION OF LOCALLY PRODUCED FRUITS

by

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In 1969 a National Food and Nutrition Survey was conducted in Barbados. This revealed that very small quantities of all fruits were consumed. (Table 1). Another survey conducted in 1981, again indicated that fruits did not contribute significantly to the dietary intake of Barbadians. (Table 2).

Table 1: Per capita consumption of fruits for selected years

	1960	1963	1966	1972	1975	1981
FRUIT						
Fresh	112	118	108	99	90	93
Processed	1	4	10	31	23	24

Table 2: Proportion of different foodstuffs in total per capita Food Consumption 1960, 1975, 1981.

(Percentages)

PRODUCT	1960	1975	1981
Fruit	13	11	8

Source: Ministry of Agriculture, Food and Consumer Affairs

The priority food and nutrition problems of public health importance are under-nutrition, anaemia, obesity and nutrition related diseases such as diabetes mellitus and an inadequate and often inaccessible supply of food.

The analysis of the food and nutrition situation points to inadequate food intake among a large segment of the population and a heavy dependence on imported food supplies. This is due mainly to a lack of coordination between production and marketing. The Ministry of Agriculture has identified certain projects to increase the food production including fruit production. However, although the strategy is based on emphasizing the improvement of the quality of planting material, some constraints have been identified. Among these are; the lack of data, low level of fruit technology, low fruit consumption and lack of market organization.

From a nutritional point of view, our aim is to increase the consumption of fruits because of the vitamin, mineral and fibre content of this food group but we cannot talk about consumption without considering the vital aspects of fruit production, marketing, storage and distribution systems. Food and Nutrition should go together and therefore any programme planned to increase the consumption of fruits

should be a concerted effort not only of the the Ministry of Health but also the Ministries of Agriculture and Education.

The Food and Nutrition Policy Proposal for Barbados recognizes that future programmes must be related to an integration of services of the various ministries concerned, and should focus on the production and consumption of nutritious foods, emphasizing those that are locally grown and promoting home food production.

The overall objective of this policy stems out of the national goal,"health for all by the year 2000", and seeks to improve household food availability, dietary well-being and the nutritional status of every segment of the population. These objectives will be met by identifying projects and programmes which address specific problems of food availability, food safety, food demand, health and nutritional status and community participation.

It should therefore be our aim to increase the number of persons engaged in backyard gardening and also to have a corresponding increase in the contribution of home-produced food to the overall food consumption of individual families.

The Programme through the Ministry of Agriculture could therefore address the following:

1. Increase production of fruits.

2. Improve the quality of planting material.

3. Encourage the planting of orchards.

4. Have demonstration projects to show members of the public how to plant and care for their fruit trees.

5. Educational sessions by Extension Officers, Agronomists and other key persons in the Ministry of Agriculture who are

involved in fruit production. Use should also be made of the mass media.

6. Promote and support the marketing, storage and distribution of locally produced fruits.

7. Provide some incentives to members of the public to encourage fruit production.

The Programme through the Ministry of Health should focus on:-

1. Lecture/discussions on the nutritive value of fruits to members of the community. These would include community groups e.g. P.T.A., Church Groups etc. and also to persons attending various clinics held at the health centres/ polyclinics.

2. Mass media dissemination of information on the importance of fruits in the diet etc.

3. Production of educational materials, e.g. pamphlets, posters.

4. Demonstrations in the preparation of fruit drinks from local fruits; and also on the preservation of fruits.

5. Disseminate information to the public on the best fruit buys.

Again the Ministry of Education could reinforce the efforts of the Ministries of Health and Agriculture by:

1. Encouraging the planting of fruit trees if land is available around the schools.
2. Encourage whenever possible the utilization of local fruit and fruit drinks in the School Meals Programme.

3. Lecture/discussions on the importance of fruits to children of all ages in the schools.

4. Promote the selling of local fruits and fruit drinks in the school canteens.

5. Conduct regular in-service training programmes for home economics teachers.

I hasten to add that most of the activities outlined above are addressed by the various ministries, but a more integrated approach is needed. For example, the Ministry of Education has a recent scheme which is intended to make fruit available to school children through the planting of fruit trees at all schools where space is available.

This in itself could be a complete educational programme involving not only the teacher, but also the agricultural extension officer, the community nutrition officer and the home economist, each fulfilling and reinforcing their respective roles - the agricultural extension officer educating on the importance and contribution of fruits in the diet and the home economist carrying out culinary demonstrations on the fruits produced.

In the 1970's we had an Applied Nutrition Programme here in Barbados. This was a concerted effort by the Ministries of Agriculture, Education and Health, to promote better nutrition in Barbados as a result of the major nutritional problems that were identified in the 1969 National Food and Nutrition Survey.

This programme I believe has helped Barbadians to become more aware of the importance of good nutrition to health. The programme focussed on backyard gardening, small livestock production, demonstration on the utilization of local foods and recipe development and information dissemination. The aim was to encourage individuals to utilize available resources and to promote self-sufficiency.

Unfortunately, this programme is no longer in operation but if we are to continue to promote good nutrition among our people, then we must go back to this type of integrated approach.

The proposed National Food and Nutrition Policy for Barbados recommends that a National Food and Nutrition Council be established. This council would be the principle body performing that role and in so doing, it will among other things seek to ensure that nutrition information coming from the various public agencies, e.g. the advertising media, school system, health and food and nutrition professionals is consistent. The national food and nutrition policies provide the broad framework for intersectorial linkages in food and nutrition. National Food and Nutrition Councils provide the functional setting for programme development and monitoring and can ensure integration with primary health care programmes.

In developing an overall food and nutrition planning process, the need for a co-ordinating mechanism to optimise the use of resources in the achievement of short and long-term goals is a vital prerequisite. Through this therefore, the production and consumption of nutritious foods can be insured with emphasis on those that are locally grown.

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