Ministères des
Affaires Etrangères

FRANCE

Fonds Interministériel
Caraïbes-Guyanes

IICA

THIRD REGIONAL WORKSHOP ON TROPICAL FRUITS

GRENADA
16–20 May, 1994

IICA OFFICE IN TRINIDAD AND TOBAGO

"WHAT IS IICA?"

The Inter-American Institute for Cooperation on Agriculture (IICA) is the specialized agency for agriculture of the Inter-American system. The Institute was founded on October 7, 1942, when the Council of Directors of the Pan American Union approved the creation of the Inter-American Institute of Agricultural Sciences, to be headquartered in Costa Rica.

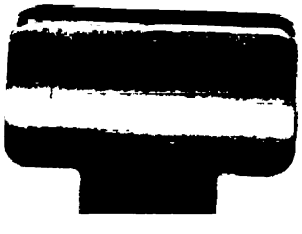
IICA was founded as an institution for agricultural research and graduate training in tropical agriculture. In response to changing needs in the Americas, the Institute gradually evolved into an agency for technical cooperation in the field of agriculture. These changes were officially recognized through the ratification of a new Convention on December 8,1980. The Institute's purposes under the new Convention are to encourage, facilitate and support cooperation among its Member States, so as to better promote agricultural development and rural well-being.

The Member States participate in the Inter-American Board of Agriculture (IABA) and the Executive Committee, the Institute's governing bodies, which issue the policy guidelines executed by the General Directorate. Today, IICA has a geographic reach that allows it to respond to needs for technical cooperation in the countries, though its Technical Cooperation Agencies and five Regional Centers, which coordinate the implementation of strategies tailored to the needs of each region.

The participation and support of the Member States and the relations IICA maintains with its Permanent Observer and numerous international organizations provide IICA with channels to direct its human and financial resources in support of agricultural development throughout the Americas.

The 1994 – 1998 Medium Term Plan (MTP) provides the strategic framework for orienting IICA's action during this four-year period. It's general objective is to support the efforts of the Member States in achieving sustainable agricultural development, within the framework of hemispheric integration and as a contribution to human development in rural areas. The Institute's work is aimed at making changes in three aspects of agriculture: production, trade and institutions, using an integrated approach to development which is based on sustainability, equity and competitiveness. IICA carries out its technical activities in four Areas of Concentration: Socioeconomic Policies, Trade and Investments; Science and Technology, Natural Resources and Agricultural Production; Agricultural Health; and Sustainable Rural Development. IICA's action receive support from two Specialized Services: Training, Education and Communications; and Information, Documentation and Informatics.

The Member States of IICA are: Antigua and Barbuda, Argentina, Barbados, Belize Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Suriname, Trinidad and Tobago, the United States of America, Uruguay and Venezuela. Its Permanent Observer are: Arab Republic of Egypt, Austria, Belgium, European Communities, France, Germany, Hungary, Israel, Italy, Japan, Kingdom of the Netherlands, Portugal, Republic of Korea, Republic of Poland, Romania, Russian Federation and Spain.



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Contents

Foreword

The Tropical Fruit Crop Project (TFCP) of the Inter-American Institute for Cooperation on Agriculture (IICA) is a partial response to the Agricultural Diversification Programme that has been adopted by the Standing Committee of Ministers responsible for Agriculture within CARICOM. The major components of the TFCP include training and dissemination of information, germplasm introduction, improvement and exchange, and technology adaptation, improvement and transfer.

Within the component, training and dissemination of information, the TFCP, in collaboration with the Caribbean Agricultural Research and Development Institute (CARDI) and the Agricultural Diversification Coordinating Unit/ Organization of Eastern Caribbean States (ADCU/OECS), agreed to conduct a series of regional workshops to enlighten a wide cross-section of the agricultural population on major topics dealing with the production, processing, marketing (including export) and commercialization of an extensive range of tropical fruits.

The first of these workshops was held in February 1991 and dealt with avocados, citrus and passion fruits. The second workshop, which was held in Antigua in December 1991, highlighted mangoes, papaya and pineapples.

The third workshop, which is the final one in the series, was held in Grenada with the assistance of that country's Ministry of Agriculture in May 1994. Minor fruits were addressed at this workshop thus completing the coverage of Tropical fruits of interest to the Caribbean. An average of 55 persons attended the workshop including researchers and officers from national and regional organizations, farmers, processors and exporters from the private sector. However, participants noted the need to increase the involvement of producers (farmers) in exercises such as this which are aimed to increase production and productivity.

An important additional achievement of this workshop was its endorsement of IICA's proposal to establish a fruit network called CARIFRUIT and approval of the objectives and guidelines and procedures for its operation. As a result of this action, CARIFRUIT was subsequently launched by the SCMA in June 1995 which moves the TFCP into another phase of its activities.

IICA commits itself to working closely with all of its collaborating institutions and individuals in the promotion of the fruit sub-sector in the Caribbean. We trust that these proceedings will serve as a tangible reminder of this commitment.

H. Arlington D. Chesney
Director – Caribbean Regional Centre and
Representative in Trinidad & Tobago and Barbados

SECTION 1 - GROUP REPORTS

REPORT FROM THE WORKING GROUP ON PRODUCTION

This group considered the production systems, availability and need for improved germplasm and immediate constraints to the development of selected minor crops in the Caribbean.

Production System

Table 1 shows that few minor crops are produced in pure stands. The few crops with significant cultivated area (>100 ha) under this system include cashew, West Indian cherry, guava and carambola (five-finger). Other crops grown in much smaller pure stands are soursop, sugar apple, mammey apple and dunks. Therefore, the most prevalent production systems for the minor fruit crops are occurrence in the wild or abandoned plantings, and interplanting with other crops on farms or in backyards.

Most of the crops are well known throughout the region but there are some which are relatively unfamiliar in some countries, e.g. bilimbi in Barbados, Dominica and St Lucia. Mangosteen and rambutan are generally not known, mainly because they are relatively new introductions.

Germplasm Status

Table 2 shows that improved germplasm is available in the Caribbean for 75% of the minor fruits; this was not the case for hog plum, mammey apple, bilimbi and barbadine.

This improved material is available in various countries which creates a basis for germplasm exchange. Improved germplasm was requested for all crops excluding hog plum and barbadine. The items most in demand include the dwarf Brazilian cashew which is available in St Lucia, the dwarf golden apple, the soursop cultivar 'Burris', the seedless Cuban guavas suitable for fresh consumption and for processing, and the sapodilla cultivar 'De Meillac'.

Constraints

Constraints to production and development include:

- The need for more effective methods of pest and disease management, especially on the soft fruits, e.g. guava and soursop.
- The lack of packages of recommended cultural practices. The deficiency is largely related to current systems of production and especially to the large number of trees found in the wild. The need for transfer of available information to farmers was also recognized.
- Tree size poses a serious challenge to harvesting crops such as breadfruit and golden apple. Considerable loss is incurred either by reduced quantity of fruit harvested because some are inacessible and reduced quality and increased wastage due to fallen and damaged fruit. There is need to develop technologies for reducing tree height, e.g. use of dwarfing rootstocks or pruning.

Recommendations

- Germplasm:
  - There is need for the development of mechanisms which will facilitate germplasm exchange within the region.
  - Live germplasm collections should be established in specific territories.
  - The existing fruit-crop germplasm in the region should be identified and registered in order to allow access to the gene pool for crop improvement purposes in the future.
- Cost-effective agronomic practices (including fertilizer and irrigation regimes for the extension of the bearing season, and tree height management) need to be developed for minor fruit crops. Pure-stand production systems should not be advocated over the interplanted systems.
- Pests and disease management methods need to be developed for those problems to which the minor fruits are susceptible.

Tables 1 and 2 follow

Table 1: Production systems of minor fruits in the Caribbean

Crop	Barbados	Dominica	Grenada	Guyana	Jamaica	Martinique/ Guadeloupe	St Lucia	St Vincent	Suriname	Trinidad & Tobago
Cashew	W	W	W*	W***	W**1'(1.5)	B	B,I,P(21)	B	W,B	W,B,P(71)
Golden apple	W	W	I***	B,I**	I***	B**	W,B,I***	B**,I*	B**,I*	B*** B,I
Jamaica plum	W	B	B	O	B,W	B	B***	B*	O	B
Hog plum	W	W	W,I	W***	W	B	W	W	W***	W*
Soursop	B,P(3)	B,P(1)	P(1.5)	B,I	B,I,P(6)	B**	B*P(8)	B,I*	B,P(20)***	B
Sugar apple	B,W	B	W,B,I**	B	W*,P(2)	B*	B	W,B***	B	B
Mangosteen	O	W 3 trees	W 2 trees	O	O	50 trees	O	3 trees	O	32 trees
Mammy apple	W,B	W**	W**,P(0.12)	B,I,P(5)**	W**	B,I,P(5)	W,B	W,B***	W***	W,B,P(0.5)
Tamarind	W	W**	W,I,B**	B,W	W**	B	W,B	W***	B***	B,P(0.2)
West Indian cherry	B,P(62)	B	B,P(0.25)	B,I,P(35)***	B***	B, expt. plot	B	B	B***P(100)	B
Breadfruit	W,P(3)	B,W,I***	W,B,I***	I**	B,I,W***	B**	W,B,I***	W,B,I***	B***	B,W,P**(0.3)
Guava	W,B,P	W***	W,B,P(0.5)	B,W***	W***P(3)	B.P(150)	W,B***	W,B***		
Pommerac	B	B	W,I**	B,I**	B,I***	B	W,B,	B,I***	B***	W,B,I,P(1)
Five-finger	P(1)	B,P(1)	B,I,P(0.5)	P(100)	P(2)	B	P(1)	B	B***	P(5)B
Bilimbi	O	O	W,B,P,(0.25)	B	B,W	B	O?	3 trees	B	B
Barbadeen	O	B	B	B	B	B	P(0.5)	B,I	?	B
Dunks	W***	O	W***	B***P(4)	W	B	W,B,P(0.5)	1 tree	?	W*
Rambutan	O	O	I 2 trees	6 trees	O	30 trees	O	O	13	P(0.4)
Sapodilla	B	B,W	W,I,P(0.5)**	B*	W,I***	B expt. plot	W,B	B***	?	W,B,P(1)
Litchi	n/a	n/a		n/a	P(2)			n/a		
Jackfruit	n/a	n/a		n/a	B,P			n/a		
Governor plum	n/a	n/a		n/a	n/a			n/a		
Other			Chili plum B,W				Chili plum***		Chili plum***	Chili plum-B

W – Wild
B – Backyard
n/a – Not available
I – Interplant
O – None present
P( ) – Pure stand (hectares)
*** large population
**significant population
*fair population

Table 2: Improved germplasm of minor fruit-tree crops available in the Caribbean

Crop	Barbados	Dominica	Grenada	Guyana	Jamaica	Martinique/ Guadeloupe	St Lucia	St Vincent	Suriname	Trinidad & Tobago
Cashew	I	I-Dwarrf	I-Improved types*				A-Brazil	I	I	A,I
Golden apple		I-Dwarf		I-Dwarf					I	A
Jamaica plum					A					I
Hog plum										
Soursop		A	A		I	I			I	I
Sugar apple						A		A		
Mangosteen		I	I	I			I			A
Mammy apple								I-sapote		
Tamarind			I-Sweet, Guad.			A		I		I,A-Sweet
West Indian cherry	A				A	A,I	I		A	
Breadfruit					A			A		
Guava	A-I	A-cuban		A-Seedless	I-Process, types	A,I	A-chinese	I	I	A,I
Pommerac			A-waxed Apple/Rookmin							I,A-Rookmir
Five-finger				A	I	A			A	A
Bilimbi										
Barbadeen										
Dunks			A	I						A,I
Rambutan				A		A,I	I	I		A
Sapodilla			I-DeMeillac T'dad		A Seedless I	A		I-Latex tree		A,I
Governor plum			A seedless							A-chili plum

A – Selected germplasm available either in museum plots or commercial fields
I – Interested in acquiring selected germplasm
* – St Lucia and Brazil

REPORT FROM THE WORKING GROUP ON MARKETING AND POST-HARVEST HANDLING

RONALD PILGRIM
COORDINATOR, CARDI-ST LUCIA

Members of the working group were:

F Grauwde
C S Baichoo
M Olesky
B Mc Intosh
M Lambert
F A Jones
R N Pilgrim (Coordinator)
B Brown
R Brathwaite
R St Hill
S Carrington (Rapporteur)
A Powlette
P Bruno
T Joseph
A Satney
R Leandre
J Pennycooke

The majority of the minor tropical fruits face growing competition from African and Pacific countries. Caribbean countries therefore need to get their act together both in marketing and post-harvest strategies if any gains are to be achieved on the international tropical fruit market.

The approach to be adopted therefore should be the identification of suitable cultivars complemented with an aggressive marketing thrust and the constant monitoring of changes occurring in the market-place.

Priority crops identified for 12 countries for which emphasis is being placed for both the local and export market, are given in Table 1. It was recognized that although market potential exists for these crops, the majority of them cannot be exported due to quarantine restrictions from importing countries. However it was suggested that the processing of such crops was the strategy to be adopted to overcome this problem.

The more important and specific comments that were articulated in the discussion on the various crops were:

Carambola:
This crop cannot compete on the international market with other producers and there was also a problem with the carambola fruit fly. Nonetheless it is important for local processing.

Condicion (bilimbi):
Present production is insufficient for export. It is a very perishable crop, very prone to fruit fly. Post-harvest work is required.

Breadfruit:
There is slow growth in the export market and it is unlikely to expand in the future. No expansion of acreage was recommended. Some post-harvest work is still needed and scope exists for processing. The depression where the peduncle is attached to the fruit tends to collect scale insects etc. which makes the fruit unsightly. Over-zealous cleaning of this area can damage the fruit - the possibility exists for use of a high-pressure hose or brush.

Table 1: Priority minor fruits for 12 Caribbean countries

	BVI	Barbados	Dominica	Grenada	Guyana	Jamaica	Monsterrat	St Kitts	St Lucia	St Vincent	Suriname	Trinidad & Tobago
Carambola					L					L	L	
Condicion				E							E	
Breadfruit		L,E	L,E	L,E		L,E			L,E	L,E		
Breadnut				L,E								
Soursop	L	L,E	L	L,E		L,E	L		L,E		L,E	L
Sapodilla				L,E	L	L						L
Tamarind				L,E					L			
Golden apple	L			L,E				L	L,E	L,E	L,E	
Guava			L		L		L					L
Pomerac										L,E	L,E	
Plums (yellow)										L,E	L,E	
Plums (red)				L,E					L,E	L,E	L,E	
Cashew	L				L							L
Gooseberry							L					
WI cherry	L		L		L			L				

L = local market
E = export market

Breadnut:
It should be recognized that this provides essentially two types of crop — immature, whole fruit exported for cooking and the local use of seeds. There is a need for education of West Indian consumers and the hotel sector about this crop (seeds). Acreage should also be increased.

Soursop:
Fresh fruit markets exist mainly in Canada with low interest in the United Kingdom. Restriction of exports to the United States is due to quarantine measures. Post-harvest work is required — fruits are easily bruised; better temperature management. There is a need for better packaging/boxes taking the fruit shape and spurs into account.

Sapodilla:
Good markets exist which Grenada cannot presently satisfy. There is a need for better maturity indices and possible post-harvest work.

Tamarind:
As a fresh fruit the major problem relates to boxes/packaging. It is recommended for export in a semi-processed form.

Golden apple:
There is a need for market research and more post-harvest work. Sooty mould was the major problem; it is difficult to control by spraying due to tree size. Current post-harvest washing with bleach and detergent needs standardizing and controlling for residues.

Guava:
This crop is mainly processed for export and local use. It cannot compete in the export table guava market.

Pomerac:
The fruit is very perishable and difficult to export. It is not too certain whether local demand is enough to justify further post-harvest work.

Plums (yellow):
There is limited export to the Netherlands with some inter-regional export. Fruit fly is a problem.

Plums (red):
Markets are available within the region and for local use. Post-harvest work needed.

Cashew:
Largely harvested for the processing market.

Gooseberry:
Largely harvested for the local processing industry.

West Indian cherry:
Largely grown for the processing industry. Fruit fly is a major problem.

At present four fresh fruits can be identified with existing export markets: breadfruit, sapodilla, soursop, and golden apple. However, some of the other fruits show some degree of promise and potential but can only assume that status when the problems specifically related to them are addressed.

REPORT FROM THE WORKING GROUP ON PROCESSING

JUDITH FRANCIS - COORDINATOR
ERNST BLEYERT - RAPPORTEUR

The group approached the discussion as follows:

- Determination of the scale of processing of minor fruits by country and major products produced.
- Identification of constraints with respect to:
  - production of fruits for the industry
  - processing technology
- Recommendations for development of the industry.

Major Products

The majority of products prepared using minor fruits include jams, jellies, beverages, wines, ice-creams, pickles and dried fruits.

The minor fruits predominantly used in the industry are guava, tamarind and soursop and to a lesser extent pomme cythere, carambola, West Indian cherry, sour cherry, plums, sapodilla, dunks, cashew.

Table 1 shows the scale on which these fruits are processed by country. Cottage Industry (*) refers to kitchen type operations using small quantities of fruits; medium scale (++) refers to a plant which occupies a factory shell with some sophisticated equipment and processes significant quantities of fruits; large-scale (000) refers to processing plants with a certain degree of mechanization and utilizing large quantities of raw material annually.

Constraints in Production

- Little organized production making harvesting difficult.
- Poor post-harvest handling resulting in unnecessary losses.
- Inadequate cold storage facilities.
- Lack of available technology for storing fruits or pulps.
- Lack of available information on cost of production of fruits for processing.
- Competition between fruits for fresh fruit market and for processing, creating high prices and limited availability of raw material.
- Lack of confidence between processor and producer resulting in breakdown in contractual arrangements.
- Seasonality of fruits limits processing life.
- Land tenure situation in most countries forcing farmers to use lands for short-term cash crops.
- Inadequate research on identification of fruits for processing.
- Limited financing available to producers and processors for investments.

Constraints in Processing

- Lack of standards for raw materials (fruits) and for semi-processed raw materials (pulps, etc.).
- Variations in quality of fruits for processing.
- Lack of product variety; limited research in product development.
- Not enough linkage between processing and the tourist industry.
- Lack of available information on processing technology and equipment for many of these minor tropical fruits.
- Refusal on the part of the processors to pay for technical information.
- Not enough collaboration between research institutions in the Caribbean.
- Lack of standards for many finished products.
- Legislative agencies for enforcement of existing standards are not functioning at an optimum.
- Limited variety for packaging material and high cost of packing and labelling materials.
- Inadequate promotion and marketing of tropical fruit products.

Table 1: Scale of processing of minor fruits in the Caribbean

Fruits	Grenada	St Kitts	Jamaica	Martinique	St Vincent	Tobago	Monsterrat	Suriname	Trinidad	Dominica	Guyana
Guava	*,++	*	*,000	000	*	*,++	*,++	*	++	*,++	*,++
Tamarind	*,++	*	*,000	000	*	*,++	*,++	*	++	*,++	
Soursop	*,++	*	*		*	*	*,++	*	++	*,++	
Plums	++					++		*	*,000	++	
Pomme cythere		*		000	*	*,++		*			
Sugar apple											
Sapodilla	++							*	++		
Mammey apple			000								
Carambola				000		++		*,++	*		*,000
WI cherry								*,000			*,000
Bilimbi											
Sour cherry									*		
Dunks								*	*		

Scale of operation: Cottage (*); Medium (++); Large (000)

Recommendations

- Identification and selection of fruit varieties for processing (standard size, shape, high yield, year-round, chemical composition).
- Increased production of the varieties identified. Orchard management to facilitate harvesting at minimal cost should be considered.
- Provision of adequate facilities or development of suitable storage techniques to reduce post-harvest losses. Provision of centralized pulping and storage facilities to service existing cottage industries.
- Development of regional standards for raw materials and finished products; put in place the necessary mechanisms to ensure enforcement.
- Training and upgrading of skills of persons involved in food processing.
- Improve collaboration between producers, processors and researchers.
- Improve financing of credit available to processors.
- Improve quality of finished products.
- Improve promotion and marketing of Caribbean tropical fruit products.

SECTION 2 - COUNTRY PAPERS

BARBADOS

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MINISTRY OF AGRICULTURE, FOOD AND FISHERIES

Abstract
Fruit in Barbados has been targeted for increased production to offset the marketing problem of sugar, the main agricultural export commodity. High wind intensity, low rainfall, and calcareous soils are the main ecological factors limiting fruit production. Other limiting factors include pests and diseases such as weevils, whiteflies, the sooty mould complex, aphids, scales, anthracnose and mites. Birds, monkeys and rats also cause problems. Marketing of fruits is handled by national and regional agencies in Barbados, in addition to small-scale marketing by farmers. The Florida Sweet and B-17 are the main cherry cultivars grown on the island. Numerous local cultivars of guava are grown in addition to Centeno Prolific and Ruby Supreme, two important table cultivars. There are no named cultivars of soursop. The agronomic practices for West Indian cherry, guava and soursop are highlighted since crops such as cashew, plum, tamarind, genip, golden apple, fat pork and dunks are mainly cultivated in backyard systems. Large-scale processing is limited to cherry and guava.

Résumé
Le développement des productions fruitières en Barbade fait partie des stratégies mises en oeuvre pour contrebalancer les problèmes de commercialisation du sucre qui reste la première rubrique d'exportation dans ce pays. Des vents forts, les faibles précipitations et les sols calcaires constituent les principaux facteurs limitants des productions fruitières. D'autres problèmes sont dûs aux maladies et parasites, en particulier des charançons, la mouche blanche, la fumagine, des pucerons, des cochenilles pour les cerises et les goyaves, et en plus des acariens et de l'anthracnose pour le corossol. La commercialisation des fruits est entre les mains d'agences nationales et régionales basées à la Barbade; les produteurs commercialisent une petite partie de leur production par eux-mêmes. "Floride doux" et "B17" sont les deux principaux cultivars de cerise plantés sur l'île. Il existe de nombreux cultivars locaux de goyave en plus de "Centeno prolific" et "Ruby supreme", deux variétés da table importantes. Pour le corossol il n'existe pas de nom de cultivar. L'article décrit les techniques culturales employées pour la cerise des Antilles, la goyave et le corossol. Les autres fruits - anacarde, prunes mombin, tamarin, chénette, prune de cythère, icaque et jujube - sont cultivés dans les jardins. La transformation se limite à la cerise et à la goyave.

Resumen
Hay planes para aumentar la producción de frutas en Barbados de manera a compensar la caida del mercado del azúcar que es el principal rubro agrícola de exportación en Barbados. Los fuertes vientos, la escasez de agua, y los suelos calcáreos son los principales factores ecológicos que limitan la producción de frutas. Otros factores limitantes incluyen plagas y enfermedades tales como gorgojos, mosca blanca, fumagina, áfidos, escamas en acerolas y guayabas así como anthracnosis y ácaros en guanábana. El mercadeo de frutas es manejado por agencias nacionales y regionales; pequeños productores también lo hacen en pequeña escala. 'Florida sweet' y 'B-17' son los principales cultivares de acerola en la isla. Numerosos cultivares locales de guayaba son cultivados además de 'Centeno Prolific' y 'Ruby supreme', dos variedades de mesa importantes. No hay ningún cultivar denominado para la guanábana. Las prácticas agronómicas para acerola, guayaba y guanábana se destacan; otras frutas tales como marañon, ciruelas, tamarindo, mamón, jobo de la India, icaco y jujube se cultivan principalmente en traspatios. El procesamiento a gran escala se limita a la acerola y la guayaba.

Background

Barbados lies within the humid tropics, its climate being influenced by the north-east trade winds. Precipitation, the most variable climate factor, fluctuates annually, seasonally, as well as within the island.

Soils in Barbados are mainly limestone-derived and many of them display vertisol properties. However, in one area called the Scotland District, the soils have a distinctly non-calcareous nature. These silky clays are often slightly acid, but contamination by coral colluvium often raises the pH above 7.

The main export crop of Barbados is sugar cane, but recent problems in marketing of this crop have spurred a drive towards a diversification programme. Fruit production has been cited as one of the subsectors for increased development.

1. Generalities

1.1 Projects

The only formal programme which is being expedited at the moment is the Fruit Development Programme. This programme is funded primarily by the government of Barbados with only a few external inputs in the area of marketing.

1.2 Ecological Problems

1.2.1 Wind

High wind intensity affects production and quality of fruits. The same conditions that induce rainfall are often accompanied by strong winds. Some fruits are susceptible to wind damage.

1.2.2 Rainfall

Few areas on the island offer possibilities for rainfed

production, so complementary water is required for good productivity. Whereas rainfall figures may seem adequate when an annual total is quoted, the distribution is often where the problem lies. During the dry months the rainfall drops below the level required for nearly all of the crops. This combines with high solar radiation and steady winds to place trees under a lot of stress. Numerous young plants are lost due to wind/drought stress. Most plants do not perform well in the drier areas without strategic irrigation. Other effects of rainfed planting have been reduced growth and yield and poor quality fruit.

1.2.3 Soils

The calcareous nature of the soils poses a problem for most fruit species but the appropriate chemicals can be used to manage orchards under these conditions. The main problem is the availability of these chemicals. The inputs may also prove to be expensive to growers.

The fact that many of the soils are vertisols complicates the estimation of irrigation requirements. The strong water retention capacity of such soils has its implications for the type and frequency of irrigation that is desirable. It is also likely that a large portion of the moisture that enters the soil in the drier months is not available to fruit trees. The cracking nature of these soils may also damage the roots of the trees and make them further unable to extract water from the soil. This is an area which seems worthy of some research.

1.3 Limiting Factors

1.3.1 Pests and Diseases

A range of pests and diseases affects fruit in Barbados. Table 1 shows the main problems affecting the major species. These pre-harvest problems have been found to seriously affect the quality of fruit and consequently, marketing. The variations in quality that result are particularly limiting to export-oriented production.

The problem in controlling these biological invaders is often the lack of adequate spraying equipment. Critical to solving this problem for commercial orchards is the development of private spraying units. The government provides this facility only on a very limited basis.

1.3.2 Monkeys and Birds

These larger pests are a serious problem and are very difficult to control. Susceptibility of fruit varies depending on species, location and time of year. Electrical fencing seems the only practical way of controlling monkeys. The measures that control birds in the orchard situation tend to be very expensive.

Table 1: Main problems affecting production

Crop	Factor	Effect	Control
Cherry	Weevil	Holes in fruit Abortion in flowers Holes in leaves	Chemical
	Whiteflies	Discolouration of leaves Leaf fall	Chemical
	Sooty mould complex	Stress on trees in dry season	Chemical
	Aphids	Leaf curling in young growth	Chemical
	Birds	Heavy fruit loss	Nets (small scale)
Guava	Sooty mould complex	Stress on plant during dry months	Chemical
	Whiteflies	Leaf fall	Chemical
	Cherry weevil	Holes in fruit	Chemical
	Scales	Reduced plant growth	Chemical
	Birds and monkeys	Loss of yield	—
Soursop	Wasp	Holes in fruit	Chemical
	Snow scale	Death of young plant. Poor appearance of fruit	Chemical
	Mites	Bronzing of leaves Bronzing of fruit	Chemical
	Anthracnose	Post-harvest rot	Chemical
	Mice, bats	Fruit damage	—
	Rats	Fruit damage	Chemical

1.3.3 Livestock Damage

The problem of damage by livestock has been a serious constraint to fruit production, especially in the establishment phase. The trampling and chewing of young plants can be devastating, especially in the dry season when fruit trees may be the only green plants in the field. Recently the government has undertaken the task of correcting this problem and the impounding of stray animals is being effected on a daily basis. The accompanying fines to owners of these strays seem to be acting as a deterrent. Fruit-crop and other farmers have welcomed this development and there seems to be resurging interest in fruit-crop farming.

1.3.4 Praedial Larceny

The problem of praedial larceny, although very serious in general, is not all that serious in crops such as cherry, guava and soursop.

1.4 Area Planted

During the past decade there has been a significant increase in the planting of cherry orchards. There has also been an increase in soursop and guava plantings. There seems to be a growing potential for crops such as genip and golden apple and increased planting could be realized in the near future (table 2).

Table 2: Current area of fruit planted in Barbados

Crop	Commercial (ha)	Backyard (ha)	Government (ha)
Cherry	62	38	62
Guava	28	28	25
Soursop	1.6	Undetermined	—
Golden apple	0.6	21	0.6
Coconut	25	52	10
Genip	0.6	5	0.6
Carambola	1.8	Undetermined	1.6

1.4.1 Other Fruits

Cashew, dunks, fat pork and sea grape are very important crops in as much as they are contributing significantly to the incomes of small entrepreneurs. These crops are mainly grown in the wild.

1.5 Seasonality of Production

Production seasons can be seen in table 3.

Table 3: Crops and time of production

Crop	Time of maturity
Carambola	July–December
Cashew	April–June
Coconut	All year
Dunks	November–February
Fat pork	April–January
Golden apple	September–January
Gooseberry	June–January
Mammy apple	March–June
Sea grape	October–January
Soursop	April–June/September–December
Tamarind	March–May

1.6 Markets

There are three main organizations involved in fruit marketing. These are the Barbados Agricultural Development and Marketing Corporation (BADMC), the Agricultural Commodity Trading Company (ACTCO) and the Caribbean Agricultural Trading Company (CATCO).

The BADMC (formerly BMC) is a statutory board and typically handles very little of the market (less than 10%) but has played a major role in cherry exports. ACTCO, which is the marketing arm of the Barbados Agricultural Society, has been active in purchasing and distributing non-sugar commodities. Breadfruit has been exported to the United Kingdom on a significant scale.

The processing plant which was in operation in the late 1980s and early 1990s has not been functioning recently. As a result it is more difficult for farmers to sell crops such as cherry and guava.

For ease of analysis and presentation a number of markets are differentiated in this paper as each one of these demands a specific treatment. The distribution is as follows:

From farm to packing and processing:

There is little information on the volume of fruit handled by processors and on the whole these facilities are limited. The main problem at this stage is a vicious circle which prevents the development of agroprocessing, i.e. insufficient fruit production causes processors to be unable to develop and this precludes them from offering contracts to farmers for the development of fruit crops.

Little information on volumes is available. There are imperfections in the market at the farmgate as well as at the retail point. Buyers set the price at the farm and again at the retail market. Bargaining in the market-place is almost unheard of, perhaps due to the limited amount of fruit being available or maybe because sellers are not close together in one market building. This situation, however, gives way to more competitive pricing when fruits are plentiful.

Public markets do not play a very significant role in the market system of fresh produce. Very little produce is sold from within these buildings. This may be because many of the vendors, especially of imported fruits, practice more aggressive marketing in high traffic areas such as bus stands and main streets. Consumers often have no need to go to the market building. Also, within recent times a larger amount of local fruits is being sold in the bigger supermarkets.

The problem of praedial larceny tends to complicate the marketing process since stolen fruits are sold at prices which bear no relation to normal market prices. Another source of competition for fruit vendors who concentrate on local fruit is the trend towards the sale of imported fruit such as grapes and apples. While this activity has generated income to the persons who sell them, the share of the consumers' income which is spent on these fruits is no longer available for purchasing local fruit.

From packing and processing to:

- **Export**

  Exports of processed fruits are very small and consist mainly of fruit flavourings and preserves. Many of these exports are to CARICOM countries.

  Export of cherry has been done on a significant scale. The biggest problems facing these export ventures has been maintaining volume in significant quantities.

  Most of the processed fruit is consumed locally. The cherry fruit is not readily accepted for processing because it is said the colour is not suitable.

- **Import**

  Imports of the crops that are being discussed in this paper are negligible if they exist at all.

2. Pre-production

2.1 Cultivar Selection

2.1.1 Cherry

The main cherry grown on the island is the West Indian cherry. Two lines have been developed in Florida over the years. These are the Florida Sweet and the B-17. These have larger and juicier fruits but they are pale red at maturity.

2.1.2 Guava

There are numerous local types of guava growing across the island. The ratio of seed to edible portion is very high and hence the economic value is low. However, there are some very good table cultivars, namely the Centeno Prolific and the Ruby Supreme. These have very large fruits with a low seed count.

2.1.3 Soursop

There are no named cultivars.

2.2 Propagation

2.2.1 Cherry

Propagation is by cuttings. Cuttings are taken from trees producing a good quality fruit. These cuttings are then rooted in a mist-house where temperature and humidity are controlled. The success rate for this type of propagation is very high.

2.2.2 Guava

Propagation is done in a similar manner to cherry.

2.2.3 Soursop

Propagation is by seed. The soursop wasp (*Bephratelloides paraguayensis*), if not controlled might cause other methods of propagation to be adopted.

2.3 Plant Demand and Supply

With the exception of large-scale commercial plantings of cherry in the mid 1980s there has been no great demand for these crops over the years. There has, however, been numerous plantings in backyard systems.

Plants are available throughout the year. If there were a need for large volumes of plants a request would have to be made so that the stock could be raised to suit that demand.

3. Production Systems

3.1 Planting Distance

The plant spacings for various fruit trees are shown in Table 4

Table 4: Fruit tree crops and their spacings

Crop	Within row (m)	Between rows (m)
Cherry	3	6
Guava	6	8
Soursop	6	8
Golden apple	10	10
Coconut	10	10
Genip	10	10
Tamarind	10	10

3.2 Crop Husbandry

3.2.1 Cherry

Incorporation of pen manure and a phosphate fertilizer at planting is recommended. This is especially important for suboptimal soils. If irrigation is used, planting can be done any time of the year.

Pruning is done only when trees begin to block pathways or sometimes for rejuvenation. For grafted trees it is usually necessary to remove rootstock shoots which can be very persistent.

Irrigation of cherry trees has not been deeply researched in Barbados but on the basis of observations on the phenology there are a few important points to note. Watering must be done on a cycle which matches the growth cycle of the crop. The bearing cycle occurs over roughly a monthly interval (from irrigation to harvest). In dry locations harvesting can therefore be programmed by timing irrigation.

Fertilizer (12-12-17+2; NPK+Mg) is used at a rate of 0.45 kg/tree/year. More recently there seems to be a need to look more closely at phosphorus and micronutrient applications for dry calcareous soils.

Few pests and diseases affect the cherry tree. The main problems have been scale insects and the remainder of the sooty mould complex. More recently, the cherry weevil (*Antomonas* sp.) has become a significant pest, especially affecting the varieties introduced from Florida.

3.2.2 Guava

Planting is done in a similar manner to cherry.

Pruning is not practiced but this might be because there are no large commercial orchards.

The guava plant seems to be very drought-tolerant and irrigation is never applied. For large-scale production, however, the benefits of irrigation should be assessed.

Fertilizer (12-12-17+2) is used at a rate of 0.45 kg/tree/year.

The major pest and disease problems are the sooty mould complex and the cherry weevil.

3.2.3 Soursop

Soursop is mainly cultivated in backyard systems and as such its crop husbandry has not been fully determined. At present, there is one large commercial farm and a government unit where the needs and problems of the crop can be better observed.

Of immediate concern, however, is control of the soursop wasp, *Bephratelloides paraquayensis*. This pest after completing its cycle within the seed, tunnels its way through the fruit.

3.2.4 Other Crops

Crops such as cashew, plum, tamarind, genip, golden apple, fat pork and dunks are mainly grown in backyard systems or in the wild. Cultural practices are hardly associated with these crops.

3.3 Yields

3.3.1 Cherry

No accurate data on yields have been recorded. However, an estimated average for 4-year-old trees is 6500 kg/ha per year.

3.3.2 Guava

No yield figures have been determined.

3.3.3 Soursop

Average production from 3-year-old trees is 3500–4500 kg/ha per year.

3.3.4 Other Crops

Other fruit crops are usually very productive but because of the system of planting, harvesting and selling no yield data are available.

4. Harvesting

There are no mechanized harvesting systems in use. Harvesting is done mainly by handpicking or by using a pole and bag.

Maturity is usually detected by personal judgement based on experience. Cherries are harvested when the colour changes from green to light red. Guavas are harvested when mature green or yellow. Soursops are harvested when the spines open out.

5. Post-harvest Handling

5.1 Transportation from Field to Packhouse

This is more appropriate for cherries. Cherries are harvested and placed in 5-gallon meat pails. These are then transported to the pack-house on trucks.

For the other crops, the containers are often nothing more than the commonly available utensils such as buckets and bags.

5.2 Packhouse Operation

Cherry and soursop are probably the only crops that have been exported as fresh fruit. The cherries are usually washed and graded and placed in white pails for export. Soursops are graded and wrapped in paper and placed in cardboard boxes for export.

Fruits that are sent to the agroprocessing plant or to small-scale processors are usually carried in almost any type of container.

5.3 Rejection Rate and Causes

Rejection rates for produce that is exported could not be determined. The main causes of rejection could be blemishes and bruising.

Rejection on the local market is usually because of pest damage and bruising.

6. Processing

Large-scale processing is mainly done for cherry and guava. Up until recently cherry and guava have been processed into pulp by the agroprocessing plant and sold to the Pine Hill Dairy where it is manufactured into juices and drinks.

Small-scale operators usually process a significant amount of cherry and guava into jellies and jams, mainly for local use but some has been exported.

7. Marketing

7.1 Markets, Demand, Supply, Potential, Channels

There is a local demand for most of these crops as fresh fruit.

There is a rising demand for fruit on markets in the United Kingdom, Holland, the United States of America and Canada. The greatest potential seems to be for cherry, soursop, genip and golden apple.

BRITISH VIRGIN ISLANDS

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MINISTRY OF AGRICULTURE

Abstract
The main objective of an ongoing fruit tree project in the British Virgin Islands (BVI) is to establish 40 ha of assorted fruit trees over a 5-year period. The project commenced in 1990 with 17 participating farmers. Factors affecting production of soursop, cashew, West Indian cherry, golden apple and other minor fruits in the BVI are low rainfall, poor fruit set, and soils which are shallow, generally stony, with a varying reaction from slightly acidic (pH 6.5) to strongly alkaline (pH 8.8). These minor fruits are marketed locally with peak demand outweighing supply. There are no exports of these minor fruits and no large-scale processing takes place. Cultural practices for the production of these minor fruits in the BVI are described.

Résumé
Dans les Iles Vierges britanniques (BVI) il existe un projet d'établissement de 40 ha de fruits divers sur une période de 5 ans. Ce projet a débuté en 1990 avec 17 agriculteurs. Plusieurs facteurs écologiques affectent la production de corossol, anacarde, cerise des Antilles, prune de cythère et autres fruits mineurs: pluviosité réduite, faible mise à fruits, sols généralement pierreux, peu profonds dont le pH varie de légèrement acide (6,5) à fortement alcalin (8,8). Ces fruits mineurs sont commercialisés localement; en périodes de forte demande l'approvisionnement ne peut être assuré. Il n'y a pas d'exportations et pas de transformation non plus. Les techniques culturales employées pour ces fruits mineurs dans les BVI sont décrites dans l'exposé.

Resumen
El objetivo principal de un presente proyecto de frutas es el establecimiento de 40 hectáreas de varias especies durante un período de 5 años. El proyecto comenzó en 1990 con la participación de 17 granjeros. Los factores ecológicos que afectan la guanábana, el marañon, la acerola, el jobo de la India y otras frutas menores en las Islas Vírgenes británicas (BVI) son la escasez de lluvia, el bajo cuajo de frutas, y los suelos poco profundos, generalmente pedregosos, de pH poco acido (6.5) a fuertemente alcalino (8.8). Estas frutas ménores se comercializan localmente y en periodo de fuerte demanda el suministro no es suficiente. No existe ninguna exportación y ningún procesamiento importante ocurre. El artículo describe las prácticas culturales usadas en la producción de estas frutas ménores en el BVI.

1. Generalities

1.1 Projects

The objective of an on-going fruit tree project is to establish 40 ha of assorted fruit trees over a 5-year period. The project commenced in 1990 with approximately 17 farmers participating. The size of each plot ranges from as low as 0.05 to 0.2 ha of trees. To date a total of approximately 20 ha have been planted but only about 17 ha have become established.

1.2 Ecological Problems

The ecological factors affecting soursop, cashew, West Indian cherry, golden apple and other minor fruits are:

- Low rainfall
- Poor fruit set due to wind blowing blossoms and leaves off the trees
- The surface soil is very shallow (15–45 cm), generally stony, friable, well-drained with a range in reaction from slightly acid (pH 6.5) to strongly alkaline (pH 8.8)

1.3 Area Planted

The area planted under fruit tree crops is not known. They are widely grown and scattered throughout the islands. The fruit tree project has approximately 0.6 ha under fruit trees.

1.4 Production Costs and Returns

Since fruit tree crops are scattered throughout the islands, no estimates of production costs and returns have been made.

1.5 Seasonality of Production

- Soursop can be produced all year round
- Cashew: The main season is April–July
- West Indian cherry can be produced all year round
- Golden apple: The main season is May–August
- Other minor fruits: There is some production throughout the year of guava, tamarind and plum.

1.6 Main Markets, Demand and Supply

These fruits are marketed locally to supermarkets and hotels. Usually peak demand far outweighs supply.

2. Pre-production

2.1 Cultivar Selection

For cashew, yellow and red cultivars have been selected. No work has been done on other fruit crops to find out the different cultivars that are grown.

2.2 Propagation

Most of the fruit trees are propagated by seed in seedling bins and then transplanted to potting bags.

West Indian cherry is propagated from stem cuttings or by air-layering.

About 10% of cashew plants die back during the period between germination and transplanting into bags. The tip dies back and this infection moves throughout the plant very quickly resulting in death. There is no problem with the other fruit-tree rootstocks.

2.3 Plant Demand and Supply

During the production season fruit trees are in great demand but the supply is limited due to trees being scattered throughout the islands. There are no distribution problems.

3. Production Systems

3.1 Planting Methods and Planting Distance

In the fruit tree project the area is generally lined out at the recommended spacing of 6 m x 6 m. The area within the immediate vicinity is cleared, leaving the other trees in the area to act as wind-breaks and prevent excessive soil erosion. The holes are normally dug at 60 cm × 60 cm × 60 cm with a pickaxe, hoe pick or a small-bucket backhoe. Organic manure, compost or Promix is mixed with topsoil and then incorporated in the hole to a depth of about 15 cm before planting the fruit-trees. These holes are prepared well in advance of the planting. One tree is planted per hole.

3.2 Crop Husbandry

3.2.1 Fertilization

The trees in the fruit tree project are at the non-bearing stage. A complete fertilizer application of about one and a half handfuls per tree is given at planting. This is repeated three times per year at the convenience of the department of agriculture. A nematicide (Mocap) is also used as a protective measure against grubs in the soil. Periodic spraying is done and applications of foliar micronutrient sprays are made when necessary.

3.2.2 Weed Control

Monthly manual cutlassing of the drip-circle to keep it weed-free is carried out. In some instances if the participant has small stock, the area is grazed but the fruit trees are individually protected with a fence.

3.2.3 Pest Control

Periodic sprays of insecticides, fungicides and scalicides are used at the rates recommended by the fruit-tree division. Pruning is carried out at the same time.

3.2.4 Irrigation

A drip irrigation system has been set up by the department of agriculture on each of the participants' plots in the fruit tree project. One of the criteria for joining the project is that the participant must have water readily available for irrigating the fruit-trees.

3.3 Yield

Yields have not been determined as yet since the fruit-trees in the project are still at the non-bearing stage. There are no records in the project on the yield of these fruit-trees.

3.4 Causes, Effects and Control of Factors Affecting Production

For the existing bearing trees which are scattered throughout the islands, inadequate pruning causes tall growth. This hampers management of harvesting and spraying. Poor cultural practices result in increased diseases and pests which readily destroy the crop.

4. Harvesting

Fruits are harvested manually either by hand-picking and throwing the fruit to someone on the ground, or by using a picker which is made from different types of material. The main techniques used to determine the maturity of the fruits are firmness of the fruit, feeling, colour, stem judgement and sight.

Problems at harvesting include:

- Most of the fruits are borne on thin branches which can be easily broken when stepped upon
- Labour is expensive

5. Marketing

No fruits are exported due to the limited supply within the islands. They are used and sold locally. No processing on a large scale is being done, but housewives stew various types of these fruits and use them in making pastries, pies, jams and jellies for the family and also for sale to the public.

There is one processing unit that makes drinks from these fruits which are exported throughout the Caribbean.

5.1 Prices

Price competition is common when the supply is greater than the demand. Locally grown foods could have great potential if there were a steady supply at a reasonable price. Advertising is done individually.

DOMINICA

POTTER BRUNO
MINISTRY OF AGRICULTURE, TRADE AND TOURISM

Abstract
Soursop, West Indian cherry, guava, sapodilla, plum, tamarind, golden apple, cashew and carambola are all minor crops in Dominica. They are mainly cultivated in small, dispersed areas. These fruits are mainly sold on the local market which is increasing due to an increasing tourist market. The main limiting factors of production for these crops are insect pests: fruit boring wasp in soursop and fruit fly in guava and West Indian cherry. No organized control system is being implemented. Processing is mainly by the cottage industry: fruits are processed into jams, jellies, nectars, syrups, and juices. Currently the supply of tamarind juice cannot meet the demand.

Résumé
Corossol, cerise des Antilles, goyave, sapotille, prunes mombin, tamarin, prune de cythère, anacarde et carambole sont tous des fruits mineurs à la Dominique. Ils sont cultivés généralement en forme très dispersée, sur de petites parcelles. Ces fruits sont surtout vendus sur le marché local lequel s'accroît à cause du développement du tourisme. Les insectes constituent les principaux facteurs limitants: charançon du corossol et mouches des fruits sur cerise et goyave. Aucun système de contrôle n'a été mis en place. La transformation se fait au niveau de petites industries artisanales, principalement sous forme de confitures, gelées, nectars, sirops et jus. Actuellement la production de jus de tamarin ne suffit pas à couvrir les besoins.

Resumen
Acerola, guayaba, níspero, ciruela, tamarindo, jobo de la India, marañon y carambola se consideran frutas ménores en Dominica. Se cultivan principalmente en pequeñas áreas dispersas. Las frutas se venden sobre todo en el mercado local el cual esta aumentando debido a la creciente actividad turística. El principal factor que limita la producción es la presencia de insectos: avispas perforadoras de la guanánaba y moscas de la fruta en guayabas y acerolas. No existe ningún sistema de control organizado. El procesamiento es principalmente de tipo artesanal; se procesan frutas en mermeladas, jaleas, néctares, jarabes, y jugos. Actualmente la producción local de jugo de tamarindo no puede suplir la demanda.

Background

Soursop, West Indian cherry, gauva, sapodilla, plum, tamarind, golden apple, cashew and carambola are minor crops in Dominica. Minor, not only in terms of acreage, but more importantly, minor in terms of the income generated. However, this is due partially to the ministry of agriculture's emphasis on traditional crops. It seems that this has begun to change, and rapidly so, because of the growing tourism industry.

Generally, there is a need to look more closely at the 'minor' crops as a means of generating income. Breadfruit (for example) has tremendous potential for export to the extra-regional market. However, very little or no emphasis is being placed on the crop from the ministry point of view. A pruning programme would make harvesting much more economical, considering that at harvest 30-50% of the crop is lost through damage.

All the minor crops will be dealt with in a general way and where special note is to be made on some aspects of any particular crop, it shall be done.

1. Generalities

1.1 Projects

There is no current project for any of the crops. The last project, which ended in 1991, established 1.7 ha of soursop. In this project, emphasis was placed on spices, not on the fruits.

1.2 Ecological Problems

The establishment of fruit crops is small and largely dispersed. The major problems are the fruit boring wasp in soursop and fruit fly in guava and West Indian cherry.

1.3 Area Planted and Value

No figures are available for the area planted except for soursop which is estimated to cover 4–5 ha. Guava is a common crop in many backyards and in many places; it grows wild or as a weed. It accounts for approximately 10 ha of land surface and is closely associated with cattle pastures. The value of these establishments is not known.

1.4 Production Costs and Returns

There are no available production costs.

1.5 Seasonality

Many of these crops produce year-round, with almost all having a main crop. This varies with ecology; at higher altitudes, bearing/fruiting may be restricted to one season a year. For most of the crops, the main bearing season is from June to September, while December to April is the minor season.

1.6 Main Markets

The fresh fruit market uses these crops as fresh fruits and for juice. This is a steadily growing market, especially with the growing tourism industry.

Processing of fruits (mainly guava and tamarind) is done by a local firm (Bello). Fruits are processed into jams, jellies, syrups, nectars, juices and in the case of tamarind, candy balls.

2. Pre-production

2.1 Cultivar Selection

Generally, there are no selected cultivars except for West Indian cherry and guava where size is the main criterion for selection. Under the TFSP programme, the soursop selected was mainly based on sweetness; it came from Grenada.

2.2 Propagation of Rootstock and Related Problems

Propagation is usually either by seed, or for cherry and guava, by marcotting. Hence there are no rootstock problems.

2.3 Plant Demand and Supply

See Appendix I.

3. Production System

Appendix I shows the area where the plants are produced and the respective amounts. It also gives the ministry's recommended planting distances and quantity per ha.

3.1 Crop Husbandry

No specific crop husbandry programme is followed. However, fertilizing and weed control is practiced mainly because these crops are either established in backyards or intercropped with a traditional crop.

3.2 Yields

There is no information available on yields.

3.3 Causes, Effects and Control of Factors Affecting Production

The main factor affecting production is insect pests, attacking soursop, guava and West Indian cherry. These pests (see section 1.2) make many fruits unmarketable. However, no organized control system is being implemented.

4. Harvesting

Harvesting is done manually. No tools are used other than a long stick with a bag attached to one end. This is locally called a 'cali'.

Maturity index is established purely by visual appearance. Harvesting is mainly for the fresh fruit market, so the mature stage is used as a criterion.

For this type of operation there are few harvesting problems, mainly the height of the trees in most cases and the denseness of cherry trees. In tamarinds, the fruits are difficult to obtain and most people harvest tamarinds when they fall to the ground.

5. Post-harvest Handling

5.1 Transportation from Field to Packhouse

No packhouse is involved in Dominica and this section may more appropriately be termed 'field to home'. Transportation is by head, using containers such as pails, baskets etc., or by pick-up trucks.

5.2 Rejection Rate

Rejection is mainly based on appearance. Bruising, wounds and pest infestation (e.g. fruit fly) are the main causes.

6. Processing

Processing is mainly by cottage industry, 'Bello' being the only brand name. Fruits are processed into jams, jellies, nectars, syrups, juices and candy balls. Tamarind juice production is not enough to satisfy local demand.

Information on the volume of processed products is not available. However, supply is lower than demand, especially for tamarind.

7. Marketing

7.1 Markets, Demand, Supply, Potential, Channels

There is a reasonable local demand for many of the crops dealt with here, especially so in the restaurants as most of them make excellent juices. For most

of the crops, demand still exceeds supply and hence there is potential for small expansion, especially for tamarind. The products are sold as either fresh fruits or in the processed form in the market place, supermarkets, by roadside vendors, and in restaurants.

7.2 Price

Most juices sell for between EC$1.50 and $3.00 a glass, depending on size. Fresh fruits sell for between EC$1.10 and $4.40/kg depending on availability.

7.3 Advertising

Any advertising that is done is geared towards the tourists as most locals expect to find a range of these products (especially the juices) at restaurants and supermarkets.

Appendix I

Distribution of fruit tree plants from the Ministry of Agriculture's propagation stations in Dominica, 1993/1994

Crop	Hills-Borough	W/ford Hill	Grand Bay	La Plaine	Ports-mouth	Botanic Gardens	Total	Planting distance (m)	Average No. of plants/ha	Est. area to be planted (ha)
Soursop	1,000	1,000	500	100	220	200	3,020	3.6 x 3.6	772	4
Sugarapple	500	600	200	100	240	100	1,740	3 x 3	1,110	1.6
W.I. cherry	200	300	—	—	600	—	1,100	4.2 x 4.2	567	2.0
Sapodilla	240	—	—	—	—	—	240	7.5 x 7.5	178	1.6
Carambola	—	—	—	—	—	—	—	—	—	2.8
Guava	200	—	—	—	500	—	700	4.5 x 4.5	483	1.6

GRENADA

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Abstract
Grenada has no major problems associated with the ecology needed for growing tropical fruit crops. A government programme which aims at establishing non-traditional fruit-trees in pure stands is ongoing. About 80 ha in Grenada is under soursop, cashew, West Indian cherry, golden apple and other minor fruits; 95% of which is not grown in fruit orchards. An overview of the production systems with some details on propagation; spacing and harvesting is provided in addition to post-harvest handling, processing, and marketing systems, for soursop, cashew, West Indian cherry, golden apple, guava, sapodilla, tamarind and plums.

Résumé
L'environnement écologique de Grenade lui autorise de cultiver différents fruits tropicaux sans problèmes majeurs. Le gouvernement a mis actuellement en oeuvre un programme de diversification agricole reposant sur l'établissement d'arbres fruitiers non-traditionnels en culture pure. En effet, les superficies en Corrosol, Anacarde, Cerise des Antilles, Prune de cythère et autres fruits mineurs représentent environ 80 ha au total, 95% n'étant pas en culture pure. Une revue des systèmes de production avec des détails concernant les méthodes de propagation, l'espacement et la récolte, des techniques de conservation et de transformation et des systèmes de mise en marché est présentée pour les fruits suivants: Corrosol, Anacarde, Cerise des Antilles, Prune de Cythère, Goyave, Sapotille, Tamarin et Prune des Antilles.

Resumen
Grenada no tiene problemas asociadas con las condiciones ecológicas para el cultivo de frutales tropicales. El gobierno tiene un programa que está dirigido al establecimiento de árboles frutales no tradicionales. Grenada tiene alrededor de 80 ha de frutales, conformadas por guanabana, marañon, semeruco, jobo de la india y otros frutales menores, pero 95% de estos frutales no estan plantados en un huerto, sino como árboles individuales. En éste trabajo,se provee un vision general del sistema de producción con detalles propagación, distancia de siembra y cosecha; ademas de postcosecha, procesamiento y mercadeo para guanabana, marañon, semeruco, jobo de la india, guayaba, nispero, tamarindo y ciruelas.

Background

There are no current fruit projects being implemented in Grenada. The government, however, is continuing its developmental orchard programme which began in 1986 and aims at establishing non-traditional fruit-trees in pure stands.

Grenada is blessed by the absence of major problems associated with the ecology needed for growing tropical fruit crops.

About 80 ha is under soursop, cashew, West Indian cherry, golden apple and other minor fruits – 95% of which is not grown in fruit orchards.

1. SOURSOP

1.1. Generalities

Presently, there are 20–25 ha planted in this crop which is grown in backyards and in cocoa fields.

The peak period of harvesting runs form October to February, with a minor crop in May to June.

Fruits are exported mainly to Trinidad and Tobago, Holland, the UK and Canada. The local market is small and its demands are met, unlike those of the export markets.

1.2. Pre-production

Seedlings made up most of the soursop population until 1985 when a selection was made by Messrs Beddoe and Burris for high sugar content among other highly desirable characteristics. 'Burris' is the main type propagated along with a few acid types.

Propagation is by stem cuttings and seed. Patch budding has been successfully introduced recently.

Plant demand is adequately met and no problems are foreseen.

1.3. Production Systems

Plants are spaced 3.6 m × 3.6 m and planted with triple superphosphate (in the hole); every 4 months after a top-dressing of NPK fertilizer is given. Bearing trees are fertilized towards the end of the rainy season (November) and the second application is given at the beginning of the rains (June); a compound fertilizer is used.

Trees begin fruiting 12–14 months after planting, yielding 15–20 fruits per tree in one year, with one fruit weighing an average of 1.4 kg.

Fruit quality in the field is affected by the presence of scales, mealybugs and a beetle which causes

malformation of the fruit, however, this damage is only superficial.

1.4. Harvesting

Harvesting is done with the aid of a bag attached to a bamboo pole (bazaar) which facilitates picking the fruit from the ground.

Fruit maturity is determined when the colour of the fruit changes from a dark green to a brighter green, and when the spines are less rigid and further apart on the fruit.

The main problem associated with harvesting is the presence of black 'stinging' ants which causes discomfort to the harvesters.

1.5. Post-harvest Handling

From the field, fruits are placed in a variety of containers for carrying to the packhouse, ranging from fertilizer bags to plastic buckets and field boxes. They are transferred to plastic field crates or directly to the back of a truck. Bruising occurs mostly during field to farm-gate transportation, and the field heat retained in the fruit in the absence of refrigerated vehicles to carry fruit to the packhouse promotes ripening before arrival at the overseas destination.

At the packhouse, fruits are sorted, peduncles trimmed, and then brushed to remove mealybugs before packing them into cardboard cartons for the extra-regional markets. Fruits are rejected mainly for immaturity, bruising and high incidence of pests.

No post-harvest techniques are done on fruit destined for the regional market. They are just transferred into wooden crates, cocoa baskets, or cardboard boxes at the packhouse and then transported to the seaports where they are loaded onto schooners. Bad packaging material and the heat from the hold of the schooners, results in a high percentage of fruits being unmarketable because they are either overripe or squashed.

1.6. Shipping

Air transportation is used for fruit destined for the extra-regional markets. With refrigerated cargo space being very expensive or non-existent on the passenger airplanes that travel out of Grenada, inadequate space is still a problem. Mixing with different crops (e.g. hot peppers) may result in an entire shipment of soursop arriving overripe at its destination.

1.7. Processing

A small amount of processing is done with ripe fruit supplying the local market for milk shakes, ice-cream and cordials.

Farmers mainly focus production on mature green fruit for the export markets, thus making ripe fruit for processing a scarce commodity.

1.8. Marketing

Fruit is sold at the farm-gate at approximately EC$1 per fruit. More than 12,000 kg of fruit were exported last year.

2. CASHEW

2.1. Generalities

About 4 ha of land is under cashew cultivation centered mainly on the east coast of the island.

Fruits mature during the drier months (February to March), and the nuts are collected to supply the local market, where they fetch a good price.

2.2. Pre-production

No known varieties are present on the island, therefore large, healthy nuts are selected for propagation.

Seeds selected are used as planting material. No problems are experienced either in propagation or distribution of cashew plants.

2.3. Production System

Seedlings are planted 9 m × 9 m with pen manure added to the hole if possible.

Plants are fertilized twice a year, at the beginning of the rainy season and at the end of the rainy season. Young plants are hand-weeded within the drip-circle and, like the older trees, a contact herbicide is used outside the drip-circle area.

Each tree yields about 20–25 kg of nuts per year. No problems affect production and quality of nuts in the field.

2.4. Harvesting

Harvesting involves collection of ripe fallen fruit on the ground.

2.5. Post-harvest Handling

Fruits are put in bags or buckets and carried out of the field where the nuts are separated from the fruits. Nuts are dried and the fruits are discarded. No sorting or grading occurs. Nuts are stored after drying until the farmer can sell them.

2.6. Shipping

Cashew nuts are sold locally.

2.7. Processing

Processing is done on a small scale as a cottage

industry. The nuts are roasted on an open fire, then the shells are removed. The nuts are then placed in unlabelled bottles.

There is no grading system and whole nuts, halves and broken pieces, can be found in the same bottle.

2.8. Marketing

Bottles of nuts are sold in supermarkets and on the sidewalk markets. A 12-oz (340 ml) bottle is sold for EC$12 and is in high demand.

Nuts sorted into various grades and put into labelled plastic packaging would most certainly compete with the quality of product on the market at present.

3. WEST INDIAN CHERRY

3.1. Generalities

West Indian cherry occupies a total of 4 ha of land in Grenada. It is mainly a backyard crop and has recently become an important crop in school gardens. There are no factors limiting the expansion of this crop. The main ripening season is around July with a minor one in September.

Fruits are sold locally mainly to housewives; some restaurants may serve fresh cherry juice when fruits are available.

3.2. Pre-production

'Florida Sweet', 'Jumbo' and a Puerto Rican selection are the cultivars being propagated for fresh fruit and juice respectively.

Cherry trees are propagated successfully by stem cuttings.

Plants are adequately supplied, sometimes with more plants available than the demand.

3.3. Production Systems

Plants are spaced at a distance of 4.5 m × 4.5 m. At the end of May, 85 g of NPK fertilizer is given to each plant, and a second application is done at the end of November or early December. Weed control is either done manually or with the use of Gramoxone. No pruning or spraying is practised and a tree can produce 15 kg of fresh fruit in a year.

Pests affecting fruit quality in the field include scales, whiteflies, aphids, sooty mould and millipedes.

3.4. Harvesting

Harvesting is done both by hand-picking, or with the aid of a short bamboo pole with a small denim or jute bag attached.

Fruits are picked when their colour changes from green to red; however green and ripe fruits are sometimes close together and green fruit may be harvested when using a picker. Ants also pose a problem during harvesting.

3.5. Post-harvest Handling

Fruits are transported from the field in plastic buckets or field boxes. Farmers sort fruits before selling to supermarkets and restaurants.

Rejection of fruits is due mainly to overripe fruit that has been squashed, mealybug and millipede damage.

3.6. Marketing

There is great potential for this crop due to its rich source of vitamin C. However, a lot of promotion has to be done to encourage farmers to plant more trees and consumers to appreciate the fruit for its nutritive value.

4. GOLDEN APPLE

4.1. Generalities

Due to the high humidity experienced where most golden apple is grown, anthracnose poses a problem during the rainy season. It is also observed that in the middle belt with an average annual rainfall of 2000 mm and an altitude of 150 m above sea level, fruits are smaller in size and experience fewer disease problems.

At present, about 16 ha of land is under golden apple cultivation throughout Grenada. Most are planted as shade for cocoa, or as an intercrop in the nutmeg-cocoa-banana mix common to the island.

The fruit begins to mature from August to November, peaking in September/October. However, early-bearing trees can start as early as July, with late-bearing trees not until January.

Golden apple is exported mainly to the USA and Trinidad and Tobago. The crop has become the second most important non-traditional one exported from Grenada (mango is first). Demands of markets are met during peak periods of production.

4.2. Pre-production

Most of the golden apple trees came from seeds of non-selected sources; others were from stem cuttings of trees selected for fruit size and pest tolerance. Recently, after studies were done, IICA selected five trees out of a pre-selection of 30. These selections were made due to their outstanding qualities: high yield, large fruit size, tolerance to major pests and small seed to pulp ratio.

Golden apple is propagated mainly by seed,

however, stem cuttings have been done and grafting is being experimented on at present. This is done with the aim of lowering the height by using dwarf golden apple trees as rootstock and as an interstock.

Most farmers use seedlings from underneath their own mature trees, selecting for high yield and large fruit size, thus making the demands for plants from the propagation station low and easily met.

4.3. Production System

Golden apple trees are planted 9 m × 9 m. Most trees are fertilized when the intercrop(s) is fertilized. Yields are an average of 450 kg per tree per year.

Weed control is done using a contact herbicide or manually when trees are intercropped. No spraying or other cultural practices are done.

Mites, scales and sooty mould affect the exterior of the fruits thus lowering it appearance, while anthracnose, gummosis and a bacterial spot make the fruit unattractive both on the exterior as well as in the interior. No control measures are taken.

4.4. Harvesting

Harvesting is done by someone climbing the main trunk of the tree and picking with the aid of a fertilizer bag attached to a bamboo pole with a metal ring (commonly called a 'bazaar'). Each cluster of fruit picked is transferred to another bag attached to a long rope which, when full, is lowered to the ground. The fruits are then placed into crates or fertilizer bags.

Maturity is based on flesh, and later, skin colour. On maturity, flesh colour changes from pale green to cream and on ripening to yellow. Skin colour moves from deep green to pale green on maturity, to a golden yellow at ripening.

Mature green fruits are required by most importers and harvesters sample fruit to test for flesh colour. Problems are encountered, however, because one cluster of fruit may have fruits in various stages of maturity. The 'bazaar' is not designed for picking individual fruits, but clusters, and thus many immature fruits may be rejected on a farmer's holding after being harvested.

4.5. Post-harvest Handling

Golden apples are put into jute and fertilizer bags as well as plastic field boxes and transported in uncovered trucks. In some cases the fruit is emptied out onto the back of the truck.

Field heat is increased by fruit being exposed to the sun during transportation, and nylon bags bruise the fruit lowering its quality and price.

At the packhouse, fruit is washed with a soft cloth to remove sooty mould, using water to which chlorine has been added.

Fruits are then sorted to remove the undesirables and then packed into 18-kg cartons.

Fruits are rejected mainly because of a black fruit spot, small or immature fruit and over-mature or ripe fruit.

4.6. Marketing

Golden apple is exported to Trinidad and Tobago, USA, (New York, Boston, Miami), Canada (Toronto), Holland and the UK. The fruit is aimed at ethnic groups which are not projected to increase in the near future, thus it is necessary to seek new markets. With the help of advertisement, greater demand for the product can be made.

Fruits are sold for an average of US$0.88/kg, while farmers receive an average of EC$ 0.66/kg. In 1992, 0.6 million kg of fruit were exported.

5. GUAVA

5.1. Generalities

Twenty to twenty-five hectares of land is under guava, most of which was not planted but grow wild, especially along the island's west coast.

Fruits ripen around January/February and then the main crop comes later during the months of September and October.

Small quantities are sold on the local market as fresh fruit, while some is used in the cottage industries. The majority of fruit, however, is left to rot in the field.

5.2. Pre-production

The only named cultivar 'Centeno Prolific' or 'Acid Pink', along with sweet types, is propagated by stem cuttings, and planted mainly in backyards. Fruits are large, some are pink-fleshed and others are white-fleshed.

Plant demands are easily supplied and there are no problems related with deficits or distribution.

5.3. Production System

Guavas are planted 5.5 m × 5.5 m. Plants are not fertilized and may receive nutrition only if they are intercropped with a traditional crop. Weed control is done manually, if at all.

A mature guava tree yields an average of 20 kg per year. There is a fruit rot which develops as the fruit develops. Thrips do superficial damage

giving the fruit a brown colour, thus reducing its quality. No control measures are taken for these problems.

5.4. Harvesting

Picking of ripe fruit is done with the aid of a short 'bazaar' as used for cherries, or they are prodded with a bamboo pole, and caught before they fall to the ground. Most of the fruit used for processing, however, is collected after falling to the ground. Fruits turn yellow on maturing so no problems are faced by picking immature fruit.

5.5. Post-harvest Handling

Fruits are transported from the field in plastic buckets or baskets and overripe fruit may be squashed.

Before processing , fruits are sorted and bird and insect damaged fruit, spotted fruit and squashed fruit are rejected.

5.6. Processing

Fruits are processed into cheese, jams, jellies, juices and nectars which are sold in good quantities in supermarkets throughout the island. These conserves are made by one commercial processor and many small home industries.

6. SAPODILLA

6.1. Generalities

Sapodilla covers an area of about 8 ha. The trees are scattered throughout the middle and lower belts of the island and are mainly found in cocoa cultivations. Fruits come into maturity during the drier months of February to March, and are exported mainly to Trinidad and Tobago, with a small quantity reaching the UK market.

6.2. Pre-production

Following a fruit competition, CARDI selected 'Kathleen' as a large heart-shaped fruit, high in sugar content and having no grittiness or latex in the pulp.

Plants are grafted on to unselected seedlings and the government-operated nursery adequately supplies the demand for sapodilla plants.

6.3. Production System

Sapodilla trees are planted at 9 m × 9 m. Fertilization and weed control are not practised for them specifically, but are done when sapodilla plants are intercropped with cocoa. A mature sapodilla tree can produce about 13 kg per year. No problems affect the quality of the fruit while in the field.

6.4. Harvesting

Fruits are harvested by someone climbing to the main branches of trees and with the aid of a fertilizer bag attached to a bamboo pole ('bazaar') picking the fruit which is put into a fertilizer bag. The bag is lowered to the ground with the aid of a rope when full.

Fruits beginning to ripen and falling to the ground, indicates that most fruits are mature, and the larger fruits are then harvested. Change in fruit colour is not used as an index to maturity due to the presence of a brown 'dust' which adheres to the fruit making it difficult to observe colour change. Therefore, immature fruits may be picked from a tree bearing large fruit.

6.5. Post-harvest Handling

Fertilizer bags are used to transport fruit from the field; the bags are then loaded on to small trucks.

Fruits for the regional market are not washed, but grading is done. Fruits may be rejected for being immature, overripe, damaged by birds or mechanically damaged.

Fruits destined for the extra-regional market are washed and sorted. Rejects are mainly due to latex staining and bruising, a preliminary grading having been done in the field.

The UK market requires fruit to be packed into cartons, whereas fruits arriving in Trinidad may be in cocoa baskets, wooden crates or cardboard boxes.

6.6. Shipping

Fruits are shipped by air and arrive in the UK in good condition. However, regional destined fruits, due to the heat from the schooners' engines, arrive in Trinidad overripe and squashed, thus lowering profits to be made by the hucksters.

The markets are not adequately supplied and efforts should be made to lower the loss of fruit experienced by poor post-harvest handling, packaging and transportation in the regional trade.

6.7. Marketing

Farmers sell their fruit for EC$40 per crate. Over 3000 kg of fruit were exported during 1992.

7. TAMARIND

7.1. Generalities

Tamarind accounts for about 4 ha of land in Grenada, and is not cultivated as a crop. The established trees are scattered around the coastal areas and were not

planted but propagated by seeds transported involuntarily by humans and animals.

Fruits are exported mainly to Trinidad and the USA, where demands for the crop are not adequately met.

7.2. Pre-production

There are no known types of tamarind in Grenada and fruits are referred to a 'less acid' and 'acids' types. At present, anyone desiring a tamarind plant will plant a seed or seedling found under a mature tree.

7.3. Production System

There is no production system developed for this fruit. If located among commercially grown plants, the trees would benefit from any cultural practices done. A mature tree may produce 45 kg in a year. No problems are observed in the field which reduce fruit production and quality.

7.4. Harvesting

Harvesting is done by hand-picking ripe fruit off the tree and collecting ripe fallen fruit off the ground.

Fruits are picked when the pod colour changes from green to pale yellow to rust brown. It may be difficult to ascertain the stage of development of fruits on the tree and immature fruits may be harvested.

7.5. Post-harvest Handling

Fruits are transported from the field in nylon bags or plastic field-boxes. Due to the brittleness of the ripe pods, breakage may result.

Fruits are put into wooden crates and shipped by schooner to Trinidad, but the fruits reaching the USA are sorted for immature fruits and broken shells before being packed into cartons and air-shipped.

7.6. Processing

Locally, processing is a cottage industry where tamarind balls are made and sold in supermarkets and on roadside stands.

7.7. Marketing

Tamarind is sold by the farmers at EC$10 per tin, and over 4500 kg of fruit were exported last year

8. PLUMS

8.1. Generalities

About 2.5 ha is under plum production in Grenada. The 'Red' or 'Jamaica' plums are found mainly in the south-eastern and northern coasts of the island as well as the Grenadine islands. The 'Yellow' or 'Chinese' plums can be found in the middle belt of the island. Chinese plums ripen from July to October while the Jamaican plums ripen from April to May.

Both varieties of plums are sold locally as fresh fruit. Jamaican plums are exported to the regional and extra-regional markets.

8.2. Pre-production

Two types as mentioned earlier are grown in Grenada. The Jamaican plum is bigger, has a deep red colour, is less acid and has a thicker flesh than the Chinese plum. The Chinese plum is yellow-skinned; it has a thin skin and thus is more susceptible to bruising and squashing, and it is more acid with a smaller seed than the Jamaican plum. The Chinese plum is borne on a taller tree, while the Jamaican plum has a more spreading tree.

Plums are propagated by stem cuttings, which is usually done by farmers themselves.

8.3. Production System

There is no planting procedure developed for plums and they are usually grown as a backyard fruit tree. No cultural practices are done unless they are found between commercial crops.

A mature tree may produce 30 kg annually. Anthracnose poses a problem in Chinese plums during humid periods, while mealybugs and sooty mould pose minor problems. However, no control measures are taken.

8.4. Harvesting

Harvesting is done with the aid of a small 'bazaar' with the harvester standing on the ground or the first branch of the tree. Fruits are considered as ripening when the external colour changes from green to red for Jamaican plums or to yellow for the Chinese plums. Problems arise at harvesting time because clusters have fruits in a range of developmental stages and immature fruits are harvested and later out-graded.

8.5. Post-harvest Handling

Plums are carried in plastic field-boxes from the field and packed into wooden crates and cardboard cartons to be shipped by schooner to the regional market. For the extra-regional markets, peduncles are removed and mealybugs and ants brushed of before packing into cartons to be shipped by air.

Rejection is due mainly to anthracnose infestation, immaturity and pests present on the fruit.

8.6. Marketing

Countries importing Grenadian plums are Trinidad, the UK and the USA. Demands of the importers are never met, especially in the extra-regional markets. Exporters buy plums from the farmers for EC$25 per tin. More than 7000 kg were exported in 1992.

GUYANA

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Abstract
Several projects targeting an increased production of minor tropical fruit crops in Guyana, covering propagation and crop demonstration, are ongoing. The more important crops included in this programme are guava, West Indian cherry and cashew, along with golden apple, sapodilla, tamarind and plum, among others. The major factors limiting the production of these tropical fruit crops are: variable rainfall intensity and pattern; the availability of suitable land as most of the good land is under rice, sugar cane and coconut cultivation. The marginal soils of the intermediate savannahs require substantial inputs of limestone and fertilizers. The fruits are marketed locally with processing restricted to West Indian cherry, guava and cashew. The cashew nuts are roasted under primitive conditions in the Rupununi area. Over 48,000 kg of blast-frozen cherry was exported to Japan in 1991. Guava cheese and jams are the only other products that are exported. There are few improved cultivars of these minor fruit crops. An outline of the cultivation systems is given detailing planting method, planting distances, fertilization, weed control, irrigation, pest control, pruning, harvesting and yield. A great deal needs to be put in place to develop the fruit sector in Guyana; its development should be supported by large-scale investors or by cooperatives.

Résumé
En Guyana plusieurs projets cherchent à accroître la production de fruits mineurs. Les espèces les plus importantes sont: goyave, cerise des Antilles et anacarde; d'autres fruits tels que prune de cythère, sapotille, tamarin et prunes mombin font aussi l'objet d'un certain intérêt. Les principaux facteurs limitants sont de nature diverse: a) variabilité de l'intensité et de la distribution de la pluviométrie ce qui a une incidence sur l'époque de production et la fréquence des maladies, et b) disponibilité de terres adéquates car les meilleurs sols côtiers sont réservés à la culture du riz, de la canne à sucre et de la noix de coco; les sols de l'intérieur (savanne intermédiaire) sont classés comme marginaux et requièrent des niveaux élevés d'intrants. Seuls la cerise, la goyave et l'anacarde sont transformés. Les noix de cajou sont grillées de façon primitive dans la savanne de Rupununi. 48 tonnes de jus de cerise congelé ont été exportées au Japon en 1991. Des barres et des confitures de goyaves sont les seuls autres produits exportés. L'exposé détaille les techniques de culture employées pour les espèces les plus importantes. Il conclut sur les efforts nécessaires pour développer le secteur fruitier en Guyana et recommande l'intervention d'investisseurs individuels ou de coopératives.

Resumen
Existen varios proyectos enmarcados a incrementar la producción de frutas tropicales ménores en Guyana. Las frutas más importantes en estos proyectos son: la guayaba, la acerola y el marañon; además se presta atención al jobo de la India, níspero, tamarindo, y ciruelas entre otras. Los principales factores que limitan la producción de estas frutas tropicales son: a) la variabilidad de la intensidad y la frecuencia de las lluvias, y b) la dificultad para encontrar tierras adecuadas ya que las mejores se cultivan con arroz, caña de azucar y cocoteros. Las tierras marginales de la sabana intermedia requieren aportes substanciales de caliza y fertilizantes. Las frutas ménores se comercializan localmente; el procesamiento es restringido a la acerola, la guayaba y el marañon. Las nueces del marañon se tuestan en condiciones primitivas en el área del Rupununi. Más de 48 toneladas de jugo de acerola congelado se exportaron a Japón en 1991. Dulces y mermeladas de guayaba son los únicos otros productos que se exportan. Existen pocos cultivares mejorados para estas frutas. El artículo presenta una breve descripción de los sistemas de cultivo que se usan: método de siembra, distancias, fertilización, control de malezas, irrigación, control de plagas, poda, cosecha y rendimientos. Se concluye que un gran esfuerzo es necesario para desarrollar el sector de las frutas en Guyana y se recomienda la participación de inversores grandes y de cooperativas.

1. Generalities

1.1 Brief Description of Fruit Projects

Guyana participates in the fruit crop programme, Supporting the Development of Tropical Fruits in the Caribbean. This multinational programme is being implemented by IICA. It sets out to give support to the ministry of agriculture and to work in collaboration with other agencies, farmers and farming groups in the promotion of fruit crops. IICA is involved in the nursery programme of the ministry of agriculture which provides training to propagators at all levels. Support is given to the establishment of commercial orchards and the promotion of non-traditional fruit crops which have an export market. This programme came into operation since 1988 and entered the second phase in 1993.

Another fruit crop programme in Guyana is the nursery programme funded and monitored by the ministry of agriculture. There are eight active fruit crop propagation nurseries spread across Guyana's 215,000 km².

They are as follows:
- The Central Horticultural Propagation Station, CHS, Timehri.
- Linden Nursery - Linden (Region 10).
- The Central Agricultural Station - Mon Repos, East Coast Demerara (Region 4).
- West Berbice Nursery — (Region 5).

— No. 63 Nursery – Corentyne Coast (Region 6).
— West Demerara Nursery – (Region 3).
— Charity Nursery – Essequibo Coast (Region 2).
— Hosororo Nursery – North West District (Region 1).

The ministry of agriculture also has a fruit crop demonstration station on the Linden Highway. The Kairuni Research and Experimental Station has 1.6 ha of West Indian lime and 0.8 ha of citrus which originally was virus-free, but is no longer so. Other crops include 3.2 ha of avocado (26 varieties) and 1.2 ha of mixed fruit crops comprising psydium, guava, bilimbi, carambola and gooseberry.

The National Agriculture Research Institute (NARI), maintains a fruit crops orchard at Ebini along the Berbice River. This comprises 0.045 ha of citrus and 4.2 ha of mango.

NARI also maintains a small orchard (1.2 ha) in the NARI compound. This orchard comprises a collection of fruits, e.g., West Indian cherry, mango, sapodilla, guava, Suriname cherry, carambola, plum and golden apple.

1.2 Ecological Problems

The major problem associated with the ecological conditions under which these crops are cultivated is the variable rainfall pattern.

The damp humidity of Kairuni, on the Linden Highway, causes the cashew nut to suffer from anthracnose diseases. There are also diverse disease problems that affect the small fruits in the riverain areas, a consequence of the high rainfall.

The bearing season of fruit trees is influenced by the rainfall pattern. West Indian cherry, for example, will not bear as much at Kairuni and the Rupununi (low rainfall) as compared to the coastlands (high rainfall).

1.3 Area Planted and Value of Production

There are few pure-stand orchards of the minor fruit crops but estimates of the overall area planted to these crops are presented in Table 1.

Table 1: Area and value of production of selected fruit crops in Guyana

Crop	Area planted/ha	Value of Production US$	G$
Soursop	2.5	4,724	600,000
Cashewnut	85	82,677	10,500,000
W.I. cherry	61	106,292	13,500,000
Golden apple	5	3,858	490,000
Guava	113	440,944	56,000,000
Sapodllla	8	31,496	4,000,000
Tamarlnd	4	8,267	1,050,000
Plum	2	6,292	800,000

1.4 The Limiting Factors for Expansion

The general factors limiting the expansion of minor fruit crops in Guyana include the following:

- The weather pattern especially in the remote areas, e.g. the Rupununi District, has a long dry spell which can severely hamper production.
- Irrigation is generally not practised since it is very expensive. There are also problems finding suitable sources of water.
- Most of the available lands along the coastline are already under rice and coconut cultivation and there is competition from short-term vegetable crops, plantain, banana and ground provisions.
- The available lands in the intermediate savannahs consist of marginal soils which demand high amounts of limestone and fertilizers.
- There is a high risk of losing the crop because of pest and disease problems.
- Market uncertainty is a serious constraint from the producer's point of view and regularity of supply is a major concern of buyers.
- Transportation from low population areas is very difficult and expensive.
- Farmers have attached very little importance to these fruits in the past, relegating them as 'backyard' fruits.

1.5 Seasonality of Production

Seasonality of production is a result of the climatic conditions and the geographical location of the crop, e.g. cashew nut is produced mainly in the Rupununi District which has a harsh dry season from December to March. For West Indian cherry, the bearing season will depend to a large extent on the rainfall pattern and supplemental irrigation. The seasonality of the crops is shown in Table 2.

Table 2: Bearing seasons of selected fruits in Guyana

Crop	Bearing season
Soursop	June–September
Cashew nut	February–April
W.I. cherry	January–February & May–December
Golden apple	July–September
Guava	July–September
Sapodilla	throughout the year
Tamarind	throughout the year
Plum	June August

1.6 Market Demand and Supply

The local fruits soursop, golden apple, sapodilla, tamarind and plum are sold at local markets and housewives make ample use of the fruits for local beverages. There is a high demand for plum, tamarind and soursop by the local juice outlets and a few eating houses. The cashew nuts are roasted locally under primitive conditions in the Rupununi area and sold in sealed plastic bags in the shops, some of the product is sent to city markets and shops.

There is a healthy local demand for these fruits in Guyana although it has not been quantified. Soursop is always in demand, especially at the local juice outlets, hotels and restaurants. Plum and golden apple are utilized throughout the year by the snack shops and fast-food outlets. These two crops are not grown in large quantities and as a result the demand is not met. There is an external market for West Indian cherry.

During 1991, a Japanese firm purchased blast-frozen cherry from Guyana and the records (New Guyana Marketing Corporation 1992) indicate that 48,321 kg were exported in 1991. Guava products exported during 1992 amounted to 2,495 kg of jam and 3,521 kg of guava cheese. Other exports have been insignificant.

2. Pre-production

2.1 Cultivar Selection

2.1.1 Soursop

There are no named cultivars. No work has been done in Guyana to categorize these fruits, but there are some varietal differences based on the size and shape of the fruit.

2.1.2 Cashew Nut

There are two main types found in Guyana. These are called the Takatu Red and the Takatu Yellow. The name is derived from the Takatu area bordering the Corentyne River and Brazil where the planting material was collected.

There are a few scattered trees of the Jumbo variety which was introduced from Trinidad. At least one farmer has 2 ha of the dwarf variety, Annai, Rupununi.

2.1.3 West Indian Cherry

The local varieties are not characterized. More than 15 types/cultivars were introduced from Puerto Rico in 1978, but the names of the varieties remain unknown and so they are called Puerto Rican varieties.

2.1.4 Golden Apple

There are some varietal characteristics among golden apple found in the country, but no varietal name is given to them. The difference is seen in size, shape, colour and taste.

2.1.5 Guava

The known varieties are the Lucknow which is pear-shaped and white-fleshed with few seeds. Other varieties known locally are Round Red (the flesh is red) and Round White.

2.1.6 Sapodilla

No varietal names are used, but there are basically two types; one is round in shape while the other is oval-shaped.

2.1.7 Tamarind

No variety is known, but there are certain characteristics by which the fruits are categorized. These are the very acid type and the mild or semi-sweet type.

2.1.8 Plum

There are many types found in Guyana but these are known only as the acid and semi-sweet types.

2.2 Propagation

2.2.1 Soursop

Soursop is propagated by seed, but grafting is done on an experimental basis. The wedge graft gives more than 60% success.

2.2.2 Cashew Nut

Cashew nut is propagated by seed; wedge grafting can also be done, but not many plants are produced.

2.2.3 West Indian Cherry

West Indian cherry is propagated by seed, but plants are now produced in large quantities at the Central Horticultural Station (Timehri Propagation Unit) by stem-cutting. A misting unit is used but the frequent outages of electricity cause a disruption in the system. It has been observed that rooted plants do have a tendency to topple when planted in pegassy/peat soils. The seedlings do not display this problem, but they take a longer time to bear.

2.2.4 Golden Apple

Golden apple is produced by seed, but stem cuttings can also be planted in the wet season. Not many of these plants are being cultivated.

Other minor fruits such as guava, sapodilla, tamarind and plum are all propagated by seed. Sapodilla plants propagated by vegetative means (wedge graft) do not seem to perform well and the plants remain dwarfed for some time.

2.3 Plant Demand and Supply

While there is a great demand for budded citrus and avocado plants, the demand is not great for the minor fruit plants. In recent times, the demand for West Indian cherry plants has been high and with the misting unit these plants can be propagated quickly. Seedlings can also be produced in a relatively short period. Farmers are advised to place orders for the minor fruit plants, thus facilitating the delivery of plants on schedule.

There is need for a germplasm unit in the main fruit producing regions (Regions 2, 3, 4, 5 and 6) so that only selected plants would be propagated. Guyana will stand to benefit from the introduction of the dwarf golden apple and better cultivars of guava.

3. Production Systems

3.1 Planting Method and Planting Distances

Fruit-trees are usually planted around homes, on vegetable farms where there is mixed cultivation, and in certain locations where there are pure-stand fruit plants. The method of planting around the homes usually involves the incorporation of an abundance of organic material in the planting holes, especially when the material is easily collected.

Another method used is the planting of selected plants around the borders of vegetable and ground-provision farms. Some fruit-trees are also planted on dams near the drainage and irrigation trenches.

Land-clearing is done in the conventional manner, i.e. clearing by hand or machinery and burning. The area is lined out and plant positions are identified, planting holes are dug and the soil is mixed with limestone to raise the pH level to 6.0. Any organic matter available is thrown in the planting hole and at least 110 g of triple superphosphate is added to the mixture. The surrounding soil is raked up to form a mound which is left to settle, and with the start of the rains the plants are planted and staked. The most common planting distances for the various crop types are as follows:

Soursop	4.6 m × 4.6 m
Cashew nut	6 m × 6 m
West Indian cherry	4.6 m × 4.6 m
Golden apple	8 m × 8 m
Guava	6 m × 6 m
Sapodilla	8 m × 8 m
Tamarind	8 m × 8 m
Plum	6 m × 6 m

3.2 Crop Husbandry

3.2.1 Fertilization

There is no rigid fertilizer programme for the isolated fruit plants around the homestead, but occasionally organic manure is added to enrich the soil.

There are a few farmers who occasionally apply NPK fertilizer; the rate usually depends on the age and condition of the plant. Generally speaking, fruit trees in pure-stand cultivation benefit from a better system of fertilizer application.

For non-bearing trees, fertilizer is applied twice per year to coincide with the rainfall pattern. NPK fertilizer is used at a rate of 110–225 g per tree per application for the first year. As the tree approaches maturity and bearing, the rate is increased yearly. From the fifth year the rate of application is approximately 2 kg per tree with one application per year. On the older trees, fertilizer is usually applied after the harvest, which also coincides with the rainy season. Sometimes an additional amount of muriate of potash is applied to boost the yield and quality of the produce; the rate is dependent on the condition of the tree and ranges from 2 to 3 kg per tree.

3.2.2 Weed Control

Weed control can be a very expensive operation so most farmers prefer to keep the weeds under control from the beginning, rather than allowing them to smother the plant. The farmer usually tries to weed around the plant so that the area is weed-free. Well-maintained fields are weeded thrice per year.

The use of a mechanical slasher is very effective in large-scale cultivations. These are brush-cutters powered by tractors; in smaller cultivations a small rotary slasher is used.

There are some noxious weeds which are difficult to control and a weedicide is usually used. The common weedicides are Karmex (pre-emergence) and Gesapax-combi which is used under wet conditions. Gramoxone, which tends to burn the weeds, and Roundup, which has a longer residual effect, are also very effective. A shield is used to avoid spray drift damaging the young plants.

There are times when weeds become overgrown; after an area is weeded the cut grass is then used as a mulch and this helps to suppress weed growth for some time.

3.2.3 Irrigation

There are no sophisticated irrigation systems in use, mainly because it is a very expensive operation. The backyard gardeners ensure that young fruit trees are watered regularly using watering-cans or hose-pipe.

On the farm lands, farmers usually use water from nearby streams to water the young plants that are affected by dry spells.

There are a few places in the riverain areas where drains are dug to allow the water to flow into the fields; this brings relief to some of the plants depending on the seepage.

3.2.4 Spray Programme

A host of pests and diseases attack these fruit crops. The pests in particular are mealybugs, aphids, thrips, scale insects, mites and the larvae of the common West Indian fruit fly which destroys the soft fruits, especially guava and soursop. The prevalent diseases

are anthracnose which severely affects the cashew nut. Other diseases are powdery mildew, sooty mould and root nematodes. In most cases, the spray programme is planned to control the pests and diseases that affect the crop.

Benlate, Kocide and Dithane are used for the control of the fungal diseases. The popular insecticides such as Malathion, Fastac, Fendona and fenitrothion are used to combat pest problems. There are a few farmers who have a regular spray programme, but the majority only spray when the attack is severe.

3.2.5 Pruning

Pruning is not readily practised by farmers, except the backyard type removal of dead or diseased branches. Extensive pruning has been done on commercial West Indian cherry. It takes much time to prune trees produced by vegetative means (cuttings), since such plants put out prolific growth and it is somewhat difficult to train them to grow with a straight trunk. Seedlings of cherry plants receive less pruning.

3.3 Yields

Yield per tree varies depending on the condition of the plant, the management system practised, fertilizer application and the nutrient status of the soil. There are some areas along the Linden Highway where the yields are very low. There are other areas in the Pomeroon where flooding is a problem and yields are also low. Then there are the better soils on the coastlands on the sand reefs, where the yields are very good.

Generally, full-bearing trees can yield the following:

Soursop	12–25 kg per tree per year
Cashew nut	25–35 kg per tree per year
West Indian cherry	25–30 kg per tree per year
Golden apple	50–60 kg per tree per year
Guava	20–40 kg per tree per year
Sapodilla	25–35 kg per tree per year
Tamarind	25–40 kg per tree per year
Plums	50–100 kg per tree per year

3.4 Factors Affecting Production

The principal factors influencing production are:

- Farmer's attitude to these crops.
- High cost of inputs, e.g. fertilizer and agrochemicals.
- Labour charges are exorbitant and labour is unreliable at times.
- High capital expenses, e.g. purchase of land, machinery and farm structures.
- Maintenance costs for machinery and buildings are extremely high.
- Transportation to market is expensive.
- Large-scale farming enterprises take a long time to produce a sizeable profit, and with fruit crops it can be a gamble because of the many constraints, e.g. marketing, post-harvest loss, etc.
- Fruit quality is not maintained due to:
  - harvesting of immature fruits
  - fruits infected with larvae
  - poor handling and packaging from farm to packhouse/markets
  - damage during transportation as farmers practice lowest cost means of post-harvest handling/packaging.

4. Harvesting

4.1 Methods of Harvesting

Harvesting is done manually. In some cases, harvesting is still primitive, e.g. guava is sometimes harvested by climbing and shaking the trees. It is not uncommon to see someone shake the tree and allow the fruits to fall to the ground. Also, there is a tendency to harvest tamarind after the ripe pod falls to the ground.

4.2 Tools Used

A clipper or sharp knife is used to harvest soursop, because the fruit can be easily damaged if it is pulled off the tree. A picking rod with a bag attached to the end of the rod is sometimes used to harvest sapodillas as well.

4.3 Maturity Indexes

No scientific instruments are used to determine maturity. Maturity is recognized by the fruit's visual appearance, especially the colour and firmness of the fruit. Sapodilla is one fruit that can be deceptive because fruit size can be very small even when it has already reached maturity. The change in colour can sometimes be difficult to identify, but experience will also help to determine the state of maturity.

4.4 Main Problem

The major problem in harvesting is insufficiently trained personnel with limited skill and experience. Newly recruited labourers are generally careless, and do not seem to exercise enough caution to harvest in the right manner and as a result, injury to the fruit can be high.

5. Post-harvest Handling

5.1 Transportation from Field to Packhouse

The main type of transportation used is small trucks, vans or landrovers. Cherries are placed in medium-sized plastic buckets; other fruits are placed in plastic or wooden crates. Sometimes, tamarind is placed in polyethylene bags weighing 10 to 20 kg when full.

The main problem is that the vehicle is not properly

packed and this leads to shaking, especially when roads are in a poor condition. Shaking results in bruises and internal damage.

When fruits reach the packhouse, market or place of discharge they are rejected due to damage caused by squeezing, bruises and compaction resulting from overpacking.

5.2 Packhouse Operations

This operation applies only to the fruits used for processing, i.e. guava and West Indian cherry. West Indian cherry is used mainly for local juice which is sold to restaurants, hotels and fast-food outlets. On arrival at the packhouse, the fruits are sorted out and the diseased fruits are discarded. The fruits are then washed and processed into juice. The juice is placed in small plastic containers (half pint; 570 ml) and kept in cold storage until it is ready for the market. The juice is also stored in 4-gallon (16-litre) containers and kept in storage until it is ready for use. Blast-freezing is also done for cherry juice.

Guava is mainly used for manufacturing jam and guava cheese. When the fruits arrive at the packhouse, they are sorted and the damaged and diseased fruits are discarded. Guavas are then washed and processed.

5.3 Characterization of Rejection Rate

Rejection rate is given a score on a scale of: 1 = more common and 6 = least common. The two important fruits which are affected are West Indian cherry and guava and this is because of the nature of the fruits. Rejection rate is as follows:

West Indian cherry		Guava	
bruised	1	bruised	1
cuts	4	cuts	3
spray-damaged	5	spray-damaged	5
smashed	3	smashed	4
pest	5	pest	3
others	5	others	5

6. Shipping and Distribution

6.1 Regulations

Barbados accepts pineapple and citrus from Guyana, but all other soft fruits are restricted, e.g. soursop and sapodilla.

6.2 Costs

Laparkan operates a cargo service to Miami and has connecting flights to the Caribbean islands. The freight rates are as follows:

US$0.44/kg for fruits to Miami.
US$0.44/kg for vegetables over 500 kg to Barbados.

Several privately owned vessels use the Guyana National Shipping Corporation (GNSC) wharf. The cost of a 20-ft refer container to Barbados or Trinidad is US$2,300. and a dry container is US$1,500. The cost to Miami is US$2,500 for a refer container and US$2,000 for a dry container.

6.3 Alternatives

Some importers use small vessels/sloops to transport their produce to Barbados and Trinidad. The main constraint is that the produce passes through a stress period due to engine heat, wetting from sea water and the effects of the sun, especially when the produce is exposed to the elements. This affects the quality of the fruits.

7. Processing

7.1 Brands and Sub-products

West Indian cherry is processed into jams and jellies by individual farmers for domestic use only and is not offered for sale in the supermarkets.

Cashew nut is also processed on a small scale at cottage-industry level. The fruits are collected from under the trees. The demand for the processed roasted nuts is high; sometimes traders purchase large quantities and then retail in the city.

7.2 Volume

No record is available on the amount of roasted nuts sold or cherry jam produced.

The volume of guava products exported during 1991/92 is shown in Table 3.

Table 3: Guava exported from Guyana

Product	1991 (tonnes)	1992(tonnes)
Guava cheese	1.88	0.18
Guave puree	14.31	—
Guava jam	—	1.87
Guava jelly	3.95	4.43

7.3 Main Problem

The main problem with processing is that there is not enough raw material to merit large-scale processing throughout the year, due to lack of storage facilities and the seasonality of the crops. In the Rupununi District, cashew nuts are gathered in an ad hoc manner and processed by individuals; this is not done in an organized fashion.

For guava, some of the raw material is purchased in the Berbice area (Black Bush Polder), which is quite a distance from the factory located on the Essequibo

coast. It takes a truck more than one whole day to make the trip which includes having to journey across the Essequibo River (3 hours) and the Berbice River (30 minutes). Also the processing factory needs upgrading with more sophisticated machinery and equipment.

8. Marketing

8.1 Market Demand and Supply

There appears to be a great demand for minor fruits in the external markets. Guyana cannot supply much of what is required externally because of the small area under cultivation. However, Guyana has the potential to grow large acreages of minor fruit crops of economic importance.

8.2 Price Competition

The price competition on the local scene is not severe. There is seldom a glut of the minor fruits and for that reason the price is more or less stable, although on the high side.

8.3 Advertising

Not much is done in advertising because there is not too much of a problem with selling the local minor fruits. The demand for some minor fruit is good and increasing. There is a trend now to produce local beverages from almost every minor fruit available, so that there is not much wastage. The eating houses, hotels and fast-food outlets purchase large quantities of the minor fruits to produce local drinks and juices.

9. Conclusion

Guyana has extensive areas which can be utilized for the cultivation of fruits. There is scope for the development of large-scale orchards. This can only be done by investors or on a cooperative basis. With proper planning and better organization, Guyana can find a place in the international fruit trade.

While Guyana has massive potential for the development of a vibrant fruit crop industry, only minimal effort is being made to reinforce the fruit crop sector. Much more needs to be done and quickly or Guyana will be left on the doorstep of the international fruit market, hoping to get a peek inside.

It should be noted that a few years ago, certain fruits such as guava, golden apple, plums, etc., were unavailable in the city markets, not because they were not produced, but because almost everyone had fruit trees of some sort in their yard.

There is an increased demand for regular supplies of high quality fruits and many farmers are beginning to gear their activities to satisfy this demand. Hence, there is need for extensionists to arm themselves with the skills and technology to teach and train farmers in this relatively new area of Guyanese agriculture.

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Abstract
The demand for the non-traditional fruit crops such as soursop, cashew, West Indian cherry, golden apple and to a lesser extent guava, sapodilla, tamarind and plums are on the increase in Jamaica. Production of these minor crops is largely restricted to backyard situations or remnants of orchards, with small established areas of improved cultivars. Limiting factors to production include lack of sound recommendations for establishment, harvesting and post-harvest practices, low prices for fruits, unavailability of quality planting materials, high initial investment cost and the control of fruit flies. There are over 30 agroprocessing firms in Jamaica, of these, five produce jams, seven juices, and six fruits in some form, including purees, chunks and sauces among others. In the market, processors are at a disadvantage as prices are usually four to five times higher on the fresh market.

Résumé
La demande pour les fruits non-traditionnels tels que corossol, anacarde, cerise des Antilles, prune de cythère et dans une moindre mesure goyave, sapodille, tamarin et prunes mombin est en augmentation en Jamaïque. La production de ces fruits mineurs reste surtout cantonnée aux jardins familiaux ou bien mélangée à d'autres espèces en vergers, avec cependant de petites superficies établies à partir de cultivars améliorés. Parmi les facteurs qui limitent la production il convient de mentionner le manque de recommandations sérieuses en ce qui concerne l'établissement des vergers et les techniques de récolte et de post-récolte, les faibles prix payés aux producteurs de fruits, la non-disponibilité de plants de qualité, le coût élevé de l'investissement initial et le contrôle des mouches des fruits. Il y a plus de 30 entreprises agro-industrielles en Jamaïque impliquées dans la transformation des fruits, parmi lesquelles 5 font des confitures, 7 des jus, et 6 soit des purées, des fruits au sirop en morceaux ou des sauces. Quant au marché, les transformeurs se trouvent en situation de désavantage car les prix sont habituellement 4 à 5 fois plus élevés sur le marché de frais.

Resumen
La demanda para frutas traditionales tales como guanábana, marañon, acerola, jobo de la India y en menor grado guayaba, níspero, tamarindo y ciruelas está creciendo en Jamaica. La producción de estas frutas ménores se limita a situaciones de traspatio o partes de huertos, con solo pequeñas áreas de cultivares mejorados. Los factores que limitan la producción incluyen la falta de recomendaciones adecuadas para el establecimiento de huertos, la recolección y la manutención pos-cosecha, bajos precios para las frutas, no-disponibilidad de material de plantación de calidad, alta inversión inicial y las moscas de la fruta. Más de 30 empresas procesan estas frutas en Jamaica, entre ellas 5 hacen mermeladas, 7 jugos, y 6 frutas procesadas en una forma o otra como purées, pedazos y salsas entre otros productos. En el mercado los procesadores están en situación de desventaja porque los precios son usualmente 4 a 5 más alto en el mercado fresco.

1. Generalities

1.1 Fruit Project

In recent years there has been a gradual increase in demand for non-traditional fruit crops in Jamaica. Soursop, cashew, West Indian cherry, golden apple (Jew plum) and minors like guava, sapodilla (naseberry), tamarind and plums fall into this group.

The demand results from:

- The increase in activities in the agroprocessing industry
- The thrust to develop exports and to increase foreign exchange earnings while developing more value-added products
- The surge of modern-day health consciousness locally
- The trend in international markets and the food industry towards convenience foods, and natural, healthy and 'green' foods.

As a result, the extension arm of the ministry of agriculture, the Rural Agricultural Development Authority (RADA), has embarked on a thrust for establishment and or rehabilitation of orchards through community economic projects or individual small-farmer participation. More recently the programme has been strengthened by large-scale production of seedlings in RADA's nursery at affordable rates to farmers. In addition a subject matter specialist has been assigned to this area to implement the development of these non-traditional crops.

Some of the focal areas being addressed are:

- Sourcing and securing of germplasm material.
- Monitoring and ensuring production of high quality planting material.
- Assisting with the establishment and/or rehabilitation of small orchards, e.g. guava.
- Documentation of technical information for the benefit of field staff and farmers.

1.2 Ecological Problems

The ecological problems encountered growing these crops vary.

In certain areas rainfall and mist are abnormal which increases the incidence of diseases like anthracnose and mildew. Cashew and soursop are usually affected. As a result these are concentrated in the drier areas.

1.3 Limiting Factors

The limitations to production are mainly in the agronomical practices due to:

- Scarce local research information
- Returns based on current prices for some crops, e.g. tamarind
- Poor availability of quality planting material
- Initial outlay costs are high - a long waiting time for production
- The difficulty in controlling fruit flies which affect many of these crops

1.4 Area Planted

It is not certain as to the acreage in production for individual crops as very little is planted as pure-stand. However estimated production areas are:

Soursop: Approximately 2 ha of new planting have been established in the last year and about 20 ha included in mixed crops. Fifty per cent of these older trees are over 10 years old. While the individual trees are found in most backyards across the island, the main areas of concentration are St Catherine (Bermaddy Mount Diablo range), Westmoreland and St Mary.

Cashew currently exists as remnants of orchards established during the 1950s. These are concentrated in the parishes of St Catherine, Clarendon and St Elizabeth. These trees have been uncared for; yield per tree is very low due to poor nutrition and disease infestation and crowding. As a result the price of nuts are very high, ranging up to J$100 /quart (litre) in the raw state.

Guava is similar in status to the above crops; in fact it is less cared for and prices are low. Most guava trees are in the wild or animal pastures and crops are usually reaped by children wherever they are found and sold to processors for less than J$4.50/ kg. It is estimated that there is some 160 ha wild and about 6 ha of established upgraded varieties

The West Indian cherry has been usually treated as a home-garden plant, eaten by children or used in punches. Although the importance of its vitamin C content is well recognized, product development is limited and offers very little scope for expansion

Others, like *tamarind, plums and sapodilla (naseberry)* are well recognized for their nutritional properties and in the processing industry. They have also been allowed to become almost extinct, as in the case of tamarind.

The overall potential of these crops currently becomes valuable as seen by the demand on the fresh market and of individual processors. For example, one of several processors requires 250,000 kg of guavas per year, mainly for jams and jellies and small amounts of nectar.

1.5 Production Cost and Returns

There is need for serious investigation in the area of costs and returns which takes time as most of these crops take 2–3 years to produce. In the meantime there is a steady growth in the cost of establishment and general inputs. However, there is some indication that crops like soursop, Jew plum, cashew, and guava can make economical returns given the potential export market for both fresh and processed products.

1.6 Seasonality

In recent years, as weather patterns change, many of these crops are found to produce year-round in small amounts. Yields could be improved with a proper fertilizer programme. Peak periods are usually March–April and August–September/ October giving two main crops per year, except for tamarind which bears annually in April/June.

Cherry produces year-round and this would allow for much flexibility in processing. On the other hand because some of these crops are so perishable there is a need for well programmed marketing, transporting and processing systems.

1.7 Marketing Demand and Supply

Currently the main market demand is the local fresh fruit market. This market has mushroomed, where fruits not usually sold can now be found in open markets, wayside stands and supermarkets. This is an indication that there are buyers in addition to the health-conscious public. Secondly, there is a demand by local processors who produce jams, jellies, nectars and confectioneries. Thirdly, the demand on the export market is steadily growing and grossly inadequately supplied.

2. Pre-production

2.1 Cultivars

There are no named or identifiable varieties of these crops. There is an urgent need to identify and describe varieties based on characteristics such as:

- Fruit texture and flavour in guava
- Shape and fewer spines in soursop
- Absence of stone cell or smoothness in guava and naseberry

2.2 Propagation Problems

Propagation is almost entirely by seed, except for

guava where a small amount is produced from rooted cuttings.

Plants should be propagated vegetatively to ensure early bearing and maintenance of cultivars. In addition, it has been observed that plants from rooted cuttings topple in bad weather conditions. There is still need for technological development in the propagation of naseberry cashew and soursop.

2.3 Demand

Nurseries, both private and government, over the years have been largely involved in large-scale production of plants for traditional export crops such as citrus, coffee, cocoa and coconut. The production of non-traditionals was geared to satisfy the need of householders as there was no organized industry for them and plants were not grown in orchards. Therefore, the demand for these seedlings was minimal.

The recent export trends have created an awareness that there is need to supply seeds for an increased supply of these plants

3. Production Systems

3.1 Planting

Crops are not usually planted in pure stand; the varying planting distances cause overcrowding. There is need for standardization in planting distances.

3.2 Crop Husbandry

No major cultural practices have been applied and as a result plants are usually overcrowded, elongated up to 10 m or wide-spreading, e.g. cashew and guava.

The tendency is to apply a similar complete fertilizer without consideration for the wide range of soil types. This practice is mainly due to the absence of local research. Further to this, the tendency is to expect production in 3–4 years after planting but there are indications that this time could be reduced with a proper fertilizer programme within the first year.

There is also need for attention to micronutrients. These crops are usually rainfed, but in some instances, a particular crop is established out of personal desire and irrespective of ecological conditions. The result is that yields are either non-existent or very poor, as for soursop or cashew.

There are varying estimates of yields, not only with respect to variety but period of time to production. The main problem is lack of pruning to allow light in and to accommodate concentrated areas for quality production. Yield examples are: cashew – 2 l/tree; soursop – 1000 kg/ha.

A typical example of inadequate yield information is in the production of cherry which produces by the end of the second year and continues year-round while there is an adequate water supply. A plant in its first year of bearing is estimated to yield up to 4 l of quality fruits but then by the second to third year, fruit size and yields fall off as there is no selective pruning or spraying programme so fruits are frequently affected by fruit flies. Fruits out of reach are not reaped and are allowed to fall to the ground.

3.3 Factors Affecting Production

Factors affecting production are:

- Absence of organized pure-stand establishment of orchards
- Improper planting distances.
- Lack of proper spraying programmes:
  There is a need for a proper spraying programme, as for any other crop, throughout establishment to reduce or eliminate incidence of: fruit fly attack on guava and cherry; fruit wasp on soursop causing immature or deformed fruits; anthracnose which affects flowering, fruiting and shelf-life of soursop and cashew; sooty mould in guava and soursop, usually because of too moist environmental conditions.
- Reluctance to prune and absence of pruning knowledge.
- Inadequate fertilizer programme.
- Field sanitation and weed control.
- Poor selection of sites which leads to disease infestation.
- Poor preparation.
- Unavailability and high cost of inputs.
- High cost of credit.

4. Harvesting

4.1 Methods

Harvesting methods are usually manual. In cases where trees are tall due to a reluctance to prune, climbing has to be done; fruits are picked in bags then let down, or hand-caught by a second person on the ground. For cashew, usually the climber stays on tree limbs which are shaken. Fruits and seeds fall to the ground and are then picked up and put in pans, buckets or baskets. Fruits in general are usually put into almost any container available. Efforts are, however, now being made by the marketing and post-harvest department of RADA to educate farmers on proper harvesting practices.

4.2 Tools

The only tools used up to now are long poles either

alone or with bags on the end, mainly to reach fruits on trees impossible to climb.

4.3 Maturity

Currently the maturity index is colour change in almost all cases. However, in soursop the widening of segments and the development of the abscission layer of the fruit stalk are taken into consideration. For sapodilla it is still difficult to identify the mature stage as on most occasions fruits in the market-place never ripen. Therefore there is need for development of specific indices.

4.4 Problems

The main problems in harvesting these fruits are:

- Picking the fruits without causing damage as trees are not properly maintained.
- Fruits are frequently picked or harvested in the heat of the day and packed in inappropriate containers causing a build-up of heat which results in rapid spoilage.
- Overripe and fruits at other stages of maturity are all packed in the same container resulting in early ripening and adding to significant losses before reaching the market-place.

5. Post-harvest Handling

5.1 Packaging

Fruits are usually packed in polypropylene or 'crocus' bags and cardboard boxes in the field. Guavas are also usually packed in plastic barrels and wooden crates. These packages are then placed in open-back tucks or vans and transported to packhouses or processing plants.

Transportation is in need of much improvement. Outside established orchards, transportation is usually on the heads of farmers or by donkeys to points of collection as the trees are usually on marginal lands not easily accessible.

5.2 Packhouse Operations

Most of these fruits do not go through a packhouse process except for sorting and washing as they are either sold directly on the fresh market or directly to processors.

There are exceptions for fruits that are exported such as sapodilla and tamarind. These are exported in small quantities and are usually packaged in special cartons.

5.3 Rejection Rate

The major causes for rejection of these fruits are either due to pest infestation or bruises due to poor handling.

6. Shipping and Distribution

6.1 Regulations

The fruits that are exported are targeted for the United Kingdom and Canadian markets mainly as regulations are less stringent in comparison to the United States ports of entry.

6.2 Costs

The perishable nature of these fruits in the fresh state creates limitations on reaping, packaging and shelf-life on those for export. As a result, there is a higher cost to ensure limited time between field and shipping time. Local costs of distribution are less than those for export but it is still a costly and irregular operation due to inadequate supplies and direct collection and distribution of fresh products or raw materials for the processor. This results in a high cost for processed products.

6.3 Alternatives

Possible alternatives to solve these problems are:

- Introduction of the mother farm concept in production areas
- Establishing larger acreages in concentrated areas which would allow for ease in collection and be less costly
- Higher volumes would reduce market price and enable affordable products to a wider cross-section of consumers
- Make a conscious effort to control fruit flies and pests in general
- Larger supply in bulk purees.

7. Processing

7.1 Brands and Sub-products

Currently, there are over 31 agroprocessing firms in Jamaica and approximately 10 distributors. Of these five produce jams; seven juices and six fruits in some form such as purees, chunks, sauces, etc. Only guava, tamarind and soursop to a smaller extent are processed by a very few operators but there is potential and need for further product development with guava and soursop and the introduction of cherry, cashew, banana and golden apple to the industry. These are definitely restricted because of low volumes.

7.2 Volume

It is difficult to obtain estimates of volume due to the absence of concentrated production in specific areas to allow for economical collection of data.

7.3 Problems

The main problems in processing are:

- Need for improved texture, flesh colour, and pectin level in guava

— Improved methods of processing soursop to reduce toxicity and to achieve durable levels of solids in the product
— Need for research in product development
— Need for good quality, reliable and adequate raw material supplies, especially for processing, not rejects from the export or fresh fruit markets.

8. Marketing

8.1 Market Demands

The growing trends for health foods locally and internationally (including both fresh and processed fruits) and the seasonality for most crops, do create high demands for these products. However, any potential solution is dependent on time and research as new acreages established will not allow any visible impact on production before the next 2–4 years.

8.2 Price Competition

Prices vary considerably for local and export markets and for the fresh market and processed products.

The lack of proper knowledge on maturity limits demand for good prices in some cases.

Processors are definitely at a disadvantage as prices are better on the fresh market (up to four or five times) where there is competition between open markets and wayside stands, supermarkets, fruit and vegetable shops, health food stores and hotels.

8.3 Advertising

Currently, there are no specific advertising programmes. While most fruits are acceptable and in demand, there is need for an educational programme regarding nutrition and versatility of these crops.

Table 1: Current farmgate prices in Jamaica

Crop	J$/kg	J$/dozen	J$/l
Soursop	5.50		
Cashew			100.00
Golden apple (Jew plum)		30.00	
Sapodilla (naseberry)		30.00	

Appendix I

Comparison of sales, production volumes and production costs fow two large processors, 1991–93

Factory Number I

	1991	1992	1993
Index of dollar value of sales	100	210.3	258.1
Production volumes of individual product lines:			
sauces	100	106	114
processed fruits and vegetables	100	83.9	95
canned juices and concelltrates	100	121	111
other	100	99.2	110
Cost of inputs as a % of sales:			
raw materials (inc. packaging)	73.7	74.2	71.4
labour	5 3	3 3	4 5
fuel and power	1.7	1.9	1.6
overheads	18.7	15.4	22.4

Factory Number 2

	1991	1992	1993
Index of dollar value of sales	100	136.6	192.1
Production volumes of individual product lines:			
Production line#l	100	115	125.1
Productionline#2	100	108.3	115
Production line #3	100	87.8	97.8
Production line #4	100	53.2	74.5
Cost of inputs as a % of sales:			
raw materials (inc. packaging)	70.8	65.2	61.9
labour	7.5	5.5	6.2
fuel and power	2.9	3.4	3.3
overheads	18.5	21.3	27.8

MONTSERRAT

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Abstract
In Montserrat, production of minor fruit crops such as soursop, guava, tamarind, mammey apple and sapodilla, is restricted to trees found growing in the wild. There are no production data for these crops but the total area is estimated to be less than 50 ha with guava and soursop being dominant. Most of these crops are produced from seed or grow voluntarily as there are few propagation facilities. There is a need to improve existing cultivars possibly to allow for year-round crop production.

Résumé
A Montserrat la production de fruits tels que corossol, goyave, tamarin, abricot de St Domingue et sapodille est limitée à celle d'arbres issus de graines, plantés ou spontanés, car le développement des pépinières est extrêmement limité. Il y a pas de données de production pour ces espèces; la superficie totale est estimée à moins de 50 hectares, goyaves et corossols étant dominants. Il est urgent d'améliorer les cultivars existants de façon à permettre éventuellement une production toute l'année.

Resumen
La producción de frutas ménores tales como guanábana, guayaba, tamarindo, mamey y níspero en Montserrat se restringe a árboles que crecen al estado silvestre. No hay ningún dato de área de producción para estas frutas pero se estima que el equivalente en área no pasa de 50 hectáreas; guayabas y guanábana son las especies dominantes. La mayoría de los árboles provienen de semillas pués la infraestructura de viveros para multiplicación vegetativa es muy limitada. Es necesario mejorar los cultivares existentes de manera a tener una producción todo el año.

1. Generalities

Montserrat opted to remain a colony of Britain either by choice or as a matter of convenience. As a result of this political affiliation, the country, as close as it is to other independent states, has been denied the benefits derived from regional projects, projects which focus on improving the agricultural sector.

Like most of the Caribbean islands, the emphasis over the years was placed on developing the traditional fruit crops, i.e. mango, avocado and citrus. These were then regarded as of major economic significance. During this period of development, large sums of money were spent on these crops. The minor fruits were taken for granted.

Following the passage of Hurricane Hugo, the island then recognized how vulnerable these crops were to strong winds and, with a growing business in cottage industries, some attention has been given to these minor crops, e.g. guava, soursop, mammy apple and sapodilla.

2. Production Systems

There are no existing production systems for any of these crops as most of them are growing in the wild and the fruits are harvested as needed. Neither is there any accurate figure for acreages of these fruit crops. However, recent rough estimates put the area in production as follows:

Soursop	6–8 ha
Guava	24–30 ha
Tamarind	0.8 ha
Sapodilla	100 seedling stock
Mammy apple	1.2–1.6 ha

2.1 Soursop

Most of this grows voluntarily. It is estimated that there can be as much as 8 ha scattered throughout the island and in backyards.

These plants are established from seed. The ministry of agriculture, over the years, has been producing some plants for sale. In recent times, the demand for soursop seedlings has grown, mainly by home-owners.

2.2 Guava

There is very little of an improved cultivar of guava on the island. However, it is estimated that there may be as much as 24–30 ha of guava growing voluntarily throughout the island, some in pure stands. In 1986 some attempt was made to develop a tech-pack which would have included parameters such as fertilizer requirements, response to fertilizer, spacing and yields. Following consultation with a regional expert, it was advised that the fruits were too small, had too many stones and were regarded as of no significant importance. The cottage industry disagrees with this suggestion. About 15–20% of these fruits are being utilized per crop and there are at least two crops per year.

2.3 Tamarind

Large tamarind trees can be seen also on roadsides and on some plantations. These trees were planted as a soil conservation measure. Very little attention is given to them with the exception of children harvesting the odd fruit and now the cottage industry and food vendors are using the fruit for tamarind balls and drinks.

2.4 Mammey apple

The 1.2–1.6 ha of trees are scattered throughout the island, but pockets of trees can be found. The fruits are harvested and used fresh. A number of cultivars have been noticed and the government nursery has now embarked on propagating rootstock with the view to establishing some of the more desired cultivars.

2.5 Sapodilla

In recent times, some seeds of sapodilla have been acquired. Rootstocks are now ready for grafting pending the acquisition of desired germplasm.

3. Processing

3.1 Processing Facilities

There is one medium-sized agroprocessing plant. Small-scale operation has begun and it is anticipated that if the harvesting of fruit can be coordinated, the plant will be able to absorb a reasonable amount of the fruit.

3.2 Cottage Industry

The cottage industry is thriving. Local jams, jellies, fruit drinks and home-made wines can be seen on shelves of stores in the capital. Some of these cottage operations are even storing pulp in deep-freezers.

3.3 Processing Limitations

The seasonality of the fruits creates a problem for processors. This calls for storage facilities to be purchased and the high cost of electricity in some cases renders these operations uneconomical.

There is therefore the need to improve existing cultivars so as to have a longer bearing season for all of the fruits, thus making it possible to obtain year-round production.

4. Conclusion

While there is no organized production system and although there is no project promoting the production of the minor fruit crops, there is a growing sensitivity among residents — one on which government agencies can benefit by introducing production systems.

There is, therefore, greater need for cooperation between the various ministries and support agencies to achieve their goal of organized production, harvesting, and utilization of these crops.

ST KITTS AND NEVIS

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Abstract
St Kitts and Nevis have a good potential for the production of tree crops but despite this, only one major commercial project exists in St Kitts and five smaller private orchards in Nevis. The present land-tenure system in St Kitts, where more than 95% of the land is owned by the state, and a scarcity of high quality vegetatively propagated plants are the main reasons for the lack of private commercial orchards. The rapid expansion of the tourism sector has created an additional demand for good quality fruits. Production of the minor fruits, namely soursop, golden apple, West Indian cherry, cashew, guava, sapodilla, tamarind and plums is characterized by low yield and quality due to poor orchard management and handling with a significant percentage of the production coming from wild trees.

Résumé
St. Kitts et Nevis a un bon potentiel pour la production de fruits; cependant il n'y a qu'un seul projet commercial à St. Kitts et cinq petits vergers privés à Nevis. Le système foncier actuel à St. Kitts, où plus de 95% des terres appartiennent à l'état, et la pénurie de plants de qualité sont les raisons principales qui s'oppopsent au développment de vergers commerciaux privés. L'expansion rapide du tourisme a créé une demande supplémentaire pour des fruits de qualité. La production des fruits mineurs notamment corossol, prune de cythère, cerise des Antilles, anacarde, goyave, sapodille, tamarin et prunes de mombin est caractérisée par de faibles rendements et des problèmes de qualité dûs au manque d'entretien des arbres et la manutention post-récolte; un pourcentage significatif de la production provient également d'arbres spontanés.

Resumen
En St. Kitts y Nevis existe un buen potencial para la producción de frutas; a pesar de esto, hay un solo proyecto comercial en St Kitts y 5 pequeños huertos privados en Nevis. El actual sistema de tenencia de la tierra en St Kitts, donde más de 95% de la tierra esta en mano del estado, y la escasez de material de siembra de calidad son las razones principales que impiden el desarrollo de huertos privados comerciales. La expansión rápida del sector del turismo ha creado una demanda adicional para frutas de buena calidad. La producción de frutas ménores a saber guanábana, jobo de la India, acerola, marañon, guayaba, níspero, tamarindo y ciruelas se caracteriza por bajos rendimientos y calidad debido al mal manejo de los huertos y de las frutas; un porcentaje significativo proviene de la producción de árboles espontáneos.

Background

The Federation of St Kitts and Nevis consists of two small islands located at approximately 17° 15' and 62° 40' in the Eastern Caribbean. They are separated by a strait approximately 3.2 km wide, with a total land area of 269 km² of which Nevis, accounts for 93 km². The estimated population is around 47,500 of whom about 9,500 live in Nevis.

There are separate civil service administrative structures in each island. There are, also, separate ministries of agriculture each with its own department of agriculture, one in Basseterre, St Kitts, the other in Charlestown, Nevis. The federal ministry in Basseterre has the responsibility for external matters.

Agriculture is a key component of the St Kitts and Nevis economy. It is the single most important employer, accounting for 25–30% of the work force. Sugar remains the mainstay of the economy despite the increasing importance of tourism and services in the last decade. Sugar cane is grown only in St Kitts where after more than 300 years it is still the main crop and occupies around 4,200 ha of prime agricultural land. The sugar industry is state-owned and managed.

The non-sugar agriculture component is small and undeveloped; it includes fruit and vegetable crops. Consequently, growth in the agricultural subsector is closely related to the performance of the sugar industry. The trend in the subsector during the 1980–1989 period shows that its contribution to national output has consistently gone down by about 50%, from about 17% of GDP in 1980 to 9% in 1989. Although the sugar export earnings decreased by more than 50% in the last decade, they still account for around 20% of total exports.

In order to offset the decline of agriculture, associated with continuous poor performance of the sugar industry, the government of St Kitts and Nevis has decided to embark upon an agricultural diversification programme. Included in their six-pronged strategy is a sustainable, more intensive, increased and profitable production/development of vegetables, root and fruit crops as well as livestock.

1. Generalities

1.1 Fruit Project

At the request of the government of St Kitts and

Nevis (in August/September 1992) the Inter-American Institute for Cooperation on Agriculture (IICA) did an agricultural sector assessment study. The report of this study in the area of the fruit-tree crops subsector can be summarized as follows:

Despite the potential of the twin-island federation to grow fruit trees, only one major commercial project exists in St Kitts, and five smaller private orchards in Nevis. Coconut is the exception for Nevis where large-scale plantations can still be found. The St Kitts-based Wingfield Fruit Project, owned and administered by the St Kitts Sugar Manufacturing Corporation (SSMC), has three main orchards: mango, avocado and citrus. Regrettably however, most of the trees show signs of neglect.

Many fruit species can be found growing and bearing well in the numerous 'ghauts' of St Kitts. Most of the trees were either planted in these ghauts by sugar workers and their families or grew voluntarily from seeds which fell from the original trees planted elsewhere and deposited by running water. Among these fruit-trees, mango (*Mangifera indica*), coconut (*Cocos nucifera*), and breadfruit (*Artocarpus altilis*) are the species most commonly found. Nevertheless, a considerable number of other fruit-trees such as papaya (*Carica papaya*), citrus (*Citrus* spp.), soursop (*Annona muricata*), sugar apple (*A. squamosa*) and golden apple (*Spondias cytherea*) can be found growing and bearing well.

In Nevis, scattered fruit-trees or sometimes small orchards are spread over the entire island. Large-scale coconut plantations still occupy a significant area, but the trees show signs of neglect. This neglect is probably due to the low prevailing price of copra and difficulties encountered in selling the products. The rapid expansion of the construction industry is mainly responsible for the significant reduction in total acreage under coconut production today. Fruit-trees such as mango, breadfruit, papaya, soursop, tamarind (*Tamarindus indica*), guinep (*Melicocca bijugata*), plums (*Spondias* spp.) and cashew (*Anacardium occindentale*) can be seen throughout the island of Nevis growing and bearing well, despite the minimum, if any, care provided.

The present land-tenure system in St Kitts, where more than 95% of the land is owned by the state, has been identified as one of the main reasons for the lack of private commercial orchards. Farmers are reluctant to plant fruit-trees or do any long-term investment under the present short-term rental agreement with government (SSMC). Although a comprehensive long-term land lease programme was included and presented in the 1986–1990 national development plan, the long-awaited law necessary to ensure its implementation has only been passed recently. In Nevis, where the government owns 30% of the lands, the main constraints seem to be the extreme dry conditions, the shortage of water for irrigation, the scarcity of labour, the limited market, the lack of promotional programmes such as demonstration plots and inadequate economic incentives to farmers.

In most countries of the Caribbean, there is a tradition of planting a few fruit-trees in almost every home garden. This tradition has contributed not only to reducing normal city noises, beautifying the cities and purifying the air, but has also proven to be an excellent source of low-cost vitamins and minerals for the family. It is noticeable that this tradition is not as popular in Basseterre as it is in other Caribbean urban areas. This absence was quite noticeable, especially in new housing development areas. The lack of promotional programmes to motivate residents to plant fruit-trees in their back garden or yard, as well as a severe shortage in the supply of planting material are the two major causes for this situation. It is also recognized that there is limitation on the land area available for cultivation as well as water for irrigation purposes. In Nevis on the other hand, almost every house has a few fruit-trees in the backyard, despite the fact that this island is drier than St Kitts.

For both islands the rapid expansion of the tourism sector has created additional demand for good quality fruits in the hotel and opened new market possibilities for locally produced fruit crops.

1.2 Nursery Management

The propagation of fruit-trees in St Kitts is carried out at the government nursery located at the department of agriculture. Under a CIDA/SPIF project, this station was recently redesigned and equipped with new facilities such as seed-bins, raised propagation tables, irrigation equipment and storage room.

Some design faults were noted in the new facility which limit the available space for hardening, budding and grafting. The propagation tables were also constructed too high and too wide and this will certainly affect efficiency in operation of the propagators.

The irrigation system of this facility is an overhead one. This system may, therefore, prove cumbersome and impractical for the ground bins and mist beds as well as other areas where plants are to be propagated vegetatively. As designed, the system will not only contribute to the waste of water, but also promote continuous mould growth thus making it difficult to maintain good sanitary conditions in the nursery.

Recently, additional space for hardening plants such as mango which require full sunlight has been found

in an area adjacent to the nursery. The UNDP/FAO project has already provided basic equipment for soil and seed sterilization as well as training in propagation techniques and other aspects of nursery management.

Although the cost of producing a seedling or grafted tree at La Guerite has not been quantified, it is well known that the production cost is well above the sale price of EC$5.00 for each plant. The plants are sold at subsidized prices to farmers on a 'first come, first serve' basis. A system of recording plant sales and distribution for all practical purposes has been established recently.

It is interesting to note that the demand for all the species of fruits being propagated at the nursery has outstripped supply. Also the high demand for planting material from neighbouring islands has created as additional supply pressure on the nursery.

The price of EC$10.00 per plant paid by a neighbouring island is considerably higher than the subsidized price paid by local farmers. The export of planting material is therefore an attractive venture and provides the nursery with a valuable source of foreign exchange revenue. In order to meet both the domestic and export markets for planting material, the government could consider providing the necessary incentives for the establishment of one or more private nurseries, or provide additional financial resources to expand the present capacity of its nursery.

In general, nursery management is weak. No production plan is in place and, generally, the propagation officer decides on the species, cultivars and quantity of plants to be propagated. The nursery annual target for the past 3 years has been 3000 citrus, 2500 mango, 300 avocado and 550 miscellaneous fruit species. The nursery budget is fixed annually by government and bears no relation to the quantity of plants to be propagated to meet the demands.

The main fruit species and cultivars propagated at the La Guerite nursery are presented in Table 1.

No quality standards are set for the release of plants by the nursery. Consequently, a high mortality rate of young plants results in the fields after planting.

The nursery staff at La Guerite are in need of training in the various aspects of plant propagation methods, decontamination practices (tool sterilization; soil and seed treatments) and management.

Table1: Main fruit species and cultivars propagated at La Guerite nursey in St Kitts

Crop	Botanical name	Cultivars
Sweet orange	*Citrus sinensis*	Valencia, Parson Brown, Navel, Pineapple
Sour orange	*Citrus aurantium*	Common
Lime	*Citrus aurantifolia*	West Indian, Tahiti (Persian)
Grapefruit	*Citrus paradisi*	Marsh Seedless, white and pink
Rough lemon	*Citrus* sp.	Rough lemon
Pummelo	*Citrus grandis*	Unknown
Avocado	*Persea americana*	Lula, Pollock, Simmonds
Mango	*Mangifera indica*	Julia, Graham, Irwin, Haden, Bombay
Other miscellaneous trees, e.g. soursop, breadfruit, cherry, plum, etc.		From local, non-selected

The method of collection as well as the sourcing of planting material (seeds and budwood) needs to be improved in both St Kitts and Nevis. There is a need to establish a well-maintained germplasm bank of economically important species of fruit trees. The Wingfield fruit orchard could have been used as a main source of planting material, but most trees there are neglected and their unsanitary conditions make them unsuitable for collection of budwood. Due to the shortages of supply and the resulting high market price of avocado fruits, there is a high demand for planting material of this fruit-tree. The practice of buying avocado seeds of unknown source and sanitary condition may have contributed, or in the long run will contribute, to the distribution of the root rot disease (*Phytophthora* sp.) from field to field.

Table 2 gives a description of the fruit-tree crops production constraints, causes and proposed actions to be taken. With the advent of the implementation of the FAO executed Agricultural Diversification Project, STK\94\004, these are being addressed and corrective measures have been implemented.

Table 2: Fruit-tree crops production constraints, causes and proposed actions

Constraint	Cause	Proposed actions
1. Pre-production		
1.1 Supplies of fruit-tree planting material do not satisfy farmers' demand.	Poor (St Kitts) or lack (Nevis) of infrastructure	St Kitts: Modify infrastructure to maximize efficiency. Rehabilitate bins in old shed and use as seed-bins. Adapt two beds in new shed into a mist and humidity bed. Nevis: Speed up construction of proposed propagation unit at Prospect.
	Inadequate training of nursery staff in propagation methods and nursery management	Organize training events including in-service training of nursery staff: Send staff for overseas training if necessary. Use the capability and (St Kitts and Nevis)resources available in institutions such as UNDP/FAO, IICA and CARDI to this end.
	Nursery operates without a propagation plan and budget is not adapted to target number of plants to be propagated. Consequently, there is scarcity and/or untimely supply of inputs and material for propagation (St Kitts)	Prepare yearly budget and propagation plan ahead of time. Secure funds and modify plan accordingly. Prioritize species and cultivars and contract inputs, e.g. seeds, ahead of time.
	Sale of plants on a 'first come, first serve' basis (St Kitts)	Enforce the booking for plants. Give priority to those farmers willing to establish commercial plots
	Sale of plants to other islands to the detriment of local supply availability (St Kitts)	Promote and give incentives for the initiation of private nursery (ies) to supply the demand for plants overseas.
	Nursery operates without proper standards, e.g. . plants are released while too tender, budding is done too low on the stock, etc.	Develop and enforce standards for the propagation and release of each species of plant including varieties, freedom from diseases, propagation methods, stock to be used, height of budding, decontamination practices required, etc.
1.2 Poor conditions /and/or quality of the planting material produced by the nursery.	Poor nursery management: — monthly and daily planning — cultural practices — pest and disease control — decontamination practices, e.g. soil sterilization, seed treatment, etc. — inefficient use of the infra-structure available. — bad sources of seeds and bud woods and lack of own organized germplasm.	Train nursery staff and propagation officer in different aspects of nursery management and develop appropriate means for follow-up. Design, establish and maintain germplasm banks for prioritized species and cultivars. Introduce disease-free material and select local clones where possible.
2. Production		
2.1 Low fruit production, yield and fruit quality.	Poor orchard management, and common negligence in handling of fruit crops.	Organize specific commodities training programmes and establish demonstration plots.
	Shortage of water in some areas. Orchards have not been protected from the high intensity of wind which causes a significant amount of damage (wind-scars, defoliation, flower and fruit drop, etc.)	Prioritize crops and do more practical zoning. Plant windbreaks. Use species such as jammon, breadfruit, casuarine, leucaena, mahogany and tarmaring.

Constraint	Cause	Proposed actions
2. Production (cont'd)		
	The lack of validated technological packages in St Kitts and Nevis.	Introduce, adapt and validate technological packages developed in countries with similar conditions to St Kitts and Nevis. Support the work of CARDI in the two islands.
2.2 Lack of farmers interest in growing fruit crops.	The few farmers willing to plant fruit-trees cannot get sufficient planting material of the desired quality.	Establish a system for booking plants at the nursery and give preference to those farmers establishing commercial plots.
	Under the present land-lease system, (1-year lease) farmers are reluctant to grow long-term crops.	Approval of the land development act for long-term land leasing (35 years).
	Government lacks promotional programmes and incentives to fruit growers.	Establish demonstration plots and develop a programme including incentives, market information, better marketing channels and technical assistance services to farmers. Prepare leaflets and organize workshops, seminars, field days and other promotional events. Involve all instruction expertise in these areas.
3. Harvest and Post-harvest		
3.1 High post-harvest losses	Extension officers and farmers need training in production, harvesting and post-harvest practices.	Improve the knowledge of both technicians and farmers on production and post-harvest handling practices following a commodity systems approach.
	Inefficient harvesting methods Poor knowledge of maturity index Rough handling of produce Overloading of containers Over-exposure to high temperatures Production and post-harvest pests	
4. Marketing		
4.1 Shortage in supply/seasonality	Concentration of production to a short period due to a narrow selection of cultivars and unavailability of early and late cultivars.	Introduce and give priority to the propagation and distribution of late and early maturing cultivars.
	Bulk of production still comes from volunteer seedlings which are mainly harvested during the mid-season period.	Initiate topworking programmes, especially for mango.
4.2 Difficulty in selling large volume of production.	Small local market and unexplored for export and processing.	Make better use of the experience in fruit processing available in the region.
		Provide incentives to maintain and create new cottage industries and agro-industrial facilities.
		Identify marketing niches.
	Competition from overseas suppliers.	Prioritize crops offering competitive advantage and those with potential but that are not included in expansion projects of neighbouring islands.
4.3 Poor quality of the supply	Most fruits come from seedling trees. Few organized orchards Poor management of existing crops	Promote the establishment of organized orchards with high quality cultivars. Improve production, harvesting and post-harvest practices.

2. Summary

The growing of fruit-trees in the backyards of private homes, something that is very common in other islands of the Caribbean, is not noticeable in St Kitts. Commercial production of fruit-trees on small farmers, plots is practically non-existent, with the exception of a few scattered plots of papaya now being established. However, a relatively large commercial fruit project was developed by the St Kitts Sugar Manufacturing Corporation (SSMC). The main components of this project are the Wingfield Tree Crop Project located at Wingfield Estate, the pineapple project at Molyneaux estate, and the coconut orchards at West Farm and Dieppe Bay. Additionally, four commercial demonstration plots of papaya (about 0.1 ha each) have recently been established under a Republic of China (Taiwan) cooperation project.

The great majority of fruit trees in St Kitts are found growing wild in the ghauts. These fruit trees are in a very poor condition because of the limited care provided. In 1989 a significant number of these trees was severely damaged and destroyed by Hurricane Hugo.

Central to any agricultural diversification programme is a well managed and operated nursery. One of the objectives of the St Kitts and Nevis Agricultural Diversification Project funded by the United Nations Development Programme (UNDP) and executed by the Food and Agriculture Organization (FAO) is 'the development of plant propagation facilities both in St Kitts and Nevis'. As has already been stated elsewhere in this paper, the unit at La Guerite in St Kitts which had been funded by CIDA under its Small Project Investment Fund was architecturally sound but inappropriate horticulturally and not providing the necessary conditions for efficient operation.

In Nevis the propagation unit was devastated by Hurricane Hugo in September 1989. The UNDP provided US$60,000 for the rehabilitation of the nursery facilities under a special project code STK/90/002.

In St Kitts renovations first had to be carried out to make the unit operational. It still does not satisfactorily allow for sound nursery management. In the past, the existing but unutilized forestry nursery was rehabilitated and well-complemented propagation activities at the station started.

In Nevis a new modern facility which incorporates a storage area for potting medium/soil mixing and a soil sterilization unit (steam), office and storeroom, hot-water bath, speeding area, four mist benches, water storage (14,000 litres) and a hardening area, has been completed (September 1992).

In St Kitts a building was renovated and a cement-mixer and a soil steam-sterilizer installed. A hot-water bath has also been purchased. This building complements the nursery.

Both units in St Kitts and Nevis have been provided by Projects STK/90/002 and STK/90/004 with a 3-year inventory of nursery equipment and supplies. In addition a 4-wheel drive vehicle was purchased for Nevis. It is anticipated that a similar type vehicle will be provided for St Kitts under the Agricultural Development Support Project funded by a loan from the World Bank.

The technical staff at both nurseries have been recently employed and are unskilled. A significant amount of time is being spent in in-service training in propagation techniques and in nursery management and production. Three technicians (one from St Kitts and two from Nevis) have attended training courses in plant propagation and nursery management at the University of the West Indies (UWI) under the Continuing Education Programme in Agricultural Technology.

Although St Kitts, and to a large extent Nevis, have not had wide experience in the production of fruit-tree crops, the infrastructure to develop the subsector is being put in place. This includes the establishment of nursery facilities, security of tenure, institutional strengthening, credit, etc. It is recognized that traditions do not die easily, and that it would require effort and the extension know-how to convince farmers to establish orchards.

The lack of farmer interest in growing fruit crops is primarily due to their lack of security of tenure. The land Development Act of 1991 where farmers would receive 35-year renewable leases has been given assent in the House of Assembly. In addition, the land surveyor under the aforementioned project has commenced the perimeter survey, preparatory to the leasing of the holdings to farmers. It is reasonable to expect that farmers would now be willing to invest and establish solid stands of named tree crops. The 35-year leases would also mean that the farmer could utilize the land as collateral to obtain development credit.

A propagation programme has been prepared and is being utilized (Appendix 1).

Appendix 1

Propagation
The propagation techniques used in St Kitts and Nevis for the crops which are being covered at this workshop will be discussed briefly in the order of listing.

Soursop:
Cuttings of the variety Burris have been introduced from Grenada and rooted under the mist system. At La Guerite, plants have been planted out and are growing vigorously. Multiplication is by using semi-hard cuttings dipped in 0.08% IBA. Rooting is easy once the cambium is active as evidenced by flushing.

Golden apple:
Propagation is by seed. At present the dwarf variety is being grown from seed imported from Guadeloupe. It is proposed to pursue two lines of research: use the dwarf as a rootstock and graft the local selected variety; use a selected rootstock and use the dwarf as an intermediate and graft the local selected variety as the scion.

Both proposed methods will, it is hoped, reduce the height of the trees to accommodate harvesting, and reduce the gumming disease. So far the dwarf variety appears resistant to the disease.

West Indian cherry:
All plants are vegetatively propagated from cuttings. At present (although a request has been made to Barbados) there are two varieties. These are still being assessed as they have only just begun to bear fruit.

Cashew:
No extensive work has begun. The project received seed from Brazil which was not viable. A few seeds collected from Guadeloupe have germinated.

Guava:
At present only the table types are being propagated from locally selected parents and one plant which was brought in from Taiwan. Again semi-hard cuttings are used and rooted under mist.

Sapodilla:
Sapodilla has been introduced from Grenada using seed supplied by the head of the tree crop division of the ministry of agriculture.

The seedlings were grafted but with a less than 1% take at the first attempt using the scion 'Jacqueline', also from Grenada. Re-grafting the same stocks, but cutting (heading) them back 7–9 days before grafting has given better results. The method appears more promising but needs further investigation.

Tamarind:
Seedlings of the dwarf 'sweet' variety have been obtained from seeds collected from Guadeloupe.

Plums:
Work has not yet started

ST LUCIA

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Abstract
Soursop, golden apple and plums are among other minor fruit crops that are grown in St Lucia, usually scattered on farms and marketed locally. Production from 14 minor fruit crops totalled 115 tonnes for the first 6 months of 1993 with a local value of EC$89,000. Among the factors limiting the expansion of these minor crops are low levels of institutional infrastructure, coupled with technical and economic constraints. These minor crops are usually interspaced with banana, receiving fertilizer and other inputs as supplied to the banana crop. Those not grown with banana receive little or no inputs. Processing is characterized by cottage-type operations resulting in a wide variation in quality of the processed product.

Résumé
Le corossol, les prunes de mombin et la prune de cythère sont quelques-uns des fruits mineurs cultivés à Ste Lucie, parmi d'autres; ils sont habituellement éparpillés sur les exploitations et commercialisés localement. La production de 14 espèces de fruits mineurs a totalisé 115 tonnes pour les premiers 6 mois de 1993 pour une valeur locale de EC $ 89,000. Parmi les facteurs limitant l'expansion de ces espèces il faut citer les bas niveaux d'infrastructure institutionnelle, couplés avec des contraintes économiques et techniques. Ces fruits mineurs sont habituellement plantés en association avec la banane et bénéficient donc des engrais et autres produits spécifiques appliqués à celle-ci, tandis que ceux qui ne sont pas associés à la banane ne reçoivent pratiquement rien. La transformation est surtout de type artisanal ce qui entraine une grande variabilité de la qualité des produits.

Resumen
Guanábana, jobo de la India y otras ciruelas son algunas de las frutas ménores que crecen en Sta Lucia, usualmente dispersas en granjas y comercializadas localmente. La producción de 14 especies de frutas ménores sumó 115 toneladas por los 6 primeros meses de 1993 con un valor local de EC$ 89,000. Entre los factores que limitan su expansión cabe destacar el bajo nivel de organisación institucional junto con constreñimientos técnicos y económicos. Estas frutas se cultivan usualmente con bananos, y se aprovechan de los fertilizantes y otros productos suministrados a las bananos; los árboles que no estan entre bananos reciben poca o ninguna atención. El procesamiento es de tipo artesanal lo que resulta en una gran variación en la calidad de los productos.

1. Generalities

1.1 Fruit Projects

Fruit crops in St Lucia fall under two broad programme areas, namely:

- Export crop development
- Import substitution replacement

Export crop promotion seeks to re-establish the importance of traditional export crops as well as non-traditional ones which can assist in the generation of foreign exchange.

Import substitution and/or replacement seeks to reduce the food import bill by encouraging the production and marketing of crops and livestock that can be produced locally.

Currently there is a marginal lands development project being implemented which aims to make greater use of such lands by production of certain crops and small ruminants. One of the crops is cashew, and some Brazilian dwarfs are being tested. This is a joint project between the governments of Brazil and St Lucia.

The ministry of agriculture (MoA) in collaboration with related agricultural institutions undertakes many activities in fruit crops related to diversification efforts.

In particular, IICA and CARDI are involved in fruit crops in relation to technology generation, adaptation and transfer, while the French Technical Mission and the Chinese mission relate more to import substitution activities. The Chinese mission is also involved in tree corps.

1.2 Ecology and Related Problems

There are no major problems associated with the ecology under which these crops are grown. Humidity and temperature are favourable but the distribution of rainfall is often problematic. There are periods of abundant rainfall causing water-logging, increased runoff and erosion as well as those of scarcity which suggests the need for supplementary irrigation. This would only be recommended if markets and prices were sufficient. Wind problems are usually site-specific.

Land and soil characteristics are not the best, but production can be optimized with the application of appropriate tech-packs.

1.3 Area Planted

The area of these crops under cultivation has not been accurately determined as they arise in large part as volunteer seedlings and planted seedlings. These are usually scattered on farms and have not been subjected to any deliberate selection.

1.4 Estimated Production and Value

The estimated production and value is shown in Table 1. It indicates a total of 115.1 tonnes valued at EC$89,000 based on local prices for the first half of 1993.

Table 1: Production and value of selected fruits in St Lucia

Crop	Total qty. marketed(tonnes)	Value (EC$ 000s)
Soursop	63.5	48.1
Golden apple	17.7	13.2
Plums	7.8	7.8
Genip	4.9	4.4
Tamarind	4.3	2.5
Guava	3.3	1.6
Cashew	2.0	3.0
Breadnut	4.0	4.0
Love apple (pomerac)	2.1	1.1
Sapodilla	1.0	1.0
Mammy apple	2.0	1.0
West Indian cherry	1.0	0.5
Gooseberry	1.0	0.5
Sugar apple	0.5	0.3
Total	115.1	89.0

The average yearly production is based on 5 years data and comprises the average yearly exports, the sales at selected local supermarkets, hotels, the St Lucia Marketing Board and an estimate of the volumes sold at the local central market (Appendix 1).

1.5 Factors Limiting Expansion

Among the factors limiting expansion of fruit crop production are the low levels of institutional arrangements coupled with technical and economic constraints. There are problems related to the organization of production, especially with respect to availability of appropriate inputs and other facets of production. The costs of many inputs and services are high or they are non-existent.

There are many problems concerning marketing including external transportation, especially relating to the volume and cost of cargo space. Income is low as well as productivity and labour cost is high. Environmental/ecological conditions though not unfavourable can be optimized with the application of appropriate technical packages supported by efficient marketing arrangements.

1.6 Seasonality

There is seasonality in marketing some of the crops, whereas other fruits can be obtained during most months of the year. This is probably due to the variation in plants (from seedlings) as well as to the differing micro-environments under which these crops are grown.

1.7 Main Markets

The main markets are local. The most important local outlet is the central market followed by the supermarkets and hotels. The export markets are, mainly, the United Kingdom, USA and the Netherlands. The demand and supply of these markets have not been determined, but indications are favourable. Cargo space often proves to be insufficient.

2. Pre-production

There has been limited use of cultivars and as indicated before, plants are mainly unselected and scattered throughout the island. Recently more deliberate planting has begun in crops like soursop where marketing shows some potential.

3. Production System

Most plants are located close to or within banana fields and receive fertilizer and other inputs as supplied to the banana crop. Plants away from banana production areas rarely receive attention, save for harvesting.

4. Harvesting

Harvesting methods for golden apple consist mainly of climbing and shaking the tree whereas soursop fruits are picked by hand. Generally sticks are used to pick where the hand cannot reach. Sticks with bags attached at the end ('kali') are often used.

The stage of maturity at harvesting depends on the market destination. Fruit for the local central market are sold at all stages (ripe, half-ripe and green mature), while those for export are harvested at the green mature stage.

The main problems relate to quality defects due to harvesting methods and tools. Generally, the local markets tolerate higher levels of quality defects than do exporters.

Another problem relates to maturity; early in the

season immature fruit can be found on the market in an effort to exploit higher prices.

5. Post-harvest Handling

5.1 Transportation

Transportation from field to packhouse is done mainly in pick-up vans and small trucks with fruit usually packed in boxes, crates, cartons, baskets and bags. Bags are usually used for fruits which are not easily damaged (e.g. golden apple) for transport to the local central markets. The main problems relate to quality defects which arise due to inappropriate handling.

5.2 Packhouse Operations

In the packhouse, post-harvest treatment consists essentially of washing, sorting/selecting and packing for export. Chemical treatments are not usual in minor fruit crops. Storage is limited to holding for a day as fruits are usually received a day before or on the day of departure.

5.3 Causes for Rejection

Rejection is based on the particular fruit as well as on the destination. Fruits for export are scrutinized the most followed by those for the supermarkets, hotels and central markets. Fruits showing noticeable pest and disease damage are usually rejected in the field. A certain level of cuts, bruises and other minor damage is acceptable on the local central market but tolerance decreases as fruits are offered to hotels, supermarkets and for export.

6. Shipping and Distribution

Regulations for shipping relate more to the volume and quality of the packaging as air transport is the means of distribution. This is also one of the reasons why production is not stimulated. Costs are usually high and alternatives appear to be in the direction of joint marketing of large quantities by sea transport. This implies the need for coordinated production with the attendant requirements of forecasting and quality specifications.

7. Processing

Processing is characterized by cottage-type industry. This implies a wide variation in quality of the processed product, packaging and labelling. In addition, the volumes processed are usually low. Although fresh produce is usually available, prices are not conductive to economic processing. Processing, like any other productive activity, should be market-led with reliable and reasonably low-cost inputs and materials.

The following crops are used and made into the products indicated:

Soursop	juice, ice-cream
Golden apple	juice, pickles
Tamarind	juice, jam, candies
Guava	juice, jam, jelly, ice-cream
Gooseberry	jam

8. Marketing

Appendix 1 indicates the volumes exported and those sold by the leading supermarket. Of the minor crops listed, soursop is by far the crop most traded followed by golden apple, plum, genip, tamarind and breadnut.

It can also be discerned that the local central market is the most important outlet with respect to volume followed by exports, supermarkets and hotels.

The main export markets are extra-regional namely UK, Canada, USA and the Netherlands while regionally Antigua, Barbados, St Maarten and Martinique are important destinations (Appendix 2).

Appendix 1, 2 and 3 follow

APPENDIX 1

Exports, Selected Local Marketing Outlets

CROP	EXPORTS (TONNES)							SELECTED LOCAL MARKETING OUTLETS							Local Central Market Est.	Local Market Total
	93	92	91	90	89	88	Ave.	93	92	91	90	89	88	Ave	(Tonn)	(Tonnes)
Soursop	67.5	44.9	44.7	40.3	52.8	67.4	52.9	7.1	3.9	4.7	4.5	3.7	3.6	4.6	5	9
Golden Apple	12.2	15.7	10.4	1. 6	3.1	2.3	7.6	12.9	6.9	2.7	7.9	7.1	2.4	6.7	6	11.1
Plums	2.3	1.4	4.3	0.4	5.0	2.5	2.7	0.4	2.6	—	—	—	.12	1.3	4	5.3
Genip	0.7	0.5	0.6	—	1.3	1.3	3	4.3								
Tamarind	0.9	0.3	0.9	—	2.2	—	1.1	0.1	1.2	0.7	2	3.2				
Guava	0.6	0.8	0.5	—	—	0.3	0.6	3	3.3							
Cashew	2	2														
Breadnut	2/4	—	1.7	0.2	0.9	0.5	1.1	0.2	0.1	0.2	0.1	—	—	0.1	3	2
Pomerac	0.2	0.1	2	2.1												
Sapodilla	—	—	—	0.1	—	0.1	0.1	0.04	.04							
Mamey Apple	0/1	—	1.7	0.2	0.3	—	0.6	2	2							
W.I. Cherry																
Gooseberry	0.1	0.1														
Sugar Apple	—	—	—	—	—	—	—	004	—	—	—	04	.5	.5		

APPENDIX 2

Exports of Fresh Agricultural Produce by Country (tonnes)

Country/Year	1990	1991	1992	1993
Anguilla	—	0.1	—	—
Antigua	179.8	209.3	214.0	394.2
Aruba	—	—	—	4.9
B'dos	150.2	99.7	76.9	190.5
Canada	126.	173.5	193.0	184.8
Martinique	16.8	—	0.8	0.4
Montserrat	10.4	—	—	—
Netherlands	22.0	11.6	40.9	29.8
Puerto Rico	107.3	—	—	—
St. Croix	—	—	—	5.0
St Marten	22.6	39.5	21.8	31.3
St Vincent	—	0.5	0.7	17.3
Tortulla	1.5	—	—	—
Trinidad	20.1	—	0.1	54.4
UK	1261.7	1591.4	1560.1	1299.7
U.S.A	283.2	204.0	185.0	248.6
Tolal	2202.2	2330.1	2293.3	2460.8

APPENDIX 3

Exports of selected minor fruit crops by country (tonnes) 1993

CROP	Soursop	Golden Apple	Plumbs	Breadnut	Total
Barbados	—	—	0.8	—	0.8
Netherlands	0.2	0.2	—	—	0.4
St Maarten	—	—	—	0.2	0.2
Canada	18.0	7.5	—	1.2	26.7
United Kingdom	10.3	4.1	—	1.0	15.4
United States	38.9	0.4	1.5	—	40.8
Total	67.4	12.2	2.3	2.4	84.3

ST VINCENT AND THE GRENADINES

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Abstract
Soursop, cashew, West Indian cherry, golden apple and other minor fruit crops are grown as scattered trees in a backyard farming system. Lack of sound recommendations for the production of these crops and proper planting material are the main factors limiting the expansion of these minor crops. Canada is the main market for soursop and golden apple with a demand of approximately 2,500 kg/week, for each. There are no established cultivars for these minor fruit crops which are generally propagated by seed in extensive systems.

Résumé
Corossol, anacarde, cerise des Antilles, prune de cythère et autres fruits mineurs sont cultivés à l'état dispersé dans les jardins familiaux. Le manque de recommandations sérieuses en ce qui concerne la production et le manque de plants de qualité sont les principaux facteurs limitant l'expansion de ces fruits. Le Canada constitue le marché principal pour le corossol et la prune de cythère avec une demande d'à peu près 2,500 kg par semaine pour chacun d'eux. Il n'y a aucun cultivar reconnu pour ces espèces mineures qui sont généralement propagées par graines dans des systèmes de culture extensifs.

Resumen
Guanábana, marañon, acerola, jobo de la India y otras frutas ménores son cultivadas en forma dispersa en un sistema de cultivo de traspatio. La falta de recomendaciones adecuadas para la producción de estas frutas y la escasez de material de siembra de calidad son los principales factores que limitan su expansión. Canadá es el mercado principal para guanábana y jobo de la India con una demanda de aproximadamente 2,500 kg por semana, para cada una. No hay ningún cultivar denominado; la propagación se hace generalmente por semillas.

1. Generalities

There are no organized projects for minor fruit crops currently being implemented in St Vincent and the Grenadines.

Soursop, cashew, West Indian cherry, golden apple and other minor fruit crops are grown as scattered trees in a backyard farming system. For this reason it is difficult to state the area planted and the value of production.

The main limiting factors affecting production are markets, lack of information and know-how on these crops and the lack of proper planting material.

The peak season for golden apple is September to December while soursop is an all-year-round crop with a peak in June to August.

The main market for soursop and golden apple is Canada.

The demand for soursop is 2000–2500 kg/week and for golden apple, 2000 kg/week.

2. Pre-production

There are no established cultivars for these minor fruit crops. Plants are propagated by seed.

A few seedlings are kept at the nurseries, mainly for backyard purposes. Nurseries sometimes get an unusual order to supply plants for about 2 ha but usually these are not honoured.

3. Production System

These minor crops are grown as scattered trees. The planting distances established by the ministry of agriculture are shown in Table 1.

Table 1: Planting distances for selected fruit-trees

Crop	Spacing	Density (trees/ha)
West Indian cherry	3 m × 3 m	1,110
Yellow plum	4.5 m × 4.5 m	494
Mauby	3.6 m × 3.6 m	772
Pomegranate	3 m × 3.6 m	926
Guava	6 m × 6 m	278
	3 m × 3 m	1,110
Sapodilla	5.4 m × 5.4 m	343
Clove	9 m × 9 m	123
Carambola	6 m × 6 m	278
Plumrose	3 m × 4.5 m	741
Golden apple	7. 5 m × 7. 5 m	178
Breadfruit	12 m × 12 m	69
Sugar apple	4.5 m × 4.5 m	494
Soursop	6 m × 6 m	278
Passion fruit	3 m × 3.6 m	926
Black pepper	2.4 m × 2.4 m	1,736

Due to the fact that these crops are grown as scattered trees there is no established husbandry practiced. Farmers fertilize according to their individual experience and capability. Fruits are usually bruised, affected with pests and diseases and small in size. Under these conditions the yield per tree fluctuates.

4. Harvesting

The exporters of these fruits regard harvesting as being similar to hunting. They simply look around the villages for any available fruits. Fruits are mainly picked by hand or using a long 'hook stick', sometimes with a bag attached to the end.

For soursop, fruits are twisted by hand then pulled. Colour change from green to a dull yellowish green is used as a maturity index for soursop. The main problems for soursop are the variation in size and the presence of ants.

Gumming causes problems for golden apple.

5 Post-harvest Handling for Soursop

Fruits are packed in plastic boxes in the field, then taken from the boxes and placed in a pick-up van. The main problem is sunburn and hence spoilage during shipping.

Fruits are packed into plastic boxes from the vehicle to a sorting counter or tank for washing. After sorting (and in some cases washing) they are packed in cardboard boxes. Less than 5% is rejected.

6. Shipping and Distribution for Soursop

A phytosanitary certificate is needed to export fruits. It costs EC$0.83/kg to ship soursop. Fruits are transported by air because it is difficult to ship them by sea.

7. Processing

No processing is done.

8. Marketing for Soursop

Canada is the main market. The demand is 2000–2500 kg/week. There is a very big potential for the export of soursop: fruits are sent to a distributor who distributes them to supermarkets.

Appendix 1.

Local Plum or Bequia Plum

(Purple mombin = *Spondias purpurea*, of the Anacardiaceae)

(Based on notes by Earle Wilkins and Raphael Rotem)

- Bequia plum is mainly grown in the Grenadines and Buccament.
- The Buccament area has the largest concentration of Bequia plum in the Region.
- A survey conducted in July 1993 by Mr Gideon Nash gathered the following information:
  - Number of farmers growing Bequia plums: 60
  - Number of plum trees: 170
  - Number of farmers with five for more trees: 7
  - Highest number of trees for a single farmer:15
- Marketing of fruit at the roadside: 10/12 fruits per bag are sold at EC$1.00; also sold in market in pails weighing 14 kg for EC$30 to $35.
- Demand locally is greater than supply.
- Trees grown on rocky soil seem to yield more and have sweeter fruit than those on more fertile soil.
- Onset of the rains seems to ripen fruit quickly and causes spoilage.
- Some of the trees are over 40 years old.
- Fruits are ready for harvesting in April; period of harvest is 3 months until end of June with a peak in the middle of May.
- Yield from a mature tree is about 200–225 kg.
- Propagation is by vegetative means.
- All farmers were satisfied with the trees they had as they had no problems selling the fruit and the only work involved was picking and selling.
- The leeward, drier part of the island, seems more suitable for this local plum.

TRINIDAD AND TOBAGO

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Abstract
Trinidad and Tobago is home to a wide variety of fruit crops which include rare exotics such as rambutan, mabolo and biriba introduced from other tropical regions. Very few of these are cultivated in organized systems or subjected to specific agronomic practices like land preparation, fertilizing spacing, weed control, pest and disease control. These minor tree crops are almost exclusively produced in backyard situations or as scattered trees on farmers' holdings. A degree of commercial production of cashew and guava takes place. For this latter, 'Centeno Prolific' (acid, pink) is the variety of choice aimed at the processing market. The paper gives a detailed list of all the minor fruit crops grown in Trinidad with a brief description of the various production systems, major problems encountered with production and marketing data.

Résumé
Trinité et Tobago est un pays hôte pour une large gamme de fruits y compris des exotiques rares tels que rambutan, mabolo et biriba introduits d'autres régions tropicales. Très peu d'entre eux sont cultivés en systèmes organisés ou soumis à des pratiques agronomiques spécifiques tels que préparation du sol, traitements phytosanitaires, contrôle des mauvaises herbes, des maladies et parasites. Ces espèces mineures sont presque exclusivement produites dans un contexte de jardin familial ou bien dispersées sur les exploitations. Un certain degré de production commerciale existe en ce qui concerne l'anacarde et la goyave; pour cette dernière 'Centeno prolifique' (rose acide) est la variété de choix pour la transformation. L'exposé donne une liste détaillée de toutes les espèces mineures cultivées à Trinité, avec une brève description des divers systèmes de production, des problèmes majeurs rencontrés ainsi que des statistiques de production et de commerce.

Resumen
Trinidad y Tobago es el hogar para una variedad amplia de frutas que incluyen algunas exóticas tales como el rambután, el maboló y la biribá introducidos de otras regiones tropicales. Pocas de éstas se cultivan en sistema organizado o sujetas a prácticas agronómicas específicas como preparación de la tierra, aplicación de agroquímicos, control de malezas, control de plagas y enfermedades. La producción se da casi exclusivamente en situaciones de traspatio o proviene de árboles dispersos en fincas. Un cierto grado de producción comercial de marañon y guayaba ocurre; 'Centeno prolific' (guayaba ácida rosada) es la variedad preferida para procesamiento. El artículo da en detalle la lista de frutas ménores que crecen en Trinidad con una descripción breve de los sistemas de producción, los problemas mayores que se encuentran en la producción y la comercialización.

Background

Trinidad and Tobago is home to a wide variety of fruit crops. This diversity is further augmented by rare exotics such as rambutan, jaboticaba, marbolo and biriba introduced from other tropical regions. Very few of these are cultivated in any organized system or subjected to specific agronomic practices like land preparation, spacing, weed control, pest and disease control. In fact, minor tree crop production is almost exclusively done at the backyard level or represented by scattered trees on farmers' holdings. Cashew and guava however enjoy some degree of commercial production.

1. Generalities

1.1 Programmes on Minor Fruits

Trinidad and Tobago's Ministry of Agriculture, Land and Marine Resources has two programmes on minor fruits. One is conducted at the Research Division, Central Experiment Station, Centeno, and the other at the Forestry Division, Northern Range Re-afforestation Programme, St Michael Estate.

1.1.1 Central Experiment Station

This station represents the ministry of agriculture's main thrust in fruit development. Plots have been established for research and commercial fruit production of the following fruits:

Caimite (*Chrysophyllum cainito*)
Carambola (*Averrhoa carambola*)
Guava (*Psidium guajava*)
Mamey apple (*Mammea americana*)
Pomerac (*Eugenia malaccensis*)
Pomme cythere (*Spondias cytherea*)
Sapodilla (*Manilkara achras*)
Tamarind (*Tamarindus indica*)

Java plum (*Eugenia cumini*) is used extensively as a wind-break at the research station and can also be found growing in the wild. In addition, the following types are established in plots of one to five trees for germplasm preservation and evaluation:

Abiu (*Pouteria caimito*)
Akee (*Blighia sapida*)
Bael (*Aegle marmelos*)
Balata (*Manilkara bidentata*)
Bilimbi (*Averrhoa bilimbi*)

Biriba (*Rollinia deliciosa*)
Camu-camu (*Myrciaria dubia*)
Canistel (*Pouteria campechiana*)
Cashew (*Anacardium occidentale*)
Chenette (*Melicocca bijugata*)
Chilli plum (*Spondias purpurea* var. *lutea*)
Chinese tamarind (*Vangueria edulis*)
Custard apple (*Annona reticulata*)
Dates (*Phoenix dactylifera*)
Dunks (*Zizyphus mauritiana*)
Fat pork (*Chrysobalanus icaco*)
Governor plum (*Flacourtia indica*)
Jaboticaba (*Myrciaria cauliflora*)
Jackfruit (*Artocarpus heterophyllus*)
Lychee (*Litchi chinensis*)
Mamey sapote (*Calocarpum sapota*)
Mangosteen (*Garcinia mangostana*)
Marbolo (*Diospyros blancoi*)
Miracle fruit (*Synsepalum dulcificum*)
Peewah (*Guilielma speciosa*)
Penny piece (*Pouteria multiflora*)
Pois doux (*Inga laurina*)
Pitomba (*Eugenia luschrathiana*)
Pommegranate (*Punica granatum*)
Pomme rose (*Eugenia jambos*)
Rambutan (*Nephelium lappaceum*)
Sapucacia nut (*Lecythis ollaria*)
Sour cherry (*Phyllanthus acidus*)
Soursop (*Annona muricata*)
Tamarind (*Tamarindus indica*)
West Indian cherry (*Malpighia glabra*)

1.1.2 Northern Range Re-afforestation Project (St Michael Estate)

This programme was initiated to address the problem of soil erosion on slopes of the Northern Range brought about by de-afforestation. Apart from the establishment of major fruit types (citrus, mango, avocado) the following minor fruits were planted and maintained:

akee, bael, bilimbi, caimite, carambola, cashew, chenette, chilli plum, chinese tamarind, custard apple, dunks, fat pork, governor plum, guava, jaboticaba, jackfruit, java plum, mamey apple, penny piece, peewah, pois doux, pomerac, pomme cythere, pommegranate, pomme rose, sapodilla, sapucacia nut, sour cherry, soursop, tamarind, West Indian cherry.

1.1.3 Caroni (1975) Ltd

The diversification programme of Caroni (1975) Ltd saw the introduction of commercial plots of non-traditional fruits. Approximately 62 ha of cashew were established at Todds Road in central Trinidad. Approximately 0.5 ha of carambola was established at the La Gloria Estate in south Trinidad.

1.1.4 La Vega Estate, Gran Couva

This fruit orchard represents a large collection of superior fruit types. It is owned by Bert Manhin, a private grower and entrepeneur. He has collected, propagated, and established a wide collection of exotic/rare fruit types particularly from the Far East. His collection comprises the following:

Abiu (*Pouteria caimito*)
Bilimbi (*Averrhoa bilimbi*)
Biriba (*Rollinia deliciosa*)
Black sapote (*Diospyros digyna*)
Camu camu (*Myrciaria paraensis*)
Caimite (*Chrysophyllum cainito*)
Carambola (*Averrhoa carambola*)
Cashew (*Anacardium occidentale*)
Cherry of the Rio Grande (*Eugenia aggregata*)
Custard apple (*Annona squamosa*)
Duku (*Lansium domesticum*)
Egg fruit (*Pouteria campechiana*)
Figi longan (*Pometra pinnata*)
Gandaria (*Bouea macrophylla*)
Governor plum (*Flacourtia indica*)
Grumichama (*Eugenia brasiliensis*)
Guyana chestnut (*Pachira aquatica*)
Ilama (*Annona diversifolia*)
Jaboticaba (*Myrciaria cauliflora*)
Longan (*Euphoria longan*)
Loquat (*Eriobotrya japonica*)
Lychee (*Litchi chinensis*)
Mamey sapote (*Calocarpum sapota*)
Mangosteen (*Garcinia mangostana*)
Miracle fruit (*Synsepalum dulcificum*)
Monstera (*Monstera deliciosa*)
Mountain soursop (*Annona montana*)
Penny piece (*Pouteria multiflora*)
Peewah (*Guilielma speciosa*)
Pulasan (*Nephelium mutabile*)
Pois doux (*Inga laurina*)
Pomme cythere (dwarf) (*Spondias cytherea*)
Rambai (*Baccaurea motleyana*)
Rambutan (*Nephelium lappaceum*)
Santol (*Salacca edulis*)
Sapodilla (*Manilkara achras*)
Sour cherry (*Phyllantus acidus*)
Soursop (*Annona muricata*)
Sugar apple (dwarf) (*Annona squamosa*)
South American sapote (*Quararibea cordata*)
Wampi (*Clausena lansium*)
White sapote (*Cassimiroa edulis*)

1.1.5 Small Farmers

Of the minor fruits, only cashew and guava are grown in commercial quantities by small farmers. There are about 10 farmers who grow about 19 ha of cashew and seven farmers who grow about 7 ha guava. There are also approximately 32 mature bearing trees of mangosteen grown in backyards and small estates in north-east Trinidad.

1.1.6 Uncultivated Fruits

Some minor fruits grow wild in Trinidad. These are

often collected by hunters for their families and some harvested for commercial use. The more nficant among these are balata (*M. bidentata*), ıny piece (*P. multiflora*), cocorite (*Maximiliana ıaea*) and gri-gri (*Martinezia caryotaefolia*).

1.2 Major Problems

Generally, ecological problems all have their genesis in the high rainfall, high humidity climatic conditions. Consequently, major crop protection problems do arise whenever attempts are made to grow these crops in pure stands for commercial production. Backyard plantings often escape these crop protection problems or show low incidences.

The following are the problems:

Guava	—	fruit fly infestation (*Anastrepha* spp.)
Sapodilla	—	fruit fly infestation
Annonas	—	attack by a moth (*Cerconata annovella*) and the wasp, *Bephrata maculicollis*.
Cashew	—	high incidence of anthracnose.
Pomme cythere	—	Gumming on fruit and stem induced by unknown factors.
Caimite	—	Fruit fly infestation
Pomerac	—	Fruit fly infestation
Jamaica plum	—	Fruit fly infestation
Pois doux	—	Fruit fly infestation

1.3 Area Planted

Commercial production of these fruit types is limited to cashew and guava. As alluded to in the introduction, the other types are basically grown in backyards or scattered plantings on private estates, or are found in the wild. The areas under production are as follows:

Central Experiment Station:

Guava	—	0.2 ha
Mamey apple	—	0.4 ha
Pomerac	—	2.4 ha
Tamarind	—	0.5 ha
Pomme cythere	—	0.08 ha
Caimite	—	0.1 ha
Sapodilla	—	1.0 ha
Carambola	—	0.1 ha

There are 1–5 trees of the other minor fruits listed under 1.1.1.

Northern Range Re-afforestation Project:

Pomerac	—	1.2 ha
Soursop	—	0.1 ha
Caimite	—	2.8 ha
Pomme rose	—	0.4 ha
Sour cherry	—	0.4 ha
Cashew	—	1 ha
Sapodilla	—	1 ha
W.I. cherry	—	0.3 ha

Caroni (1975) Ltd:

Cashew	—	62.5 ha (3–5 yr old trees)
Carambola	—	0.5 ha

La Vega Estate:

Rambutan	—	0.4 ha

All other types are established in plots of 1–10 trees.

Small farmers:

Cashew	—	19 ha
Guava	—	7 ha

1.4 Factors Limiting Expansion

Annonas	difficult and uneconomic control of of the moth, *C. annovella*, and wasp, *B. maculicollis*.
Pomerac	fruit fly infestation; uncontrolled fruitfall upon ripening; high perishability.
Pomme cythere	gumming of trunk and main branches, associated with high incidence of early die back followed by death.
Mangosteen	long gestation period
Caimite	fruit fly infestation
Guava	marketing
Cashew	marketing
Mamey apple	tree size
Sapodilla	fruit fly infestation

Public awareness of the more exotic types such as rambutan, jaboticaba and jackfruit, is not actively pursued and they are generally unknown among the general population. Consequently, a high demand for these fruits has not been achieved.

1.5 Cost of Production and Returns

Cost of production and return figures are not available.

1.6 Seasonality

The following are the main seasons for the minor crops in Trinidad and Tobago.

Crop	Production season
Guava	March–April September–October
Sapodill	February–May
Mamey apple	March–April
Pomerac	March–April; June–July; October–November
Tamarind	November–February
Pomme cythere	September–November
Dwarf pomme-cythere	Year-round
Caimite	March–April
Cashew	April–May
Chenette	August–September
Annonas	January–April

Crop	Production season
Pois doux	Year-round (but with periods of higher production)
West Indian cherry	Year-round (but with periods of higher production)
Dunks	November–March
Chilli plum	August–September
Mangosteen	August–October
Jamaica plum	March–April
Governor plum	September–October
Balata	February–April
Rambutan	September–October

1.7 Main Markets

Main markets and trade figures for minor food crops in 1991/1992 are presented in Tables 1–4.

2. Pre-production

2.1 Cultivar Selection

2.1.1 Guava

Commercial production of Guava is aimed at the processing market. Centeno Prolific (acid,pink) is the variety of choice. Approximately 7 ha are grown locally all of which is sold to a local fruit processing company (National Canners Ltd). There are no commercial plantings of table guavas.Table types occur in backyards and at the ministry of agriculture

Table 1: Imports of minor fruits into Trinidad and Tobago (1991)

Crop	Exporting country	Imported quantity (kg)	Value (TT$)
Cashew nut	Holland	4,536	138,476
	India	43,417	1,320,156
	USA	133	3,602
		53,036	1,462,234
Guava	Grenada	100	100
Pomme cythere	Grenada	29,620	32,562
	St Vincent	91,605	103,704
		121,225	136,266
Sapodilla	Grenada	51,710	57,114
	St Vincent	900	990
		52,610	58,104
Soursop	Grenada	167,370	184,560
Miscellaneous minor fresh fruits	Grenada	123,942	136,311
	St Vincent	165	202
	USA	10	290
		124,117	136,303

Source: Central Statistical Office, Port of Spain, Trinidad.

Table 2: Imports of minor fruits into Trinidad and Tobago (1992)

Crop	Exporting country	Imported quantity (kg)	Value (TT$)
Sapodilla	Grenada	26,650	29,315
Pomme cythere	Grenada	31610	39,308
	St Vincent	104,336	122,089
		135,946	161,397
Soursop	Grenada	74,386	81,865
	St Vincent	91	100
		74,477	81,965
Cashew	Canada	122	3,069
	India	47,054	1,189,635
	USA	35,040	975,803
		82,216	2,168,507
Other fresh fruits	Guyana	5,000	6,394
	Grenada	87,102	96,492
	St Vincent	10,514	11,562
	Hong Kong	400	322
	USA	2,705	24,412
		105,721	139,182

Source: Central Statistical Office, Port of Spain, Trinidad.

Table 3: Exports of minor fruits from Trinidad and Tobago (1991)

Crop	Importing country	Exported quantity (kg)	Value (TT$)
Cashew nut	Dominica	38	2,554
	Grenada	50	3,020
	St Lucia	240	14,980
	Barbados	3,605	209,891
	Jamaica	1,066	64,627
		5,00 1	295,072
Sapodilla	U K	7	37
	Canada	450	270
		457	307
Pomme cythere	U K	260	450
	Canada	678	1,449
	USA	1 364	3,158
		2,302	5,057
Soursop	U K	7	37
	Canada	41	120
	USA	114	200
		162	357
Other fresh fruits	UK	3,755	13,637
	Canada	4,859	5,781
	USA	6,529	17,657
		15,143	38,075

Source: Central Statistical Office, Port of Spain, Trinidad.

Table 4: Exports of minor from Trinidad and Tobago (1992)

Crop	Importing country	Exported quantity (kg)	Value (TT$)
Cashew	Barbados	309	18,892
Guava	Canada	37	221
Sapodilla	Canada	1,652	5,075
	Holland	424	1,838
		2,075	6,913
Pomme cythere	U K	1,475	1,475
	Canada	13,403	27,192
	Holland	720	2,637
		15,598	31,304
Soursop	Canada	4,178	11,467
	USA	96	80
	Holland	68	136
		4,342	11,683
Other fresh fruit	UK	6,681	18,533
	Canada	85,510	130,485
	U S A	43,366	65,361
	Holland	1,608	7,240
		137,165	221,619

Source: Central Statistical Office, Port of Spain, Trinidad.

research division's field plots. The characteristics of the table types selected, propagated and held in field plots at the Central Experiment Station (CES) are presented in Table 5.

2.1.2 Sapodilla

No pure stand commercial plots are available. The types in Table 6 were selected locally and identified as having good characteristics. Small plots of these are established at CES, Centeno. The characteristics of these selections are presented in Table 6.

2.1.3 Cashew

Selections grown at Caroni (1975) Ltd were carefully selected from parent plants at UWI field station, CES and Smith's collection, Mausica. Plants were propagated by seed, air-layering and grafting. Private farmers use seed from unspecified parents.

2.1.4 Caimite

A wide range of caimite types occur locally varying in colour, size, texture, taste, shape and latex content. From a premliminary evaluation exercise conducted in 1992 two local selections have been made, vegetatively propagated, and established in field plots at CES. Their characteristics are presented in Table 7.

2.1.5 Pomerac

The varieties grown in Trinidad and Tobago are:
Rookmin:

Average weight	—	93.4 g
Average length	—	8.14 cm
Colour	—	dark red

La Pastora Special:

Light red with white streaks and soft flesh texture.

Un-named type(s) bearing small dark red fruits.

2.2 Plant Demand and Supply

The availability of planting material of these minor fruits has generally outstripped the demand. Figures in Table 8 reflect the sales pattern over a 2-year period at the St Augustine Nurseries, which is the major propagator of minor fruit plants.

Table 5: Characteristics of guava (table types) grown in museum plots at the Central Experiment Station, Centeno, Trinidad

Variety	Shape	Skin color	Flesh colour	Average weight (g)	°Brix
Perseverance	Round	Yellow	White	117.1	8.3
CES 12	Round	Yellowish-green	White	74.5	10.0
St Vincent	Round	Yellow	Cream	92.61	12.0
Francis Cedros	Round	Yellow	Greenish-white	95.1	8.0
Kim Bala	Elongate	Green	White	225.6	—
Tai Vah	Pear	Green	White	267.9	—
Rooks	Oval	Yellow	Pink	151.2	11.0
Job Selection	Oval	Greenish yellow	White	186.0	7.5
Karl Selection	Round	Green	White	601.0	11.0
Mt Hope Selection	Round	Yellow	While	54.5	9.4
Chaguaramas	Oval	Yellow	Pink	164	8.0
Ahow	Oval	Yellow	White	158.5	9.4
Aranguez Selection	Oval	Green	White	449.0	8.6

Table 6: Characteristics of sapodilla types grown in museum plots at the Central Experiment Station, Centeno, Trinidad

Variety	Average weight (g)	Shape	Flesh colour	Flesh texture	Flavour	°Brix	Seed No./fruit
De Meillac	100	Engolated	Cream	Smooth	Very sweet	23	1–2
Jones	70	Engolated	Brown	Smooth	Sweet	—	2–4
Basil Clarke	98	Oval	Brown-cream	Smooth	Sweet	17.5	3–4
Williams	140	Oval	Brown-cream	Slighty gritty	Sweet	—	4–5
Celestine	141	Oval	Cream	Smooth	Sweet	24	0–2
Bayo	87	Elongated	Cream	Smooth	Very Sweet	21.5	1–2
Bazilon I	161	Round	Cream	Smooth	Sweet	20.1	2–3
Bazilon II	182	Tapered	Cream	Smooth	Sweet	16.8	1–2
Early Prolific	85	Round	Cream	Smooth	Sweet	18.5	—
Maraj	190	Elongated	Greenish-brown	Smooth	Very Sweet	24	1–2
Mustapha	135	Elongated	Cream	Smooth	Very Sweet	22	0–2

Table 7: Characteristics of two selections of caimite selected from local plants

Variety	Colour	Shape	Avg. weight (g)	Brix	Flavour
Estwick	Purple	Round	111	19	Excellent
Edwards	Green	Round	270	18	Excellent

3. Production Systems

3.1 Planting Methods and Distances

Planting distances used at CES for some of the minor fruits are as follows:

Crop	Spacing	Remarks
Soursop	5 m × 5 m	
Cashew	6 m × 6 m	Also used by Caroni
Pomme cythere	6 m × 6 m	
Guava	6 m × 6 m	Regular spacing
Pomerac	6 m × 8 m	
Mamey apple	8 m × 5 m	
Tamarind	8 m × 6 m	

A spacing of 6 m × 6 m is the general recommendation for tree crops.

3.2 Crop Husbandry

3.2.1 Fertilization

Generally fertilizer application is not part of the general crop husbandry practices in minor fruit crops. However, at the El Carmen Station, CES, Centeno, 11-11-11 and 12-12-17+2 are used in a commercial plot of mature trees at the rate of 1 kg/tree per year in a single application.

3.2.2 Weed Control

Weed control is traditionally a manual operation using an extended cutlass. On projects at CES, Caroni Ltd, and La Vega Estate mechanical and chemical control measures are also employed.

Table 8: Minor fruit plant sales for 1992/1993 from the St Augustine Nurseries

Crop	Plants sold in 1992	Plants sold in 1993	Total
Mamey apple	31	6	37
Caimite	100	16	116
W.I. cherry	768	305	1073
Cashew	441	35	476
Balata	340	70	410
Sapodilla	1947	431	2378
Guava	350	233	583
Golden apple	990	343	1333
Jamaican plum	430	31	461
Pomegranate	332	25	357
Pomerac	1149	536	1685
Soursop	852	168	1020
Sugar apple	385	81	466
Tamarind	64	142	206
Governor plum	329	25	354
Pois doux	92	121	213
Dunks	69	30	99
Chinese tamarind	129	82	211
Chenette	68	46	114
Pomme rose	158	60	218
Custard apple	29	39	68
Fat pork	107	48	115
Bilimbi	67	19	86
Sour cherry	603	119	722
Rambutan	—	5	5
	9830	3016	12846

3.2.3 Irrigation

Irrigation is generally not practised, except in some cases at the level of hand-watering of recently planted plants.

3.2.4 Spray Programme

At the crop research division, Centeno, a spray programme includes the control of fruit fly in guava and sapodilla. It includes the use of Malathion and Actellic in alternate sprays.

3.2.5 Pruning

This cultural practice is generally not done except for tree size control in some cases, and also for the removal of dead and diseased branches.

3.2.6 Bagging

Experimental bagging of soursop was carried out on a commercial plot established in 1977 at CES, Centeno. Fruits were bagged using a 1 mm mesh bag which was supported by a 5 mm galvanized mesh wire frame. Bags were anchored and supported firmly by tying them onto branches above the fruit. Bagging controlled the problem of wasp and moth damage. However, bagging is not done by either farmers or householders as a routine practice.

3.3 Yields

An estimated yield per tree for mature trees is available for the following fruit-trees:

Soursop	21–32 fruits
Pomme cythere	2000–3000 fruits
Sapodilla	1000–1500 fruits
Mamey apple	50–75 fruits
Guava (table)	40 kg
Pomerac	150 kg
West Indian cherry	8–15 kg
Mangosteen	3000–4000 fruits

4. Harvesting

4.1 Methods

No special harvesting techniques are employed. Where fruits cannot be reached and harvested from ground level, they are reached by climbing. Some fruits are shaken off the trees. In some cases small fruits such as chenette and balata are harvested by removing small branches that carry fruits. These branches are tied and lowered to the ground where the fruits are removed either individually or in bunches. Large fruits on tall trees (eg. mamey apple) are harvested individually by plucking them off the tree using a long rod and catching them at ground level either by hand or with the aid of a sack.

Extra-large fruits (e.g. jackfruit) are also harvested individually using a rope to gently lower them to the ground

4.2 Tools

A fruit picker is used from time to time in the harvesting of sapodilla and other larger fruit types. Some farmers fashion their own picking rod made with an extended bamboo rod and sack.

4.3 Maturity Indices

Colour change is the main technique employed to determine maturity and ripeness. In sapodilla, where maturity is not indicated by colour change, a technique is used where the suspected mature fruit is scratched with the finger nail. A yellow to orange colour beneath the outer surface may indicate maturity. Natural fruit-fall is also a good indicator.

4.4 Main Problems

Guava (processing) and pomerac show a high level of vulnerability to fruit-fall due to attack by birds, high winds, and a high abscission level. These two fruits and West Indian cherry also show a high level of perishability. Observations on pomerac grown at the research division's field plots at Centeno show that, as a consequence, over 39% of pomerac harvested became unmarketable within 1 day. Large fruits, coupled with large tree size, constrain the harvesting of fruits such as mamey apple and jackfruit. On the other hand, large tree size with small fruits (such as chenette and balata) also present problems with harvesting.

5. Post-harvest Handling

No special post-harvest handling of minor fruit is currently practised in Trinidad and Tobago.

6. Shipping and Distribution

Not applicable.

7. Processing

Cashew nuts are processed only at the cottage industry level and guava by a medium-sized plant (National Canners Ltd). Processors are unwilling to divulge information on brands, volumes and main problems.

8. Marketing

The fresh fruit market is essentially local. Fruits are exhibited for sale at fruit stalls along the main streets of cities, towns, and shopping malls. Supplies are always deficient, which is a good indicator of the market potential.

These indigenous fruit types, because of the limited supply, invariably fetch a fair price.

SECTION 3 - INSTITUTE PAPERS

WHAT CARDI IS DOING IN SUPPORT OF MINOR FRUIT PRODUCTION IN GRENADA

CLAUDE BROWNE
CARDI, GRENADA

Abstract
Activities of the Caribbean Agricultural Research and Development Institute (CARDI) relating to minor fruit crops are limited to soursop (*Annona muricata*) and sapodilla (*Manilkara zapota*). Work on soursop is related to the development of a production/marketing system and agronomic studies. Activities with sapodilla are geared towards a production/marketing system for commercialization which includes the characterization of fruit types on the island; this has already resulted in the selection of the cultivar 'Kathleen' which is now being multiplied. Future work will focus on the characterization of minor fruits of importance to Grenada such as star apple (*Chrysophyllum cainito*), ginep (*Melicocca bijugata*), golden apple (*Spondias cytherea*) and guava (*Psidium guajava*).

Résumé
Les activités de l'Institut caribéen de recherche et développement agronomique (CARDI) relatives aux fruits mineurs sont limitées au corossol (*Annona muricata*) et à la sapodille (*Manilkara zapota*). Le travail sur corossol concerne des études agronomiques et le développement d'un système de production/ commercialisation; 'Burris' est le principal cultivar. Quant à la sapodille, ce même souci de développement d'un système de production/commercialisation inclut la caractérisation des types de fruits présents sur l'île; ceci a déjà permis la sélection du cultivar 'Kathleen' lequel est maintenant multiplié. Le travail futur portera sur la caractérisation d'autres fruits mineurs d'importance économique pour Grenade: la caïmite (*Chrysophyllum cainito*), la chenette (*Melicocca bijugata*), la prune de cythère (*Spondias cytherea*) et la goyave (*Psidium guajava*).

Resumen
Las actividades del Instituto caribeño de investigación y desarrollo agrícola (CARDI) en relación con frutas ménores en Grenada se limitan a la guanábana (*Annona muricata*) y el níspero (*Manilkara zapota*). El trabajo en guanábana consiste en desarrollar un sistema de producción/mercadeo y en estudios agronómicos. El trabajo con níspero se enfoca también hacia el desarrollo de un sistema de producción/mercadeo que incluye la caracterización de tipos de la fruta en la isla; este resultó en la selección del cultivar 'Kathleen' que se multiplica ahora. Futuros trabajos enfocarán la caracterización de frutas ménores de importancia para Grenada tales como el caimito (*Chrysophyllum cainito*), el mamón (*Melicocca bijugata*), el jobo de la India (*Spondias cytherea*) y la guayaba (*Psidium guajava*).

1. Soursop *(Annona muricata)*

Since 1990 CARDI included work on soursop in its Grenada workplan. The 1990/91 workplan had an activity entitled 'Development of a production/ marketing system for soursop' and the 1991-1994 workplan had an activity entitled 'Agronomic studies on soursop'.

Work on the first activity involved the study of the current marketing arrangements, case studies being done on the Marketing and National Importing Board (MNIB) and the Productive Farmers Union (PFU).

This activity not only highlighted marketing deficiencies and possible methods of combating them but at the end of it there was an indication of different peak production times of fruit throughout the island.

The second activity, agronomic studies, had severa facets, the main one being a fertilizer trial. However, other parameters such as flowering, fruit set and time from flowering to maturity, were also looked at. All of this work was done at the CARDI field station where a plot of the cultivar 'Burris' was established.

2. Sapodilla (*Manilkara zapota*)

The 1990/1991 workplan had an activity entitled 'Development of a production/marketing system for commercialization of sapodilla'. In setting out to do this it was realized that sapodilla was mainly traded by the hucksters and that there were no fixed standards with regard to the quality being exported. Therefore it was decided that a more meaningful exercise would be to do some characterization of fruit and seek to identify germplasm of superior types.

The activity then took the form of a contest where farmers were asked to bring in fruit from their trees for characterization. Traits looked at included: fruit weight, pulp/seed ratio, brix, number of seeds, uniformity of ripening (within the fruit), texture of pulp, colour of pulp and gumminess of pulp. When the analysis of fruit with desirable characteristics was completed, CARDI and the ministry of agriculture jointly visited farms to observe the plants from which these fruits were obtained. This resulted in the

selection of a cultivar 'Kathleen' which is now being propagated by the Mirabeau Nursery.

3. Future Work

In the upcoming work programmes, CARDI will emphasize characterization of varieties of the minor fruits of importance to Grenada. In addition to the two currently being worked on, work will be done on star apple (*Chrysophyllum cainito*), ginep (*Melicocca bijugata*), golden apple (*Spondias cytherea*) and guava (*Psidium guajava*).

At the end of this exercise named varieties will be propagated for commercialization.

CARIRI'S ACTIVITIES IN FRUIT PROCESSING

JUDITH ANN FRANCIS

Abstract
The Caribbean Industrial Research Institute (CARIRI) is an autonomous institution run by a board of management. Its involvement in fruit processing can be divided into research and development, training and consultancy services to agroprocessors, analytical services (chemical and microbial) and machinery development/adaptation. Research and development has included various products: a tea from sorrel, cordials from sorrel, passion fruit and guava juice, jams and jellies from sorrel. Work on mango included: characterization of major mango varieties (green and ripe) including beta-carotene content of 'Julie' and 'Graham' mangoes; a storage method for bulk storing green and ripe mango fruits under ambient storage conditions to extend the processing life; improved processing technologies for traditional mango products; developing new mango products such as mango cheese and rainbow mango; and the production of a dry white wine, among others. Regular surveys of the fruit processing industry of the Caribbean are conducted. An ongoing training programme is aimed at improving the food processing skills of small to medium-scale entrepreneurs. CARIRI conducts routine chemical and microbial analyses and can perform specific nutrient analyses as required. CARIRI's engineering section continues to support the fruit processing industry in the region through the provision of machinery suited to the scale of operation usually practised in the Caribbean.

Résumé
L'institut caribéen de recherche industrielle (CARIRI) est une institution autonome dirigée par un conseil d'administration; son activité en transformation de fruits peut être divisée en: recherche et développement, formation et service d'expertise pour l'agro-transformation, services d'analyses (chimiques et microbiennes) et développement/adaptation de matériels. La recherche et le développement incluent divers produits: infusion et liqueur d'oseille de Guinée (*Hibiscus subdariffa*), liqueurs de fruit de la passion et goyave, confitures et gelées d'oseille de Guinée. Le travail sur mangues comporte la caractérisation des variétés les plus importantes (vertes et mûres) avec en particulier le contenu en béta-carotène de 'Julie' et 'Graham', les méthodes de conservation à température ambiante des fruits verts et mûrs, l'amélioration des technologies de transformation pour des produits traditionnels, le développement de nouveaux produits tels que les barres de mangue et la mangue "arc-en-ciel" ainsi que la production d'un vin blanc sec. Des enquêtes régulières sur la situation des industries fruitières de la Caraïbe sont entreprises. Un programme permanent de formation est en place qui vise à améliorer les capacités des petits et moyens entrepreneurs. LE CARIRI conduit des analyses microbiennes et chimiques routinières et peut effectuer des analyses nutritionnelles spécifiques sur demande. Le département d'ingéniérie du CARIRI continue à soutenir l'industrie de transformation des fruits dans la région en mettant à sa disposition des équipements adaptés à l'échelle des opérations pratiquées habituellement dans la Caraïbe.

Resumen
El instituto caribeño de investigación industrial (CARIRI) es una institución autónoma dirigida por un Consejo de Administración; su envolvimiento en procesamiento de frutas se puede dividir entre investigación y desarrollo, capacitación y servicios de consultoría para agro-procesadores, servicios de analísis (químico y microbial) y desarrollo/adaptación de maquinaria. Investigación y desarrollo incluyen varios productos: un té de alazán (Hibiscus subdariffa), cordiales de alazán, jugos de passiflora y guayaba, jaleas y mermeladas de alazán. Trabajos en mangos consisten en la caracterización de las principales variedades (verdes y maduras) incluyendo el contenido en beta-caroteno de las variedades 'Julie' y 'Graham', estudios de los métodos de almacenamiento a temperatura ambiente de mangos verdes y maduros para aumentar su duración de vida en vista al procesamiento, mejoramiento de las tecnologías de procesamiento para productos, desarrollo de productos nuevos tales como dulces de mango y el mango "arco-iris", y la producción de un vino seco blanco entre otros. El CARIRI conduce regularmente estudios de las industrias de procesamiento de frutas en el Caribe. Un programa continúo de capacitación apunta a mejorar las habilidades de los pequeños y medianos empresarios. El CARIRI conduce análises químicos y microbiales rutinarios y puede hacer análises de nutrientes si se requiere. La sección de ingeniería continúa apoyando a la industria de procesamiento de frutas en la región gracias a la provisión de maquinaria adaptada a la escala de las actividades en el Caribe.

1. CARIRI's Activities in Fruit Processing

The Caribbean Industrial Research Institute (CARIRI) was established by the Government of Trinidad and Tobago in 1970 and became a legal entity by an Act of Parliament of April 1971. It is an autonomous institution run by a board of management, comprising representatives of the private sector, the University of the West Indies and the Government of Trinidad and Tobago. The day-to-day operations of the organization are handled by a chief executive officer with the support of a management team.

The professional capacity of the Institute is organized into discipline-oriented divisions:

- Food and biotechnology
- Engineering
- Chemical and petroleum analytical services
- Industrial materials
- Technical information services
- Business development unit
- Computer and support services

These are supported by laboratory and pilot plan facilities, machine shop, a well-stocked documentation centre and supporting technical and administrative staff.

CARIRI's involvement in fruit processing can be divided into the following categories:

- Research and development
- Training and consultancy services to agro-processors
- Analytical (chemical and microbial)
- Machinery development adaptation

2. Research and Development

Within the last 5 years projects handled in these areas included:

Sorrel:

- Development of a sorrel tea product for a small entrepreneur.
- Standardization of colour of sorrel cordial beverage for a medium-scale processor to improve the shelf-life of the product.
- Development of jams and jellies using sorrel fruit.

CARIRI had also been instrumental in the establishment of the sorrel concentrate factory which was subsequently closed but has now re-opened under new management. Consultancy services are being provided to the cooperative which is now running the plant.

Passion fruit:

- Establishment of a multi-fruit processing facility based on commercialization of a successful passion fruit cordial product. This was later sold to a client who now produces a range of fruit pulps for the local market and a range of fruit-based beverages for the local and export markets.

Guava:

- Experimental trials on clarification of guava juice at laboratory and pilot plant level for use in the manufacture of sweets for local and export markets. The client was pleased with the results.

Mango:

- Characterrization of mango varieties (green and ripe) including beta-carotene content of 'Julie' and 'Graham' mangoes.
- Development of storage methods for bulk-storing green and ripe mango fruit under ambient storage conditions to extend the processing life.
- Improving processing technologies for traditional products (red mango, amchars, kuchelas).
- Development of new products for local and export markets; 'rainbow' mango and mango 'cheese' (which is sold as is and chocolate coated).
- Through collaboration with CIRAD-FHLOR work was conducted on the enzymatic treatment of mango pulp to improve juice yield prior to researching production of a mango concentrate.
- CARIRI is also collaborating with IICA in researching the production of a dry white wine using a popular local mango variety and a commercial wine yeast. This has been made possible through the French government sponsorship of a training attachment of a French student from ENSAM.

Pomerac, Pineapple, Papaya, Bilimbi, Carambola, Cherries and Sapodilla:

- CARIRI has conducted research on the production of candied fruits for various clients. However, given the policy adopted by government to pursue trade liberalization, many processors are facing competition from low-priced imported raisins.

Plantain and Breadfruit:

- CARIRI has investigated appropriate processing technology for the production of plantain chips.

3. Surveys in Fruit Processing

CARIRI conducted a survey of the local fruit wine industry. Results of the survey in 1993 showed that:

- Information on the composition of local fruit is inadequate.
- The cost of materials and equipment is high.
- Selection of appropriate wine yeast and levels of yeast nutrient for use with local fruits needs to be investigated.

At present, CARIRI is collaborating with IICA, CRITT and CIRAD-FHLOR in the conduct of a survey of the major fruit processing enterprises and 20% of the cottage industries in the English- and French-speaking countries of the Caribbean, to determine as far as possible: levels of production; quantities of raw material used both from regional and imported sources; equipment capabilities; problems facing the industry; projections for future expansion. An analysis of the laboratory facilities which provide back-up support services both in research and product development and testing and accreditation will be performed.

4. Training and Consultancy Services

CARIRI has embarked on an outreach programme with the primary goal of improving the food processing skills of small to medium-scale entrepreneurs and those interested in starting a business. In 1993, approximately 200 persons were trained in mango processing, 60 persons in the production of tropical fruit wines and 20 persons in

the production of plantain chips and candied fruit. In 1994, courses conducted up to May have included: production of jams and jellies; mango processing; production of tropical fruit wines; production of sauces and other condiments. A series of other training courses has been planned for the rest of the year.

5. Analytical (Chemical and Microbiological)

CARIRI provides an ongoing service to the industry through its chemical and microbiological laboratories. CARIRI in conjunction with the Trinidad and Tobago Bureau of Standards is in the process of upgrading its laboratory facilities under a World Bank project. This is in keeping with ISO 9000 certification requirements.

CARIRI conducts routine chemical and microbial analyses and can perform specific nutrient analyses as required.

6. Machinery Development/Adaptation

The machinery development unit which is part of the Technological Services Division, Engineering Section, continues to support the fruit processing industry in the region through the provision of machinery suited to the scale of operation usually practised in the Caribbean. The machinery development unit has now established a partnership with Grell Taurel Limited to produce equipment as needed by the industry.

Some of the major pieces of equipment produced at CARIRI have included:

- Food press (50 - 150 kg/hr fruit)
- Pulp extractor (1000 kg/hr)

7. Conclusion

CARIRI has contributed to the development of the local and regional fruit processing industry. However, its impact both in Trinidad and Tobago and regionally has not resulted in a reduction in the dependence on imported raw material and the maximization of local fruits to support the fruit processing industry.

What are the recommendations for the future? These can be stated as follows:

(i) Identification and selection of fruit varieties for processing into finished products which will be utilized regionally and which also have export potential.

(ii) Production of the fruit identified at (i) above in sufficient quantities to sustain a viable fruit processing industry. The production costs of the fruits must be low enough to ensure that the prices do not inhibit use by the industry.

(iii) Continued research on characterizing regional fruits, improving post-harvest handling techniques and identifying new ways to maximize the processing potential of these fruits, e.g. enzymatic treatment of fruit pulps. Additionally, there is need for continued product development to identify new products.

The immediate question is: who will fund this work? Is it the responsibility of the government or private enterprise? CARIRI has seen a reduction in government subventions but recognizes that the areas identified above are of vital importance to the survival of the fruit processing industry.

The private sector recognizes that there is a need for continued research but is not willing to invest financially in any project unless monetary returns can be projected up-front.

Additionally, the bulk of agroprocessors who utilize raw materials available regionally is comprised of the small to medium-scale entrepreneurs and they do not have the capital to invest in research. The responsibility for continued research and development therefore falls heavily on governments with the support of international funding agencies and professionals who are committed to the development of the fruit industry.

WORK ON TROPICAL FRUIT CROPS BY THE AGRICULTURAL TECHNICAL MISSIONS OF THE REPUBLIC OF CHINA ON TAIWAN

S H LAI AND JAMES TSAY
THE AGRICULTURAL TECHNICAL MISSION OF THE REPUBLIC OF CHINA TO ST LUCIA AND GRENADA

Abstract
Very intensive small farming systems and many varieties of various crops suitable for tropical conditions have been developed in Taiwan; they include grains, vegetables and fruits . There are 45 agricultural technical missions from the Republic of China in 32 developing countries including five in the Eastern Caribbean. The introduction of promising varieties and species of fruit-tree crops for agricultural diversification is part of its technical cooperation in this region. A range of cultivars of papaya, pineapple, carambola, passion fruit, guava, wax apple, Indian jujube, longan, loquat, peach, pear, plum, grape and litchi, among others, have been introduced and evaluated in St Kitts and Nevis, Dominica, Grenada, St Lucia and St Vincent and the Grenadines. Some of these crops (or varieties) such as guava, wax apple, carambola, Indian jujube, pineapple and passion fruit have already been identified as having great production and marketing potential.

Résumé
Des petits systèmes de culture très intensifs et de nombreuses variétés de divers produits agricoles adaptées aux conditions tropicales ont été développés à Taiwan, en particulier des céréales, des légumes et des fruits. La République de Chine a 45 missions techniques agricoles dans 32 pays en voie de développement, dont 5 dans la Caraïbe orientale. L'introduction de variétés et d'espèces fruitières pour la diversification agricole fait partie de sa coopération technique dans cette région. Une gamme de cultivars de papaye, ananas, carambole, fruit de la passion, goyave, wax apple, jujube indienne, longan, loquat, pêche, poire, prune, raisin et litchi entre autres, ont été introduits et évalués à St. Kitts et Nevis, Dominique, Ste Lucie, St. Vincent, Grenade et les Grenadines. L'exposé conclut que certaines de ces espèces (ou variétés) telles que goyave, wax apple (*Sygyzium aqueum*), carambole, jujube indienne (*Ziziphus mauritania*), fruit de passion et ananas ont été identifiées comme ayant le meilleur potentiel de production et de commercialisation.

Resumen
Pequeños sistemas de cultivo muy intensivos y muchas variedades de diferentes cultivos adaptados a condiciones tropicales se han desarrollado en Taiwan: entre ellos cereales, legumbres y frutas. Hay 45 misiones técnicas agrícolas de la República de China en 32 países en vía de desarrollo, incluyendo 5 en el Caribe oriental: una parte de su cooperación técnica en esta región consiste en la introducción de especies y variedades prometedoras de frutas para ayudar a la diversification agrícola. Un rango de cultivares de papaya, piña, carambola, maracuyá, guayaba, pera malaya, jujube, longan, loquat, melocotón, pera, ciruela, uva y litchi entre otros se ha introducido y se esta evaluando en St Kitts y Nevis, Dominica, Sta Lucia, Grenada, San Vincente y las Granadinas. Algunas de estas especies tales como la guayaba, el jobo de la India, la carambola, el jujube, la piña y la maracuyá han sido pre-seleccionadas en base a su potencial de producción y mercadeo.

1. Introduction

In Taiwan, we have developed the most intensive small farming systems and many suitable varieties of various crops including grains, vegetables and fruits, for tropical conditions. We are pleased to share these agricultural techniques with other countries. Hence there are 45 agricultural technical missions from the Republic of China (ROC) in 32 developing countries around the world. There are five missions in the Eastern Caribbean region. They are in St Kitts and Nevis, Dominica, St Lucia, St Vincent and the Grenadines, and Grenada for cooperation on the improvement of agriculture.

Introduction and identification of promising varieties and species of fruit-tree crops for agricultural diversification is part of the technical cooperation in this region. However, the crops emphasized are different due to the differences in physical and socio-economic conditions, particularly the policy for agricultural development among these countries. Several varieties of non-traditional fruit-tree crops have been introduced, not only from Taiwan, but also from other sources where promising material might be available. Observation trials of these materials have been (or are being) carried out. This paper briefly presents the progress and results of these trials.

2. St Kitts and Nevis

Although the agricultural technical cooperation started in 1984, the efforts were concentrated on vegetable crops and only a few fruit-tree crops were introduced in recent years (Table 1). The production of papaya varieties, including Tainung #2, Sunrise and Solomon, was not stable due to high rates of bunchy top and bacterial decline infections. The

varieties of pineapple (Tainung #4, Tainung #11 and Smooth Cayenne) are showing great potential. Their fruits weigh between 2 and 3 kg with a brix of 15-16%. Planting material of these varieties is being propagated for farmers. The evaluation of carambola and passion fruit varieties is ongoing.

Table 1: Number of varieties of fruit-tree crops introduced to St Kitts by the Republic of China agricultural mission

Crop	No. of varieties	Year
Papaya	12	1990
Pineapple	3	1990, 1991
Carambola	1	1993
Passion fruit	1	1994

3. Dominica

Table 2 shows the number of varieties of seven fruit-tree crops introduced and tested since 1987. Results showed that the production of papaya is more stable in Dominica than in St Kitts, St Lucia and Grenada. This is attributed to a lower rate of bunchy top and bacterial decline infections. The main recommended variety is Tainung #2 for its high productivity and quality. With higher yield and higher brix than the local cultivars, the introduced pineapple variety, Smooth Cayenne, is recommended. And the planting material of this variety is being propagated in large quantities.

Table 2: Number of varieties of fruit-tree crops introduced to Dominica by the Republic of China agricultural mission

Crop	No. of varieties	Year
Carambola	1	1987
Pineapple	3	1990
Papaya	12	1990
Guava	1	1992
Waxapple	1	1992
Inlian jujube	1	1992
Citrus	1	1992

4. St Lucia

The introduction of fruit-tree crops by the ROC agricultural mission to St Lucia started earliest and with the greatest number of varieties and species among the five missions in the Eastern Caribbean region (Table 3). The introduced varieties of longan, loquat, peach, pear and plum did not produce any fruit after several years in trials and are not suitable for the region. Several varieties of other introduced fruit-tree crops are promising, based on their potential in production and marketing, and have been recommended for promoting in St Lucia (Table 4).

Table 3: Number of varieties of fruit-tree crops introduced to St Lucia by the Republic of China agricultural mission

Crop	No. of varieties	Year
Logan	2	1986
Loquat	2	1986
Peach	2	1986
Pear	2	1986
Plum	2	1986
Wax apple	2	1986, 1989
Carambola	6	1986, 1993
Grape	1	1987
Guava	4	1987
Sugar appple	2	1987
Mango	2	1987, 1993
Citrus	2	1987,1994
Indian jujube	5	1989, 1994
Papaya	18	1991, 1993
Pineapple	2	1992, 1993
Passion fruit	8	1993

Table 4: Recommended varieties of fruit-tree crops for St Lucia

Crop	Recommended variety
Wax apple	Nan Yang
Carambola	Cheng Chui
Guava	Pear type
Indian jujube	Bin Yun
Pineapple	Tainung #11
Passion fruit	Tainung #1

5. St Vincent and the Grenadines

Table 5 shows the number of varieties of seven fruit crops introduced and evaluated by the ROC agricultural mission in St Vincent. However, most effort on fruit-tree crops is mainly concentrated on grapes. A series of studies including evaluation of varieties and improvement of cultural practices have been conducted. 'Alden', 'Ribier' and 'Ruby Seedless' are the best varieties among the 12 (Table 6) introduced. They can produce two crops of high

Table 5: Number of varieties of fruit-tree crops introduced to St Vincent by the Republic of China agricultural mission

Crop	No. of varieties	Year
Papaya	3	1989
Grape	12	1989, 1990
Passion fruit	2	1992
Wax apple	1	1993
Guava	1	1993
Carambola	1	1993
Indian jujube	1	1993

quality fruit a year with an average production of 5–6 kg per plant. These varieties are promising and should be promoted.

6. Grenada

The mission in Grenada started 3 years ago. The development of non-traditional fruit-tree crops has been given top priority in technical cooperation by the ministry of agriculture. Hence progress in the introduction and evaluation of varieties of fruit-tree crops is rapid. Table 7 shows the number of varieties of fruit-tree crops introduced and tested. The results may be summarized as follows: a purple passion fruit variety, Chia-yi Selection, with the character of self-compatibility and hence high and stable yield and high quality, is promising and has been promoted. The area planted to this variety had reached 1.6 ha by end of 1993 and is expanding rapidly. Indian jujube, pineapple, wax apple and guava are the other fruit-tree crops that have already showed their potential. The demand for their planting material is high. The mission is working closely with the ministry of agriculture on the propagation of these planting materials.

7. Conclusion

The ROC agricultural missions have introduced many varieties of non-traditional fruit-tree crops to the Eastern Caribbean since 1986. Some of these crops (or varieties) such as guava, wax apple, carambola, Indian jujube, pineapple, and passion fruit have been identified as having great production and marketing potential. However, this potential has not been fully exploited. During this critical transition stage of agricultural development in this region, the ROC agricultural missions would like to ensure the close cooperation with the host countries on the development of these promising crops for agricultural diversification.

Table 6: Varieties of grapes introduced to St Vincent by the Republic of China agricultural mission

Alden	Himord Seedless
Cardinal	Isabella
Chaou von Degamenkey	Nocera
Concord	Ribier
Ferdinamd de Lasseps	Ruby Seedless
Grey	Dattier

Table 7: Number of varieties of fruit-tree crops introduced to Grenada by the Republic of China agricultural mission

Crop	No. of varieties	Year
Atemoya	3	1991
Grape	34	1991
Guava	3	1991, 1994
Indian jujube	3	1991
Litchi	3	1991
Mango	1	1991
Papaya	12	1991
Passion fruit	7	1991
Pineapple	3	1991
Strawberry	6	1991
Wax apple	2	1992

PRESENTATION BY COLEACP

D HIRST
UK Representative, COLEACP

Abstract
Initial efforts by the Commission of the European Economic Communities to assist fresh produce growers in Africa to participate in European trade fairs in the early 1970s lead to the creation in 1973 of an international, non-profit making, private association known as COLEACP, which is the acronym for the European, African, Caribbean, Pacific Liaison Committee with the objective of promoting tropical and off-season fruits, vegetables, flowers, ornamental plants and spices. The structure of COLEACP, its activities such as providing market price information to member countries, technical and commercial training provided, annual ACP/EC trade conferences, trade promotion such as the Julie mango promotion, diversification of products and markets for minor tropical fruits, are among the components of COLEACP described.

Résumé
Les premiers efforts de la Commission des Communautés économiques européennes pour soutenir la participation des producteurs africains de produits frais aux foires commerciales européennes datent des années 70 et conduirent en 1973 à la création d'une association internationale privée, sans but lucratif, connue sous le nom de COLEACP. COLEACP signifie "Comité de liaison entre les pays ACP et la CEE pour la promotion des fruits tropicaux, légumes de contre-saison, fleurs et plantes ornementales et épices". La structure du COLEACP et ses principales activités sont décrites dans l'article; celles-ci recouvrent la fourniture d'informations sur les marchés aux pays et entreprises membres, des formations de caractère technique et commercial, la conférence commerciale annuelle ACP/EC, des promotions commerciales telles que celle de la mangue 'Julie' et la diversification des produits et des marchés pour des fruits tropicaux mineurs.

Resumen
Los primeros esfuerzos de la Comisión de las Comunidades económicas europeas para apoyar la participación de los productores africanos de productos frescos en las ferias comerciales europeas data de los años 70 y dió origen en 1973 a la creación de una asociación internacional privada, sin motivo de lucro, conocida como COLEACP. COLEACP significa "Comité de enlace entre los paises ACP y la CE para la promoción de las frutas tropicales, vegetales fuera de temporada, flores y plantas ornamentales y especias. La estructura del COLEACP y sus principales actividades se describen en el artículo; éstas cubren el suministro de informaciones de mercadeo a los paises y empresas miembros, capacitación de carácter técnico y comercial, la conferencia comercial anual ACP/EC, promociones comerciales como la del mango 'Julie' y la diversificación de los productos y los mercados para frutas tropicales menores.

1. The Background and Origins of COLEACP

In the early seventies, to assist fresh produce growers in Africa to participate in European trade fairs, the Commission of the European Economic Communities organized meetings between professionals at these events. These early contacts led to a demand for a permanent flow of information between importers and exporters and a joint effort to expand trade beyond traditional crops, such as bananas and citrus, to less well-known tropical fruits, vegetables and off-season items.

In 1973, backed by the European Commission, more specifically by the trade Development Division of DG-VIII, members of the trade created an international, non-profit-making, private association, now known as COLEACP, which is the acronym for the Europe - Africa, Caribbean, Pacific Liaison Committee, with the objective of promoting tropical and off-season fruits, vegetables, flowers, ornamental plants and spices.

2. The Structure of COLEACP

COLEACP is a private association under Belgian law and has about 150 members; approximately half are exporters and producers in ACP countries, about one third are importers in Europe and the remainder are service operators, external trade authorities, ACP professional associations and others connected with the trade. Policy is formulated by a board of directors comprising 10 ACP members and 10 European members, and the general assembly of members, and is executed by the general delegation which comprises 10 permanent staff based at the head office in Rungis, France, and a permanent representative in the UK. Having built up strong representation through its membership in trade in Europe and in ACP countries, COLEACP now constitutes an effective structure for ACP/EC trade liaison.

3. Activities of COLEACP

Activies were originally centered on trade promotion,

but they have since diversified thanks to financial backing from the EC under a series of 3-year programmes. These activities can now be divided into six main groups:

3.1 Trade Information

From its trade data-bank, COLEACP sends weekly market price information by fax to ACP members, covering a range of selected products in six European markets. A monthly information bulletin gives a regular summary of market prices and movements and general trade information and provides a link between members. This is also available to non-members on subscription. Updates of market statistics are prepared on an annual basis and special market studies can be made at the request of members.

3.2 Technical and Commercial Training

COLEACP organizes annually two 3-week commercial training courses (one anglophone and one francophone) for eight ACP exporters, involving visits to several European countries, introduction to their markets and opportunities to meet and talk to leading importers, enabling them at first hand to see how the markets operate and the competition that they face.

These are supplemented by 10-day technical training sessions, which usually take place in an ACP country, also twice per year and which are designed to assist production/export managers to improve the quality of produce exported and reliability of supply, covering production/post-harvest technology, etc.

COLEACP now plans to add one training session per year for specific needs of a particular region based on the requirements expressed by exporters and producers. All of these training courses are free of charge to participants. Besides the support of COLEACP members in training courses, we also call upon the expertise and facilities of various research institutes, specialists, consultants and trade support organizations, including CIRAD/FLHOR, NRI, CBI, GTZ Protrade, with whom we enjoy close cooperation. We are also keen to work together with local or regional organizations, in the Caribbean; these might include ADCU, CARDI, IICA for example.

3.3 Technical Assistance

In response to specific requests, which would normally be directed through the local EC Delegation, a wide range of technical assistance can be offered. This might include:

- Investigatory/pre-feasibility missions to examine the potential of a country's horticultural sector.
- Specialized technical assistance to solve particular problems which might compromise successful export.
- Supportive missions to increase the awareness of local ACP and EC officials to trade problems.
- Setting up of joint consultative meetings between sections of the trade and international operators; transport, finance, packaging. etc.

3.4 Annual ACP/EC Trade Conferences

These are the annual 'high point' of COLEACP activities, bringing together members and many others involved in the trade for discussion and debate on trade topics, analysis of opportunities and re-definition of COLEACP services according to members' needs. The person-to-person contacts which take place are one of the most highly valued aspects of COLEACP activities and enable people from different countries and different aspects of the trade to have a better understanding of common concerns and problems. The conferences are organized on a regional basis and alternate between venues in east and west Africa and the Caribbean.

3.5 Trade Promotion

This takes two forms, the first being through the cooperation of importer members of COLEACP, who conduct promotion campaigns for ACP produce by means of in-store demonstrations, tasting, display of posters, publication of promotional leaflets, etc., and COLEACP now finances some 1,600 of such events annually in the EC.

The second is through COLEACP participation in the major trade fairs in the EC, using stands provided by the commission, usually in close association with the stands of ACP exhibitors.

3.6 Diversification (of Products and Markets)

Due to its origins and the main interests of the majority of its members, COLEACP had until recently been concerned principally with the trade in fresh fruit and vegetables but as world trade conditions changed and the competition became increasingly fierce, it became necessary for exporters to extend the range of products offered and to look for new outlets. In accepting this challenge on behalf of its ACP members, COLEACP is currently, for example, placing more resources in the investigation of possibilities in the field of floriculture, and having commissioned, in 1993, a preliminary study of the opportunities open to Caribbean producers, two seminars have been held this month (May 1994) in Trinidad and St Lucia.

Similarly, COLEACP is currently investigating the prospects of the Middle East markets for horticultural products from ACP countries, notably in Africa.

4. Resources of COLEACP

COLEACP activities are funded 70% by the European Commision under regional programmes of the Lomé

Conventions and the remaining 30% is derived from income generated from members' subscriptions, sale of monthly bulletins and contracted work for governments and various other organizations. The budget for the 3-year programme 1991/93 amounted to some Ecu 6.5 million.

5. Recipients of COLEACP Services

Services are available to paid-up members, all of whom are professionally involved in ACP/EC trade in horticultural products (as previously described). Participation in training courses is not restricted to members, but where applications exceed the number that can be accepted, members would normally have first priority

If they wish to derive the fullest benefit from COLEACP services, ACP exporters are recommended to apply for membership, but in order to serve the best interests of ACP trade development, membership is not necessarily taken as an essential pre-requisite to be eligible for assistance.

6. Promotion of the 'Julie' Mango

At the COLEACP Annual Regional Trade Conference held in Santo Domingo in January 1993, it was generally concluded by delegates that if the Caribbean ACP countries wished to compete on equal terms in extra-regional markets with major sources of tropical fruits and vegetables, it was necessary for them to cooperate in establishing and maintaining common standards for certain recognizable items which had wide actual or potential market appeal and to work together to market the selected products in a regionally coordinated way in terms of general quality and packaging specifications and possibly using a common logo. It was resolved to take the 'Solo' papaya as a test case, but subsequently, after some futher investigation, the as yet unsolved problems faced by several Caribbean countries with viral and bacterial diseases were thought to present too high a risk to a major promotion campaign and this idea was therefore shelved.

At the Food & Drink Expo '94 held in Birmingham, UK, in March 1994, the proposal was put forward by the ADCU of OECS that the Julie mango, as a distinctive, typical Caribbean variety and well distributed in the region, had high potential for more extensive marketing in Europe. Currently it was known only to the West Indian communities and exported for their consumption in bulk boxes, ungraded, with no attempt made to present them attractively or to any uniform standards. It was thought that after setting (and adhering to) strict quality standards and by presenting the mangoes in an attractive pack, correctly graded, a promotion campaign could be launched in Europe to bring this fruit to the attention of the general public, stressing the excellent eating quality of the Julie variety, and familiarizing them with the name.

COLEACP has already achieved considerable success in promoting the 'Amelie' mango from West Africa, a variety similar in some respects to Julie, and provided that the producers and exporters are prepared to comply with a common set of specifications and maintain strict quality standards and a regular supply of fruit during the season, there seems to be a good prospect for the launch of a promotion campaign. As a first step to increase the awareness of distributors and consumers of the Julie variety COLEACP has had 2 million stickers printed for individual fruits. These have been supplied to the ADCU and will be distributed free of charge to those exporters who agree to comply with the laid down standards and conditions, of which they will be informed by the ADCU prior to the issue of stickers. For the 1994 campaign the issue will be restricted to OECS exporters as a test marketing exercise, but it is hoped to be able, in 1995, to extend this to other countries in the region having substantial quantities of the variety, when it should also be possible to produce posters and other promotional literature and organize in-store tastings and other events.

Of course, it is vitally important that exporters should only use the stickers on top quality Julie mangoes, with no blemishes or defects, well-graded and attractively presented in single layer boxes. There must be no confusion with the 'jumble-packed' ungraded fruit sent in bulk in 30-lb boxes, which will still continue to be sent for consumption by the ethnic Caribbeans and which are acceptable to them, but if the stickers were to appear on such mangoes, it would kill the campaign stone-dead.

A suggested type of presentation pack is displayed on the table in this hall.

7. Markets for Minor Exotic Fruits

The 'minor' exotic fruits of the Caribbean can, for the purposes of marketing outside the region, be divided into three categories:

- Those which are familiar to West Indian consumers and are traditionally eaten in season, but for reasons of taste, inconvenience and cost, relative to other available alternatives, are unlikely to have any significant appeal for the general consumer market. These are often referred to in Europe as 'ethnic' products. In this category could be included golden apple, various plums, genip, local cherries, ackee, dunks, etc.
- Those which are readily accepted by the general

consumer market, often as expensive luxury items, some of which, with adequate promotion, increased production and lower selling prices have the potential to reach moderate to high volume sales. In this category can be included the carambola, mangosteen, rambutan, passion fruit, pitahaya etc.

- Those which are now eaten mainly by consumers of Caribbean origin, but are acceptable in the wider market; so-called 'cross over' items. Few of these would be likely to have the potential for high volume sales. This category might include tamarind, sapodilla, soursop, custard-apple, guava, sapote, etc.

One might ask: "Does the Caribbean have a local fruit with the potential of the kiwi?" This is difficult to answer, but one can usefully examine the criteria which would be required to be met if a 'new' fruit were to be successfully introduced on the markets of Europe:

- It should look good and appetising, both in itself and in its presentation.
- It should taste (and smell) good, remembering that strong flavours appreciated in the Caribbean may not always appeal to European palates (eg. guava)
- It should be relatively be easy to prepare and eat (cf. 'fish bones' in golden apple)
- It should be easily transportable and have an adequate shelf-life.
- It should not be too expensive to produce and be marketable at an affordable price for volume sales, while allowing enough profit margins down the marketing chain.
- It should have a long season of availability, preferably year-round.
- There must be the potential for sustained and reliable production of consistent quality fruit to follow a promotion launch.

In the opinion of some European importers, one of the most promising prospects is the yellow pitahaya, currently available exclusively from Colombia, but which might possibly be grown in the Caribbean, where several of its related species occur naturally. This might well be worth researching, though only time will tell if it can become the Caribbean equivalent of the kiwi fruit.

THE INVOLVEMENT OF THE FRENCH TECHNICAL MISSION IN AGRICULTURAL DIVERSIFICATION IN THE ECS

WILFRED FOUSSE

Abstract
Agricultural diversification in the Eastern Caribbean States (ECS), is important because of the socio-economic conditions created by falling banana prices. Since its inception in 1984, the cooperation programme between France and the ECS has promoted agricultural diversification. Fruit production was identified as one of the most important areas for diversification. The French Ministry of Foreign Affairs in collaboration with the Inter-American Institute for Cooperation on Agriculture (IICA) is working on development of fruit production in the Caribbean countries. This work has shown that the production of the farms needs to be organized on a more commercial basis in order to be competitive. Traditional fruit species seem to have the biggest potential for the development of the local and export markets. ECS countries are unlikely to compete successfully in unprotected markets for more popular fruits such as pineapple. However, these countries can take advantage of the 'ethnic markets' for fruits such as Julie mango, breadfruit, golden apple and soursop among others. A proposed programme for development of the fruit industry in the Caribbean by the French Mission for cooperation is discussed.

Résumé
La diversification agricole dans les Etats de la Caraïbe orientale (ECS) est importante de par les conditions socio-économiques créées par la chute des prix de la banane. Depuis ses débuts en 1984, le programme de coopération entre la France et les pays ECS a promu la diversification agricole. La production de fruits a été identifiée comme l'un des domaines les plus importants pour la diversification. Le ministère français des Affaires Etrangères en liaison avec l'Institut inter-Américain de coopération en agriculture (IICA) travaille sur le développement des productions fruitières dans la Caraïbe. Ce travail a montré que la production doit s'organiser sur une base plus commerciale pour être compétitive. Les espèces traditionnelles semblent avoir le potentiel le plus grand pour le développement des marchés locaux et d'exportation. Il est peu probable que les pays ECS puissent être compétitifs en situation de marché libre pour des fruits aussi populaires que l'ananas. Cependant, ces pays peuvent tirer parti des "marchés ethniques" pour des fruits tels que la mangue 'Julie', le fruit de l'arbre à pain, la prune de cythère et le corossol entre autres. L'exposé présente également une proposition de programme pour le développement de l'industrie des fruits dans la Caraïbe de la part de la Mission Française de Cooperation.

Resumen
La diversificación agrícola en el Caribe oriental es muy importante por las condiciones socio-económicas creadas por la caída de los precios del banano. Desde su inicio en 1984, el programa de cooperación entre Francia y los paises ECS ha promovido la diversificación agrícola. Las frutas fueron identificadas como una de las áreas más importantes para la diversificación. El Ministerio francés de Asuntos Extranjeros en colaboración con el Instituto Interamericano de Cooperación en Agricultura (IICA) trabaja al desarrollo de la producción de frutas en los paises del Caribe. Este trabajo ha mostrado que la producción necesita ser organizada en una base más comercial para ser competitiva. Frutas tradicionales parecen tener el potenciàl más grande para el desarrollo de los mercados locales y de exportación. Es poco probable que los países ECS puedan competir en una situación de mercado libre con frutas populares tales como la piña. Sin embargo estos paises pueden aprovechar los "mercados étnicos" para frutas tales como el mango 'Julie', la fruta de pan, el jobo de la India y la guanábana entre otras. El artículo presenta también una propuesta de programa de desarrollo de la industria de frutas en el Caribe, por parte de la Misión Francesa de Cooperación.

Introduction

The drop in banana price has created an agricultural diversification awareness. Farmers become increasingly interested and involved in agricultural diversification. Governments and others institutions now fully back the needs of this sector.

Since its inception in 1984, the cooperation programme between France and the OECS states has always tried to promote and develop agricultural diversification.

In St Lucia, the French-funded TREDU project seems to have successfuly managed the transfer of the greenhouse technology to vegetable producers. The use of this technology which allows a better quality and a year round production, is now taking root in other countries of the OECS such as Dominica and Grenada.

In Dominica, the TREDU project has successfully promoted and supported farmers' organizations. SEDPA specialized in plantain and is now the biggest exporter of agricultural diversification products. The TREDU project in Dominica is also supporting the organization and the development of the pig Industry. For instance, last year the French Technical Mission in collaboration with the ministry of agriculture of Dominica has successfully imported high quality breed animals that have boosted the technical and financial performance of the producers.

In Grenada, the French Technical Mission has supported the creation of a centre for agricultural excellence as suggested by the Honourable Minister Brizan. The introduction of new techniques is not only a means for increasing the productivity and the farmers' incomes, it is also a tool for social promotion and therefore a means to attract young people to farming activities.

Fruit production is certainly one of the most important areas for diversification. The French Ministry of Foreign Affairs in collaboration with IICA is coordinating a programme for the development of fruit production in the Caribbean countries. This programme has been funded by the Fonds Interministeriel Caraibe (FIC) which involves three French ministries: the Ministry of Foreign Affairs, the Ministry of Overseas Departments and the Ministry of Cooperation.

This regional programme has allowed:

- The organization of training workshops and studies.
- The exchange of information on research programmes, experiences and vegetables.

The results of this work has led the French Technical Mission for Cooperation to make the following assumptions:

- To be competitive, the production of the farms needs to be organized on a more commercial basis.
- Traditional fruit species seem to have the biggest potential for the development of both the local and export markets.
- Tourists are more and more attracted by fresh juices of local traditional fruits and may be willing to pay higher prices for such produce.
- OECS countries are unlikely to compete successfully in unprotected export markets for popular fruits such as pineapple.
- OECS countries can take advantage of the so-called 'ethnic' market for specific species or varieties such as the Julie mango, plantain, breadfruit, golden apple, etc.

On this basis the French Technical Mission is now proposing a programme of action for the OECS countries to develop the fruit industry. The programme is looking at improving production, processing and marketing of local traditional species such as cherries, golden apple, soursop, etc.

A pilot programme has been initiated in Grenada with a funding from the French Ministry of Cooperation. It will be extended to other OECS countries if it proves successful. French agronomists working on the vegetable and ornamentals programmes are already present in Grenada and St Lucia and can give technical support to this programme. The full implementation of this programme at regional level will however require additional funding which might be secured from the European Union and the Caisse Francaise de Developpement (private sector).

In terms of production, the programme will seek to increase the productivity of the farmers by:

- Introducing and selecting different varieties of traditional species with higher yields and a shorter delay in getting into production (6 months for some golden apples).
- Providing technical support to increase the plant production output of the propagation centres.
- Providing incentives to producers for the establisment of commercial orchards, notably in the Centre of Excellence developed by Grenada in collaboration with the French Technical Mission for Cooperation.
- Training extension services and producers in new techniques of pest control, pruning and orchard management.

However, most of the effort must go to the marketing side. Farmers will invest in modern orchards only if there is a market for the produce.

For the development of the local market, the project will:

- Support the organization of the local market by urging producers to associate themselves around necessary collective equipment (cold storage rooms, packaging room, specialized wholesale market).
- Support the installation of processing units for the production of traditional fresh fruit juices.
- Provide technical expertise to enhance the quality and the durability of traditional fruit fresh juices.
- Provide incentives to the private sector as well as farmers' organizations and facilitate their access to credit lines for the purchase of equipment.
- Promote the sales of fresh local traditional juices by the hotels and restaurants
- Develop the sales of local traditional juices along the tourism routes and sites.

For the development of the export market, the programme will:

- Support the installation of equipment to ensure commercialization in the best possible conditions in terms of grading and packaging to standardize the products.
- Facilitate access to export credit schemes and marketing information.
- Seek foreign partners for the establisment of joint ventures.
- Create labels and packaging that will enhance the image of the local products.
- Train local staff and producers in export marketing and international regulations.

This programme will need a lot of support from the different governmental and private partners. Other

organizations not yet named will be able to help a lot. I am thinking in particular of ADCU and DEXIA for marketing activities and CIRAD for technical advice.

We are therefore proposing the establisment of national sectorial coordination committees that will review the different problems faced by the different actors. The committee should include: the producers, the extension and the pest control services from the ministries of agriculture, the farmers' organizations, the trading and banking sectors, representatives from the ministries of trade and the ministries of finance.

SECTION 4 - TECHNICAL PAPERS

CULTIVATION OF SELECTED ASIAN FRUITS IN THE LESSER ANTILLES

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Abstract
The article provides concise information on the ecological requirements, genetic diversity, production season and yield potential, market acceptability and cultural management such as propagation, soil preparation, planting density and for mangosteen (*Garcinia mangostana* L.) rambutan (*Nephelium lappaceum* L.), (*Nephelium longan* Lour) and durian (*Durio zibethinus*).

Résumé
Les fruits considérés sont le mangoustan (*Garcinia mangostana* L.) le rambutan (*Nephelium lappaceum* L), le longan (*Nephelium longan* Lour) et le durian (*Durio zibethinus*). Des informations concises sont fournies concernant: les exigences écologiques, la diversité génétique, la conduite de la culture, les saisons de production, le potentiel de rendement et l'acceptabilité sur le marché.

Resumen
El artículo provee información concisa en cuanto a los requisitos ecológicos, diversidad genética, estaciones de producción y rendimiento potencial, aceptabilidad en el mercado y prácticas culturales tales como propagación, preparación de la tierra y densidad de siembra para el mangostán (Garcinia mangostana L.), el rambután (Nephelium lappaceum L.), el longan (Nephelium longan Lour.) y el durián (Durio zibethinus).

Introduction

Biodiversity is recognized as the key to development and health. For this reason, and as native fruits of the region have been introduced and developped in different parts of the world, it should be interesting to develop some Asian fruits in the West Indies.

According to the very large number of Asian fruits and their climatic and soil requirements, some of them could be grown in the region. Some Asian fruits were introduced into the West Indies and still exist in different locations but are mainly unknown by the local population.

In Martinique,one of the best known Asian fruits is certainly the lichi (*Litchi chinensis* Sonn.), but this subtropical tree does not bear well in humid tropical conditions. Other Sapindaceae, originating from more tropical to equatorial parts of Asia, should be tested.

The introduction and development of such cultivars are interesting not only for the local market but also for export markets. Some Asian fruits are now exported and sold on different markets, and people are getting more and more used to these new fruits. On an other hand, more and more Asian people are now living everywhere in the world and are potential consumers.

Of the species present in the West Indies, some of them have been already investigated for propagation techniques, management, etc. but for others, everything needs to be done.

With respect to the possibilities for developing ramboutan, EEC funding has been obtained by CIRAD-FLHOR in Martinique to test the behaviour of this specie in different soil and climatic conditions and to introduce some selected cultivars from different countries of Asia. This programme is just beginning.

Some other Asian fruits are well known to West Indian people: mango (originating from the Indian-Burmese border region), jackfruit, carambola, bilimbi, jujube.

Four Asian fruits are presented here :
Mangosteen (*Garcinia mangostana* L.)
Durian (*Durio zibethinus* J. Murr.)
Ramboutan (*Nephelium lappaceum* L.)
Longan (*Euphoria longan* Steud.)

Mangosteen (*Garcinia mangostana* L.) Family Guttiferae

Mangosteen originated in Malaya and is now well established in Malaysia and Indonesia. This fruit is generally considered as the 'Queen of fruit' or the 'first fruit of the world'.

Climatic and soil requirements:
- Equatorial climate
- High even temperature
- High humidity
- Deep soil; even moisture, well-drained, high in organic matter; pH 5–6

Genetic diversity:
- Very little diversity due to nucellar seeds

Production season and yield potential:
- 1 crop/year, in August–September (West Indies)
- Mature trees yield 500 to 1500 fruits (from 15 years)
- Under favourable conditions, mangosteen begins to bear fruits at 7 years of age but may take as long as 15 years in poor conditions.

Market acceptability:
- Fresh fruit for local or export markets (fruit can be marketed up to 21 days after harvest).
- Prices in Europe (wholesale): 8 Ecu/kg (February –March 1994).

Cultural requirements:
- *Propagation:* by seed or grafting (node to node wedge). The most serious problem with seed propagation is the slow development of plants after seed germination. Grafting is now done successfully by using seedlings of mangosteen as rootstock. Tissue culture propagation is also used by CIRAD/FLHOR in Guadeloupe.
- *Soil preparation:* subsoiling and deep ploughing; soil should be well prepared due to the poor root system.
- *Planting density*: 100 trees/ha (10 x 10 m).
- *Management:* Young trees require shading; constant supply of water (they withstand some waterlogging); prefer fertilizer high in organic matter.

Durian (*Durio zibethinus*) Family Bombacaceae

Durian is naturally distributed in Malaysia, Thailand, Indonesia and Borneo.

Climatic and soil requirements:
- Successfully grown within 18–15° Lat.
- Up to 650 m elevation
- Yearly rainfall over 2500 mm
- Rich deep well-drained sandy clay or clay loam soils; the plant is sensitive to standing water

Genetic diversity:
- Very heterozygous
- Selected cultivars are available in Malaysia, Thailand and Indonesia

Production season and yield potential:
- Possible to get two crops/year (Malaysia and Sumatra)
- 10 to 18° Lat; flowering during spring months, harvest between midsummer and autumn
- 8 to 10 t/ha at 10–15 years and 50 trees/ha

Market acceptability:
- Fresh fruit: appearance, smell and flavour should be abhorrent; very much appreciated by Asian people.
- Different preparations; flavouring for ice-cream, sweets.
- Price in Europe (wholesale): 8.9 Ecu/kg (February–March 1994).
- Export from Thailand: 14,392 t (1990), 7,987 t (1991).

Cultural requirements:
- *Propagation:* by grafting, using seeds of durian as rootstock or seeds of some *Durio* species.
- *Planting density*: maximum of 156 trees/ha (8m x 8m)
- *Management*: young trees require shading; after 3 years the interior of the tree is thinned out: cut surfaces are treated; 12-4-7 fertilizer at 4 kg/tree/yr (12 yr old).

Ramboutan (*Nephelium lappaceum* L.) Family Sapindaceae

Ramboutan is native to west Malaysia and Sumatra. Under normal conditions it is a tree of medium size from 12 to 25 m high with a canopy width of approximately two-thirds the height. However, there are variations in form in the cultivars from erect to lax weeping crown. Flowers are 600 to 2000 per panicule and are usually functionally unisexual.

Climatic and soil requirements:
- Within 12–15° of the equator; 22 to 30°C
- Up to 500 m
- High rainfall (2000 to 5000 mm/year)
- Deep soil; well-drained sandy loams or clay loams with high organic matter content
- pH range of 4.5 to 6 (Fe and Zn deficiencies at higher pH)

Genetic diversity:
- Plenty of variation — form, growth, colour, adherence of aril
- Three groups according to flower characteristics:
  - only staminate flower (male) 40 to 60% of seedlings
  - hermaphrodite flowers which are functionally female
  - hermaphrodite flowers functionally female with some male; the most common form in cultivar selections (0.05 to 0.9 male).
- Selected cultivars are available in Malaysia (15 commercial clones), Thailand (5), Indonesia (21), Singapore (4), Philippines (4).

Production season and yield potential:
- Martinique : September–October
- About 100 kg/tree at 12 years for selected cultivars

Market acceptability:
- Attractive for fresh market or for canning with syrup.
- Price in Europe (wholesale): up to 7.3 Ecu/kg (February–March 1994).

Cultural requirements:
- *Propagation:* by grafting onto vigorous seedling; air layering should be limited due to high mortality rates.

— *Planting density:* 100/ha (10 x 10 m) to 156/ha (8 x 8 m)
— *Management:* windbreaks are essential; pruning to induce strong canopy regrowth; good water supply from flowering to harvest time; 12-4-7 fertilizer at 0.1 to 4 kg/tree.

Longan (*Nephelium longan* Lour. syn. *Euphoria longan*) Family Sapindaceae

Longan is indigenous to the lowlands of Ceylon, southern India, Burma and China. The tree is of medium size, 10 to 20 m high tending to a hemispherical crown.

Climatic and soil requirements:
— Between 15 and 28° of the equator
— Most successfully grown with short but cool winters
— Rainfall of 1000 to 2000 mm/yr
— Deep rich moderately well-drained alluvial clay loam soils

Genetic diversity:
— Selected cultivars are available in China (about 20 clones), Taïwan, Hong Kong, Thailand, Florida, Hawaii

Production season and yield potential:
— Flowering in spring and harvest time at end of summer
— 120 kg/tree (10 yr old) with biennal bearing

Market acceptability:
— Fresh fruit market or canning in syrup
— Fruit weight varies from 5 to 20 g and the commercial grades weigh from 12 to 18 g.
— Export from Thailand: 14,355 t (1990), 7,618 t (1991)

Cultural requirements:
— *Propagation*: mainly by air layering
— *Planting density*: 50 to 100 trees/ha
— *Management:* susceptible to wind damage; pruning after harvest.

BREADFRUIT AND BREADNUT PRODUCTION

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Abstract
The breadfruit and its relatives were brought from Indo-Malaysia, its centre of origin, by the French explorers and by Captain William Bligh to the Caribbean where the seedless types are more important for food. Neither breadfruit nor breadnut is deliberately planted to any extent except perhaps in backyards. These crops thrive best in warm humid climates. In the Caribbean, the Yellow Heart and the White Heart breadfruit cultivars are most common with the former being preferred for its flesh colour and roasting quality. At a density of 100 plants/ha, a yield of 20–40 t/ha may be realized. Breadnut is propogated by fresh seeds whereas the seedless breadfruit is usually propagated by root suckers but layering, budding and grafting, stem cuttings and micropropagation produced varying degrees of success. Presently, a decline problem is affecting mature trees throughout the Caribbean; nematodes have been implicated. Premature fruit drop is associated with both excessive drought and excessive moisture, as well as with breadfruit decline.

Résumé
L'Arbre à pain originaire d'Asie du sud-est (Indonésie, Malaisie) a été importé dans les Caraïbes par les explorateurs français et le Capitaine William Bligh. Aucune plantation d'Arbres à pain ou d'Arbres à châtaigne ne s'est développée dans les Caraïbes, à l'exception peut-être des arbres plantés dans les jardins familiaux. Ce sont sous les climats chauds et humides que ces cultures se développent le mieux. Dans les Caraïbes, les cultivars d'Arbre à pain « Yellow heart » et « White Heart » sont les plus communs, le premier étant préféré pour la couleur de sa chair et sa qualité à la cuisson. 11 est possible d'atteindre un rendement de 20 à 40 tonnes/ha avec un densité de 100 plants/ha. La propagation de l'Arbre à châtaigne s'effectue à partir de graines fraîches, alors que c'est le drageonnage qui est le plus utilisé pour la propagation des variétés sans graines d'Arbre à pain. Les techniques de marcottage, greffage, bouturage et micropropagation donnent des résultats mitigés. Actuellement, un problème de nématodes affecte les arbres adultes, provoquant une chute prématurée des fruits. Celle-ci peut aussi découler d'un excès d'humidité ou de sécheresse.

Resumen
El árbol del pan y sus especies relacionadas, fueron traidas de Indo-Malaysia, su centro de origen, al caribe donde los frutos sin semillas son importantes como alimento; por exploradores franceses y por el capitan Williams Bligh, . Ni el árbol del pan, ni la nuez del pan son cultivadas comercialmente, y solo son plantados en los patios de las casas. En el caribe los frutos de pulpa amarilla y blanca del árbol del pan son los mas preferidos por el color y la calidad al tostado. A una densidad de 100 árboles/ha,se puede obtener una producción de 20-40 t/ha. El árbol del pan es propagado por semilla nueva, mientras que los tipos sin semillas son generalmente propagados por enrraizamiento de "chupones", pero acodos, injertación, estacas y micropropagación tienen cierto grado de exito. Actualmente un tipo de declinamiento está afectando los árboles maduros en el caribe. La caida prematura de los frutos está asociada con exceso de sequia o humedad, asi como el declinamiento del árbol del pan.

Introduction

In the Caribbean, breadfruit (*Artocarpus altilis)* is also known as 'cow' and 'panbwa'. It belongs to the Moraceae family which also includes breadnut or chataigne and jackfruit *(A. heterophyllus)*. It has been accepted traditionally that the breadnut is in fact a seeded breadfruit, but one recent view is that it might be a different species, *A. camansi* (Ragone 1991). Both the breadfruit and breadnut will be considered in this paper, since they both occur in the Caribbean.

Origin and Distribution

The breadfruit and its relatives are natives of the area stretching from the Indo-Malaysian peninsula to Melanesia, but the breadfruit occurs most extensively in the South Pacific where the seedless types have their greatest diversity. It is from this region that the plants were taken in the 18th century to the Caribbean by French explorers (seeded types) and by Captain William Bligh (seedless and seeded types). The crops are now grown throughout the tropics but the seedless types are more important for food.

Uses

Breadfruit is a carbohydrate staple in the South Pacific. In the Caribbean, the importance varies with consumption being high in countries like St Vincent where it is consumed as a main dish, whereas in Trinidad it is largely eaten in small quantities as a side-dish. The seedless fruit is generally boiled or roasted, but the seeded type is eaten curried as a vegetable when immature and the mature seeds are boiled and consumed as a snack. Processed forms of breadfruit include flour, chips, frozen and canned slices and the candied male inflorescence. Recently, the breadnut seed has been canned.

The leaves, latex and roots, are used for medicinal purposes including the treatment of hypertension, thrush, diarrhoea and leukemia. The wood is light, strong, termite-resistant and used in house and boat construction, and the latex is used as chewing gum and for caulking boats in the South Pacific.

Production and Status in the Caribbean

Neither breadfruit nor breadnut is deliberately planted to any extent in the Caribbean, except perhaps in backyards. Most trees occurring in farmers' fields, in abandoned areas and in the wild, arise naturally. Breadfruit occurs more extensively than breadnut with large, though declining, tree populations in Jamaica and the Windward Islands. Breadnut tree populations are highest in Trinidad and Guyana where this crop is eaten in several forms.

Traditionally, both crops have been neglected but over the last 10 to 12 years, the commercial importance of breadfruit has increased because of the demand on the export market. Small volumes of breadnut and breadfruit are also exported from Trinidad. This has led to a strong interest in orchard establishment. Research work on breadfruit and to a lesser extent breadnut, has also intensified.

Environmental Requirements

Breadfruit and breadnut thrive best in warm humid climates with rainfall of 2000–2500 m mannually and well-distributed throughout the year. The preferred temperature range is 15.5 to 38°C and these crops will grow at up to 1000 m above sea level. For best growth, the soil should be deep with high fertility and a high organic matter content. The crops are found, however, in dry areas and in flooded areas in the South Pacific. The wide genetic diversity apparently allows for their adaptation to a range of environmental conditions.

Cultivars

There are a wide range of cultivars in the South Pacific which may vary in tree height and form, shape, size, flesh colour and seediness of the fruit, and the size and shape of the leaves. Within the Caribbean, the two must widely occurring breadfruit cultivars are the 'Yellow Heart' and the 'White Heart', with the former being preferred for its flesh colour and roasting quality. There is greater diversity in St Vincent and Jamaica where some of the other cultivars are: Koshi, Cocoa Bread, Captain Bligh, Waterloo in St Vincent, and Branjam, Maca, Timor, St Kitts in Jamaica.

Named breadnut selections are unknown.

Agronomy

Propagation: The breadnut grows from seed and only fresh seeds are viable. The seedless breadfruit is propagated traditionally by root suckers, but root cuttings and rooted excised adventitious shoots are now used commercially. Other methods which vary in their degree of success are layering, budding and grafting, stem cuttings and micropropagation. Plants are raised in plastic bags and are ready for planting when they are 45–60 cm tall. Depending on the method used vegetatively propagated material is ready for field planting in 4 to 18 months.

Planting: Transplants are placed in the field at a spacing of 10 m x 10 m or wider to accommodate the large size of the trees at maturity. However, it may be possible to use closer spacing with smaller cultivars and where dwarfing rootstocks and vigorous pruning are employed. The hole should be at least 60 cm in all dimensions and the backfill should be mixed with generous amounts of organic matter. Planting can proceed at any time provided adequate moisture is available. In the absence of irrigation facilities the beginning of the rainy season is preferred, but care must be taken to ensure that the plants are not placed too deeply in the hole, especially when planting at this time.

Breadfruit is commonly intercropped with crops such as coconut and banana. Care must be taken when cultivating these crops to avoid damaging the shallow root system of the breadfruit.

Pruning: This is not widely done in the Caribbean but it is a common practice in the South Pacific. The objective is to keep the plant height to a level which will facilitate harvesting. Another reason is to reduce competition with intercrops for light.

Pests and Diseases

Pests: In the Caribbean scale insects, soft scales and mealybugs all can infest the trees but the extent of the effect on yield is not known. Ants tend to infest dead or dying branches and appear after heavy fruiting; such branches should therefore be removed during the pruning operation. The most serious pest might be nematodes which have been implicated in the breadfruit decline affecting mature trees of both breadfruit and breadnut in the region.

Diseases: These crops are relatively free of diseases. Previously, the most serious problem in the Caribbean was a root rot caused by *Rosellinia* sp. which had been reported in Dominica, Grenada and Trinidad. It occurs especially where trees have been abandoned and there is heavy weed growth, where the tree roots have been damaged by cultural operations or when trees have been planted in old cocoa fields. The disease spreads quickly and no effective treatment is known. Isolation of infected areas with ditches and application of quicklime to the soil have been recommended.

In the South Pacific a root rot also occurs which may be caused by a *Fusarium*. This has led to banning of planting material imports from areas with fusarium wilt.

At present, a decline problem is affecting mature trees all over the Caribbean; nematodes have been implicated.

Premature Fruit Drop

This is associated with both excessive drought and excessive moisture, as well as the breadfruit decline.

Maturity, Harvesting and Yields

Trees come into bearing in 4–5 years and under good conditions in 2–3 years. Fruiting occurs throughout the year with two main peaks in December to April and July to September. Generally, the beginningof each cropping cycle precedes a rainy season. Flowering and early fruit growth begin in the dry season, while fruit maturity proceeds into the rainy season. The cropping season of the breadnut tends to be earlier than that of breadfruit by 2–3 months.

When the Yellow Heart breadfruit is mature, it changes colour from green to yellowish-green and latex exudes from the fruit, the surface of which becomes quite smooth. The attachment to the peduncle also weakens. The White Heart breadfruit tends to remain light green at maturity and exudes less latex.

Harvesting is manual; fruits are accessed by climbing or by long poles. The falling fruit is caught or may be allowed to fall to the ground before collection. Fallen fruits are usually damaged and should be consumed promptly otherwise portions or whole fruits have to be discarded.

In India, hand-pollination has been found to increase fruit number but this is not a suitable practice for commercial production.

A mature tree can produce an average of 250 fruits per year, each weighing 1–2 kg. Therefore, at a density of 100 plants/ha, 20–40 t/ha may be realized. Yields up to 700 fruits/year are possible however.

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PRODUCTION OF CASHEW

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Abstract
Cashew *(Anacardium occidentale* L.*)* is generally considered to be native of the northern part of South America but is now found in many tropical areas. The cashew is found throughout the Caribbean but few commercial plantations exist. India and Brazil dominates world cashew production and the United States is the most important consumer market. A brief description of the botany of the tree, its flowers, fruit and pseudo-fruit, nut and apple is provided. An appreciable crop is normally obtained after the third to fifth year after planting but only a year is required by the dwarf types. Cashew is resistant to drought on soil conditions that permit deep root penetration. Cashew needs a climate with a well- defined dry season of 4–6 months and a rainfall ranging between 800 and 1800 mm; heavy rains during flowering and fruiting affect yield. Humidity ranging between 65 and 85% is best for commercial cultivation; high humidity encourages fungal growth such as *Colletotrichum gloeosporioides* and *Oidium anacardii*. Dry conditions may result in withering of flowers resulting in considerable damage to yields. Cashew can be successfully grown on soils that are unsuited to other crops but performs best on deep, friable, well-drained, sandy loam soils where it can adapt to a wide range of pH. Many varieties have arisen due to selection of seeds from preferred trees over many years. Dwarf types exist and may be useful as rootstocks. The advantages and disadvantages of establishing cashew by sowing the nut *in situ* or by nursery-raised seedlings are outlined. Vegetative propagation is very important for the establishment of plantations of high-yielding material, producing a uniform product of high quality, however, a major disadvantage is its high labour cost. Various vegetative propagation methods have been tried but layering gives the best result. Spacing recommendations are 10 m x 10 m and 14 m x 14 m for giant types with a spacing of 6 m x 6 m for dwarf types. Bearing cashew trees remove NPK nutrients in a ratio of 4:1:2; generally cashew responds to fertilization. The major disease of cashew is anthracnose *(Colletotrichum gloeosporioides)*. Effective control can be obtained by spraying alternately with mancozeb, copper oxychloride and prochloraz every 3 weeks during the dry season and every 2 weeks in the wet season. Some details are provided for harvesting and processing of the nut and the apple.

Résumé
L'anacarde (*Anacardium occidentale* L.) est généralement considérée comme native de la,partie nord de l'Amérique du sud mais se rencontre maintenant dans beaucoup de régions tropicales. On en trouve partout à travers la Caraïbe mais peu de plantations commerciales existent. L'Inde et le Brésil dominent la production mondiale de nopix de cajou et les USA constitue le marché le plus important. Une description brève de la botanique de l'arbre, ses fleurs, fruits et pseudo-fruits, noix et pomme, est fournie. Une récolte appréciable est normalement obtenue de la troisième à la cinquième année après la plantation mais seulement une année est nécessaire pour les types nains. L'anacardier est résistant à la sécheresse en conditions de sols qui permettent une pénétration profonde de sa racine pivotante. Il requiert un climat avec une saison sèche bien définie, de quatre à six mois, et une pluviométrie variant entre 800 et 1.800 mm. Des pluies abondantes durant la floraison et la fructification affectent le rendement. L'humidité relative entre 65 à 85% est souhaitable; plus élevée, elle favorise le développement de champignons tels que anthracnose et oïdium; en conditions très sèches il peut y avoir flétrissement de fleurs ce qui résulte en une réduction des rendements. L'anacardier peut pousser sur des sols qui sont impropres pour d'autres cultures mais il donne de meilleurs résultats en bonne terres oú il peut tolérer une large gamme de pH. Au cours des ans de nombreuses sélections ont vu le jour, à partir d'arbres préférés pour la quantité et la qualité de leurs fruits. Des types nains existent qui pourraient être utilisés comme porte-greffes. Les avantages et inconvénients d'établir des plantations d'anacarde par semis direct "in situ" ou bien à partir de pépinières sont discutés. La propagation végétative de matériel de qualité est très importante pour l'établissement de plantations qui donneront des fruits uniformes de haute qualité; cependant, un inconvénient majeur est le coût de la main-d'oeuvre. Diverses méthodes de propagation végétative ont été essayées; le marcottage donne les meilleurs résultats. Les recommandations de distance de plantation varient de 10 x 10m à 14 x 14m pour des types géants et sont seulement de 6 x 6m pour les types nains. Les exportations d'arbres adultes sont dans la proportion 4 (N), 1 (P), 2 (K); généralement l'anacardier répond bien à la fertilisation. La maladie la plus grave est l'anthracnose *(Colletotrichum gloesporioides)*, laquelle peut se contrôler efficacement en appliquant alternativement différents fongicides, toutes les 3 semaines durant la saison sèche et tous les quinze jours durant la saison humide. Quelques détails concernant la récolte et la transformation des noix et des pommes cajou sont fournis.

Resumen
El marañon (Anacardium occidentale L.) se considera generalmente nativo de la parte norte de America del Sur pero ahora se cultiva en muchas áreas tropicales. Se encuentra en todas partes del Caribe pero existen pocas plantaciones comerciales. India y Brazil dominan la producción de marañon en el mundo y los Estados Unidos de América son el consumidor más importante. Se hace una breve descripción de la botánica del árbol, su floración, fruto (nuez) y seudo-fruto (manzana). Una cosecha apreciable puede ser obtenida normalmente del tercer al quinto año después de plantar pero sólo un año se necesita con los tipos enanos. El marañon es resistente a la sequía en condiciones de suelos que permiten una penetración honda de su raíz pivotante. Esta

especie requiere un clima con estación seca de 4 a 6 meses y pluviosidad de 800 a 1.800 mm. Fuertes lluvias durante la floración y fructificación afectan los rendimientos. Una humedad relativa de 65 a 85% es deseable; más alta, favorece el desarrollo de hongos tales como la antracnosis y el oidio. En condiciones muy secas puede haber marchitamiento de flores lo que resulta en reducción de rendimientos. Los marañones pueden crecer con éxito en tierras impropias para otros cultivos pero edan mejor en buenas tierras, en donde toleran un amplio rango de pH. En el curso de los años muchas selecciones se han hecho a partir de árboles preferidos por la cantidad y la calidad de sus frutos. Existen tipos enanos que se podrían usar como patrones. Las ventajas y desventajas de establecer plantaciones de marañon a partir de semillas, directamente in situ ó a partir de viveros se discuten. La propagación vegetativa es muy importante ya que el establecimiento de plantaciones con material de calidad significa la producción de frutos uniformes y de alta calidad; el inconveniente es su alto costo. Varios métodos de propagación vegetativa se han probado; el acodo da el mejor resultado. Recomendaciones de distancias varían de 10 x 10m a 14 x 14m por tipos gigantes, y son de 6 x 6m por tipos enanos. Arboles de marañon en producción extraen nutrientes en una proporción de 4 (N)/ 1(P)/ 2 (K); generalmente el marañon responde bien a la fertilización. La enfermedad más grave es la antracnosis (Colletotrichum gloesporioides); un control efectivo se puede obtener aplicando alternativamente diferentes fungicidas cada tres semanas durante la estación seca y cada dos semanas en la estación húmeda. Se proveen algunos detalles relativos a la cosecha y el proceso de la nuez y la manzana.

1. Introduction

1.1 Origin and Distribution

The cashew tree, *Anacardium occidentale*, generally considered to be native of the northern part of South America, is now found in many tropical areas. In all Spanish-speaking countries of Latin America, except Venezuela where it is called 'marey', it is named 'maranon', which may be derived from one of the first regions where the fruit was seen, the State of Maranhao in northern Brazil.

It is likely that Spanish sailors took the nut to Central American countries and certain that the Portuguese brought the cashew to their territories of the East Indies and Africa. The cashew tree exists in the Caribbean islands but has never been really cultivated by farmers.

1.2 World Production and Consumption of Cashew Nut

1.2.1 Production

Most of the world's production of cashew nut is grown in India and Brazil (Table 1). Some countries in eastern Africa produce cashew nuts in a rough state; one part of the production is exported to India, the other is processed before export.

Table 1: Cashew nut production (tonnes)

	1984/85	1985/86	1986/87	1987/88	1988/89*
India	35,000	120,000	126,000	130,000	122,000
Tanzania	32,000	18,000	16,000	26,000	27,410
Kenya	8 600	10,000	8,000	12,000	12,200
Mozambique	30,000	36,000	40,000	40,000	40,600
Brazil	116,000	120,000	76,000	136,000	132,000
Others	12,000	12,000	12,000	12,000	12,000
Total	332,600	316,200	276,600	364,000	346,000

*Estimated

1.2.2 Consumption

The most important demand in cashew almonds comes from the United States (Table 2).

Table 2: Main importers of cashew kernels (tonnes)

	1984	1985	1986	1987	1988
Australia	3,554	2,685	3,693	2,073	
Canada	3,378	3,244	3,083	2,753	
Germany	1,884	3,020	3,302	2,825	3,379
Japan	2,394	2,348	3,410	2,736	
Netherlands	2,245	2,382	2,275	2,474	3,149
United Kingdom	2,776	2,756	3,279	3,658	4,213
United States	35,573	47,982	43,445	40,661	
USSR	108	4,600	4,076		
France	778	876	851	1,177	

2. Botany and General Description of the Cashew Tree

2.1 Taxonomy

The cashew tree (*Anacardium occidentale* L.) belongs to the genus *Anacardium*, a member of the Anacardiaceae family which comprises about 60 genera and 400 species of trees and shrubs with resinous bark. It grows most abundantly in the tropics in both the southern and northern hemispheres.

Several other important fruits and nuts belong to this family:

- *Mangifera indica* L.: mango
- *Pistacia vera* L.: pistachio nut
- *Spondias dulcis* Forst.: otaheite apple
- *Spondias mombin* L.: hog plum
- *Spondias purpurea* L.: red mombin

2.2 The Plant

The cashew tree is an evergreen perennial that may grow as high as 15 m. When growing under favourable conditions and unharmed by pests, the

stem is erect, the canopy symmetrical and mostly umbrella-shaped. Under less favourable conditions the tree is much smaller with the stem often tortuous.

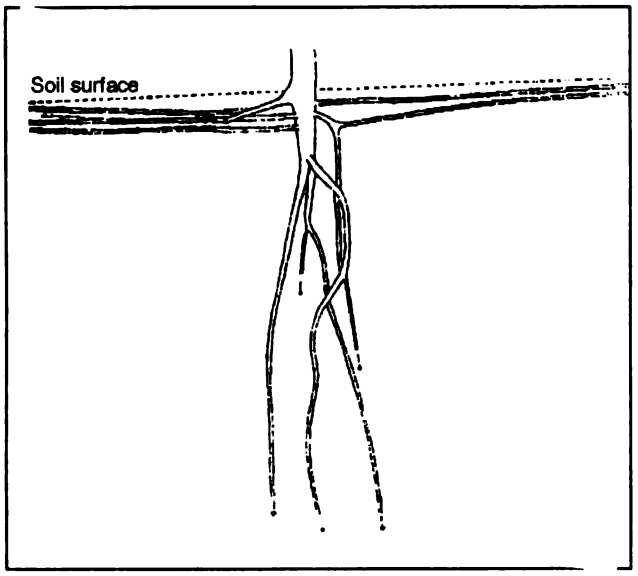


Figure 1: Root system of a 18-month-old cashew seedling sown directly

Under favourable conditions, young trees may grow at a rate of about 1 m per year, their canopy diameter increasing by about 1.5–2 m per year for the first 5 to 6 years, after which, growth may slow down.

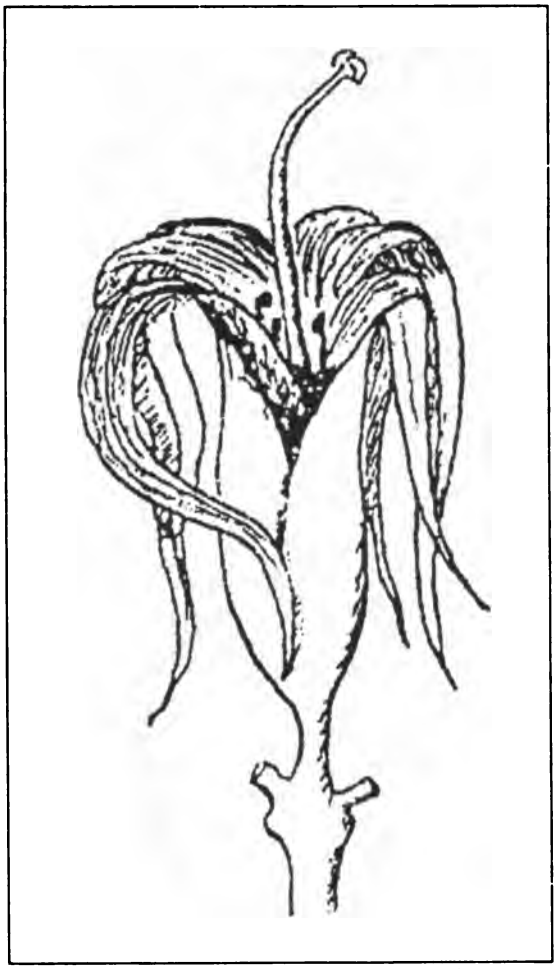
It is often stated that the tree will not grow for more than 30–40 years, or that its economic life-time is only that long.

The cashew tree has an extensive lateral root system and a tap-root that penetrates deeply into the soil (Figure 1).

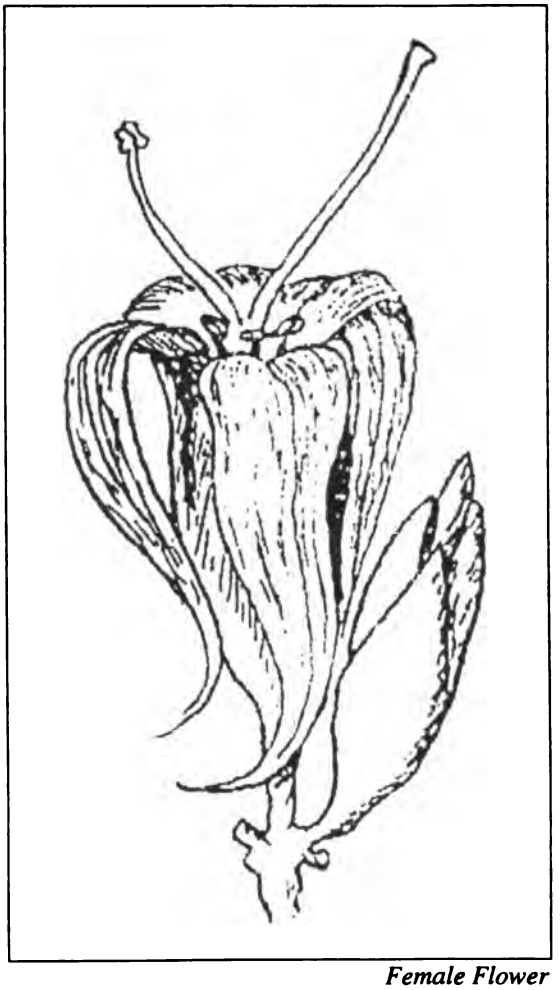
2.3 The Flowers

The inflorescence is a panicle and it may be either conical, pyramidal or irregular in shape. The flowers are small and white when just opened and in a few days turn pink.

Cashew is andromonoecious (Figure 2): in each panicle, perfect flowers and staminate flowers are produced. Generally the terminal flower of each cyme is perfect and the lateral ones are staminate. The sex ratio can vary from one perfect flower for six to eight male flowers, to one perfect flower for 25–30 male flowers.



Male Flower



Female Flower

Figure 2: Cashew flowers

In most countries with a marked dry season, nut production comes to a peak about 1 month after the first ripe fruits have fallen and continues at a high level for about 4–6 weeks, after which production slows down, indicating that most of the perfect flowers have opened. Differences in observations at various sites may be due to different ecological conditions, but also to genetic characteristics.

Generally, pollination is assumed to be by insects (ants, honeybees, flies).

2.4 Fruit and Pseudo-fruit

The nut is the true fruit of the cashew tree. It is attached to the apple (pseudo-fruit), the juice-swollen pedicel which is about five to ten times as heavy as the nut when ripe.

2.4.1 The Nut

The size, shape and components of the nut (Figure 3) vary considerably. The kernel is considered to be of high nutritional quality (Tables 3, 4 and 5). It has a wrinkled surface and is covered by a reddish brown or pink testa. The kernel itself is white. The shell of the nut has a leathery exocarp, a hard and brittle endocarp and a spongy mesocarp containing the cashew nut shell liquid (CNSC).

Table 3: Fatty acid composition (%) of cashew kernels

	A	B
Oleic acid	73.73	59.60
Linoleic acid	7.67	19.62
Palmitic acid		0.89
Stearic acid	11.24	8.75
Ligoceric acid	0.15	
Insaponifiable matter	0.42	

Table 4: Amino acid composition (%) of cashew kernel protein

Amino acids	Subramanian et al.	Montefredini	Fetuga et al.
Glutamic acid	28.00	6.51	18.74
Leucine	11.95	2.62	6.51
Isoleucine			3.86
Adanine	3.18	2.35	3.70
Phenylalanine	4.35		3.89
Tyrosine	3.20	1.42	2.37
Arginine	10.30	2.14	10.70
Glycine	5.38	1.12	4.60
Hystidine	1.81	0.88	2.06
Lysine	3.32	0.26	4.04
Methionine	1.80		1.40
Cystine	1.02	0.21	1.78
Threonine	2.78		3.10
Valine	4.53		5.80
Trpophan			1.37
Aspartic acid	10.78		9.20
Protine			3.72
Serine	5.76		4.76

2.4.2 The Apple

The size, shape and colour of the apple vary considerably. Cashew apples can be almost round, or elongated, sometimes resembling an apple but more frequently similar to a pear. Often the apple is heart-shaped, hence the name *Anacardium*. In some cases the apple is no larger than the nut but the usual ratio is 1:8 to 1:10.

When ripe, the apple is red or yellow, or some in between colour. Generally, the yellow apple is sweeter but, in all colour groups, more or less sweet or astringent apples are found.

The apples are very rich in vitamin C and riboflavin (Tables 6 and 7).

The cashew apple is a valuable fruit and it is a pity that its consumption is so low.

2.4.3 Fruiting

Cashew trees usually start bearing an appreciable crop in their third to fifth year, although some fruit may be borne on trees that are younger and sometimes little more that 1 year old. On dwarf types, first bearing often occurs in the first year.

A period of 2–3 months elapses between fruit set and fruit maturity. The true fruit reaches its

Table 5: Vitamin content (mg/100 g) of cashew kernel

Thiamine (B_1)	0.56
Niacine (PP)	3.68
Tocopherol (E)	2.10
Riboflavin (B_2)	(traces)
Pyridoxine (B_6)	traces)
Aserophtol (A)	(traces)
Vitamin D	(traces)

Source: Finzi (1966)

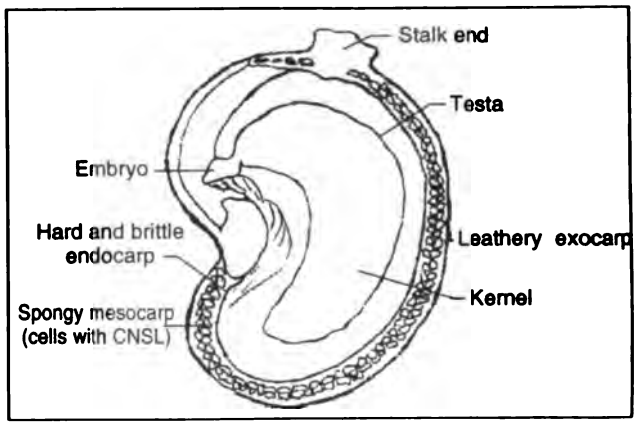


Figure 3: Cashew nut section

Table 6: Composition of cashew apples according to three different analyses

	1	2	3
Moisture (g/100 g)	86.1	85.90	87.9
Proteins	0.8	0.7–0.9	0.2
Fat	0.2	0.1	0.01
Carbohydrates	12.6	7.7–13.0	11.6
Fibre	0.6		
Ash	0.3	0.19	0.2
Ca (mg/100 g)	0.2	4.2	10.0
P	19.0	6.1	10.0
Fe	0.4	0.7	0.2
Vit. B_1 (thiamine)	0.2	0.002	
Vit B_2 (riboflavin)	0.2	0.02	
Niacin	0.5	0.13	
Vitamin C	200	140.600	262
Vitamin A (i.u./100 g)		450	

maximum size during the first half of this period, whereas the cashew apple makes most of its growth during the second half.

The harvesting period lasts from 2–4 months, depending on the region.

3. Climate

3.1 Temperature

Cashew is a tropical plant that develops well at high temperatures; it is a native of a semi-arid region where daily maximum temperatures may exceed 40°C (northern Brazil).

In most important cashew producing regions mean daily minimum temperatures vary between about 15 and 25°C and mean daily maximum temperatures between 25 and 35°C. The absolute minima and maxima are about 5 and 45°C, respectively.

All this can partly explain why regions where cashew is an important crop can be found between 15° south and 15° north.

3.2 Rainfall

Cashew can be very resistant to drought, but only under conditions where its roots can penetrate deeply into the soil and draw from water reserves that are not available to other crops.

In regions with rainfall as low as 500 mm, the depth of the phreatic level will be a major factor determining the performance of the tree. On the other hand, heavy rainfall, especially if rains are distributed throughout the year, is not favourable for cashew growing, though trees may grow and sometimes produce fruits. Light rains during flowering do not harm flowers, but heavy rains affect yields adversely.

Cashew needs a climate with a well-defined dry season of 4–6 months and a rainfall ranging between 800 and 1800 mm, depending on soil quality.

3.3 Relative Humidity

Low relative humidity is important during the flowering season to avoid the growth of fungi such as *Colletotrichum gloeosporioides* and *Oidium anacardii.* which may seriously affect cashew in humid areas. However, extremely dry air (<10%) during the flowering period due to dry desert winds such as the 'harmattan' in the interior of west Africa, may wither the flowers and cause considerable damage to yields.

However, it may be assumed that a relative humidity between 65 and 85% will be suitable for commercial cashew cultivation.

3.4 Sunshine

Generally, it is considered that cashew does best with a high number of hours of sunshine throughout the year and 1,500 hours are a minimum for good performance.

4. Soils

Cashew is often grown in soils that are considered to be too poor or strong for most other crops, but as a matter of fact, it performs better in good soils.

Table 7: Vitamin and mineral content of various tropical fruits

	Cashew apple (yellow)	Cashew apple (red)	Pine-apple	Avocado	Banana	Lime	Grape-fruit	Mandarin	Orange
Thiamine (mg/100 g)			80	120	90	40	40	70	80
Riboflavin (mg/100 g)	99	124	20	150	60	traces	20	30	30
Vitamin C (mg/100 g)	240	186	24	16	10	45	40	31	49
Ca (mg/100 g)	41	41	16	10	8	14		33	38
P (mg/100 g)	11	11	11	38	28	10		28	28
Fe (mg/100 g)	3	3	0.3	0.6	0.6	0.1		0.4	0.4

The best soils for cashew are deep, friable, well-drained, sandy loams without a hardpan and with the water-table at a depth of 5 to 10 m.

Cashew cannot withstand bad drainage, stagnant water or flooding. On badly drained land, cashew trees may suffer from too high a water-table in the rainy season and because they consequently develop superficial roots, they may suffer from drought in the dry season. On shallow soils, cashew has to compete with weeds for its water supply in the dry season.

In soils with a suitable texture, the trees appear to tolerate a fairly wide range of pH.

5. Varieties

Although the word 'variety' is often used in relation to cashew, there is some doubt as to whether this term is quite the right one.

Many local varieties may have come into existence by selection of seeds from preferred trees over many years, as a result of which the tree population has become dominated by that type of tree and intercrossing between the progeny may finally result in a certain consistency of tree characteristics.

This is probably the case in varieties such as 'Gigante de Magdalena', 'Larga de Nozare','Pequena de Meta' or 'Cayutin' from Colombia; 'Nacional' and 'Mexicana' from Panama; 'Hajari' from west Bengal.

About 10 years ago, various clones selected in Brazil were tested successfully in St Lucia and some of them (e.g. CP 09 and CP 76) show a high-yield capacity with a good nut size. Moreover, these dwarf types could be of great interest as rootstocks.

6. Propagation

6.1 Propagation from Seed

Most cashew nuts in the world are harvested from either wild self-sown seedlings or from plantations in which the trees have been raised *in situ* from seeds planted at stake (Figure 4). Propagation from seeds can also be done with nursery-raised seedlings.

The advantages and disadvantages of each technique are as follows:
Sowing cashew nut *in situ:*
Advantages:
- The plant can develop its root system, especially the tap root, naturally
- It is the cheapest way of planting
- It is the quickest method of planting (one man can easily plant 400–500 sites per day)
- It requires little technology

Disadvantages:
- Danger of damage by animals
- Less opportunity for selection of seedlings

Nursery-raised seedlings:
Advantages:
- Better rate of germination
- A selection of the most vigorous and homogenous plants can be done.

Disadvantages:
- Cost of material and transport
- Difficulties experienced in transplanting young seedlings successfully; damage to the tap root during transplanting is held responsible for a loss of ability to withstand drought

6.1.1 Selection of Seeds

Whatever the adopted solution for propagation from seed, a selection of seeds must be done. Where no

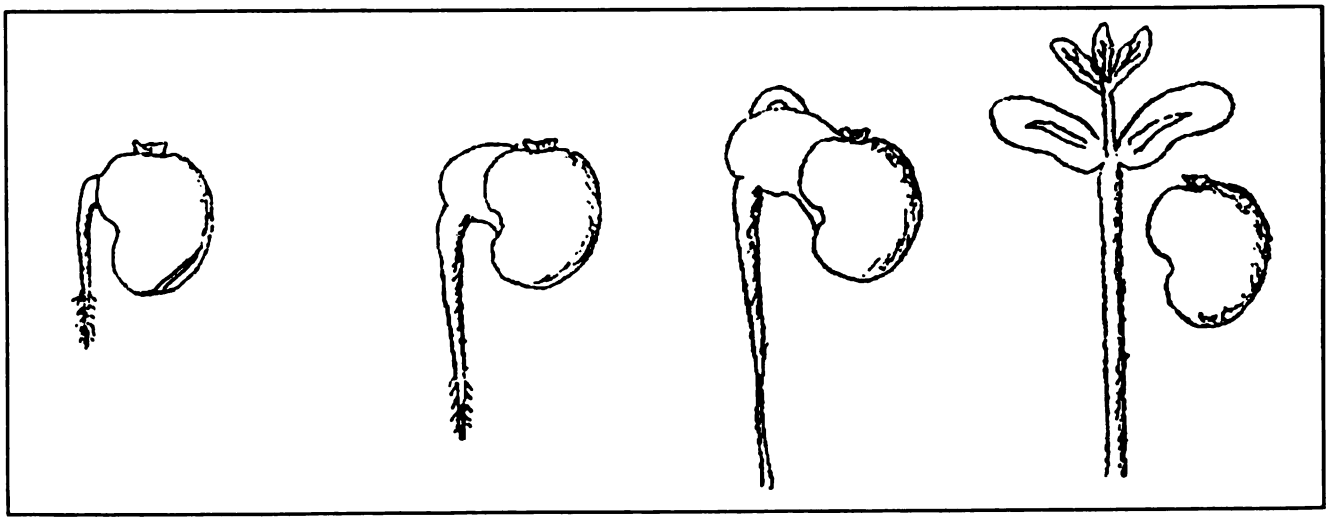


Figure 4: Successive stages of cashewnut germination

selected seed from an established seed garden is available, seeds should be taken from vigorous, high-yielding trees with nuts of good quality.

A more useful criterion of seed quality, however, is its specific gravity. A simple way of eliminating seeds with a low specific gravity is to place them in water and eliminate those that float. The latter shows lower viability and also take much longer to germinate than nuts that sink. A greater precision in sorting out seeds on the basis of their specific gravity can be obtained by using a sugar solution (about 150 g of sugar per litre of water).

6.1.2 Seed Treatment and Storage

Seed nuts should be thoroughly dry, clean and free from insect or fungal attack. Sun-drying is recommended, sometimes for as long as 12 to 14 days after harvesting. On the other hand, stored nuts gradually lose their germinating capacity after 6 to 7 months and there is no germination after 12 to 14 months in storage.

Lastly, pre-soaking the seeds in water for 24 to 48 hours slightly improves germination percentage and hastens germination by 1–4 days.

6.1.3 Seed Planting

Various experiments have proved that sowing with the stalk end upwards gives the best germination and seedling development.

Seeds can usually be sown at depth of about 5 cm , the maximum depth being at about 10 cm , depending on soil conditions.

6.2 Vegetative Propagation

Vegetative propagation is very important for the establishment of plantations of high-yielding material, producing a uniform product of high quality; the major disadvantage is its high labour cost.

Various methods of vegetative propagation have been tried, with varying degrees of success. Because of its high rate of success, layering has been the method most used until now, although patch-budding in Mozambique and approach grafting in India have also been practised. The use of cuttings has not been very successful.

Many other kinds of graftings or buddings have been tested more or less successfully, particularly tip-grafting (cleft or whip grafting; Figure 5).

7. Cultural Practices

7.1 Planting

- Holes from 30 cm x 30 cm x 30 cm to 60 cm x 60 cm x 60 cm are generally recommended, depending on the soil texture and fertility.
- These holes must be filled with topsoil and organic matter, if available.
- Sowing or planting should be done when the rains have started falling regularly and the soil does not dry out again.

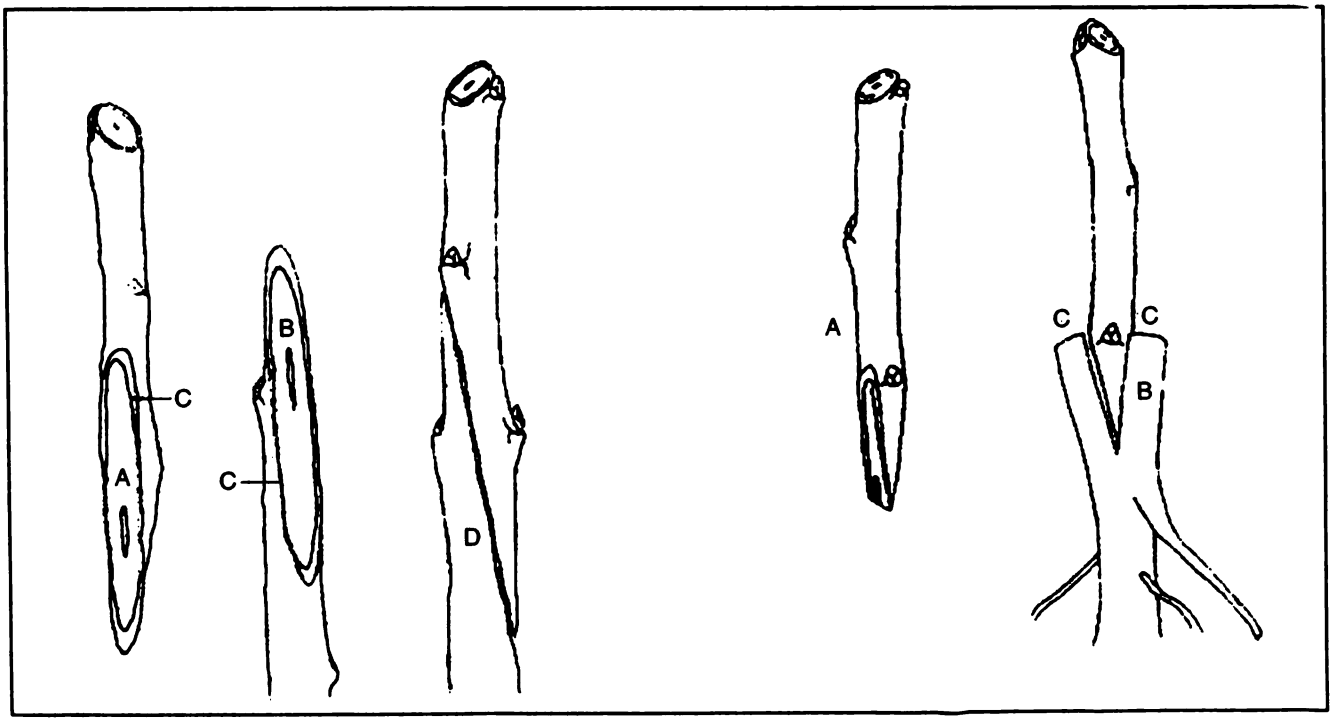


Figure 5: Grafts

For direct sowing of gaps and also to be able to select the most vigorous seedling, three or four seeds per site may be sown at a distance of about 15 cm from each other. After 10 to 15 days, if none of the seeds is growing on a site, they should be replaced by new ones, providing the rainy season is still well established.

7.2 Spacing

In practice, the spacing most frequently used varies between 10 m x 10 m and 14 m x 14 m for giant types, according to local conditions and expectations of development of the trees. For dwarf types, a spacing of 6 m x 4 m is generally recommended.

7.3 Maintenance of the Plantation

7.3.1 Fertilizing

The estimated removal of nutrients by a bearing cashew tree is in an average NPK ratio of about 4:1:2.

Various fertilizing schedules have been used depending on quality and fertility of soils. In most cases it was shown that cashew responds well to fertilizers.

7.3.2 Weeding

The need for weeding is based on the competition for water and nutrients and also for light in the young stages of the plant.

During the first years of growth, ring weeding should be practised. Weed growth beyond the clean-weeded area can be kept low by slashing. Once the trees have developed a canopy of several metres, ring-weeding can be stopped, but weeding between the trees should be intensified.

Chemicals may be used when labour is too expensive.

7.3.3 Intercropping

Intercropping can be an important factor in determining the economic results of the plantation and contributing greatly to the establishment of young trees. It is also very beneficial for the trees when fertilizers are used. Intercrops can be selected for height of growth and length of vegetative period so as not to compete with cashew. Leguminous crops such as groundnuts and beans are very suitable for intercropping.

7.3.4 Pruning

Generally, pruning is limited to removing low branches during the first years of growth to a height of about 60 cm . Removing dead wood or branches, mummified inflorescences and flower bracts would also be a good means of controlling anthracnose.

7.3.5 Fire Protection

Fire-break strips are very important to prevent eventual fires from reaching the plantation. Strips of about 10 to 15 m wide around the different big plots of the plantation should be kept free from weeds.

7.3.6 Pests and Diseases

The main cashew pests and diseases have been described throughout the world but few records are available for Caribbean areas. Guadeloupean experience shows that the main pests are mealybugs and above all thrips (*Seleno thrips rubrocinctus*) that can be easily controlled by chemicals.

Among diseases, anthracnose caused by *Colletotrichum gloeosporioides* is the most important. The disease is particularly devastating to young leaves (field and nursery) where defoliation of flush growth is common. If wet weather prevails during flowering, it causes a severe blossom blight which can destroy inflorescences and prevent fruit set. Affected nuts and apples decay and shrivel.

Effective control of anthracnose can be obtained by spraying alternately with Mancozeb, copper oxychloride and prochloraz every 3 weeks during the dry season and every 2 weeks in the wet season.

Cultural practices are also very important to control this disease. Above all, good orchard hygiene should be a priority to maximize air circulation and penetration of sunlight and consequently to reduce the multiplication of the fungus. In small holdings, where ample labour may be available, removal and burning of infected dead parts of trees and fallen leaves could reduce the fungus inoculum, but on large plantations this would be a costly practice.

8. Harvesting of Nuts and Apples

Generally, harvesting consists of reaping the nuts that have dropped to the ground after maturing. If apples are also processed, the fruit has to be harvested before it falls naturally.

When only the nuts are collected, the apples are detached from the nuts and thrown away. In order to find the nuts easily, the surface under the tree has to be free from weeds. Per man-day, a maximum of about 50 kg can be harvested. The interval between harvesting rounds in a plantation, without losing too much of the quality of the nut, depends on climatic conditions. In very dry climates, nuts can remain under the trees for several weeks without losing their quality, but where early rains start before the harvest is over nuts should be reaped sometimes as often as twice a week. This explains why harvesting is labour-consuming, but as it is not heavy labour, women and children can participate as well.

If the apples are used for processing, picking from the tree is preferred to reaping. It is recommended to pick the fruit when it is about to fall and the nuts should remain attached to the apple so as not to lose juice.

After harvest, nuts should be stored in a dry area before processing in order to avoid deterioration of the kernel due to its high moisture content (mould, bacterial attack or enzyme action).

9. Processing

9.1 Processing of the Nut

9.1.1 Roasting

Roasting is the first stage of nut processing and its main goals are to weaken the nut and make it easily breakable and to allow exudation of cashew nut shell liquid (CNSL).

In the cashew cottage industry, two ways of roasting may be used:

- The 'open pan' method where nuts are roasted in a perforated open pan over an open wood fire. The exuded shell liquid drips through the holes and is burned in the fire, causing heavy, acrid and very irritant fumes. The nuts have to be stirred frequently for uniform roasting.
- The 'hot oil bath' method where nuts are placed in wire baskets and immersed for about 90 seconds in a tank containing CNSL kept at a constant temperature of about 170–200°C. Exact time and temperature differ slightly for each size of nut. When we practised this technique in Burkina Faso for small-scale industry, we used old motor car oil for the first bath due to the unavailability of CNSL and half drums as tanks. But to be more secure the tank should be made of stainless steel to withstand the action of the hot CNSL exuded from nut shells. When roasted nuts are thrown out of the basket they must be dusted with wood ashes to neutralize the acidity of CNSL remaining on the nuts. The advantages of the hot bath method are much more uniform roasting and a much higher yield of white whole kernel.

9.1.2 Steaming

This technique has been used for 20 years in large industries including the processing of other nuts such as chestnuts.

Research modified this technique for cottage industry operations. The principle is steam cooking the nuts with the energy being provided by burning the shells.

9.1.3 Shelling

This stage has always been a great problem in the processing of cashew nuts. A good shelling technique is based on its high yield of whole kernels. In India, it has always been done manually with a high degree of competition due to the great skill and the low wages of the Indian workers. The nut is placed on a flat stone and cracked with a wooden mallet. Yields vary between 4 and 10 kg of kernels per worker and per day, the percentage of whole kernels varies between 50 and 90%.

The semi-mechanized process that has been used in Brazil for a long time, uses a pair of knives, each shaped in the contour of half a nut. When the knives come together by means of a foot-operated lever, they cut through the shell all around the nut, leaving the kernel untouched. The nuts have to be previously sorted into various sizes, each size matching a pair of knives of appropriate size. A team of two persons is used for this work: the sheller cuts the nuts and a second one opens them and separates kernel and shell. Daily production is about 15 kg of kernels per team and about 90% of whole kernels are obtained with this method.

Five persons working in a unit including a steam cooking machine and two semi-mechanized shelling machines can process approximately 250 kg of nuts per day (about 50 kg of kernels).

9.1.4 Peeling

In small-scale industry, peeling is always done by hand by rubbing the kernels with the fingers. Parts that still adhere to the kernel are removed by means of a knife. Care should be taken not to scratch the kernel surface too much as this lowers the quality.

9.1.5 Packing

As cashew kernels are subject to rancidity and get stale very quickly, packing should be air-tight and impermeable for good preservation and marketing,

9.2 Processing of the Apple

Processing of cashew apple is to a great extent similar to the processing of other fruits and various products can be made from the apples such as: fruit paste, candied fruit, canned fruit, jam and jelly, chutney, fruit juice, wine spirit and vinegar.

DISEASES OF MINOR FRUITS AND DISEASE MANAGEMENT STRATEGIES

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Abstract
Literature on diseases of the minor fruit crops of the Caribbean is sparse. Information on the major diseases of these minor fruit crops reported from around the world are collated. These diseases are identified according to the parts of the plant they affect: flowers, e.g. flower blights on cashew; leaves, e.g. leaf spots in sapodilla and mango, rust diseases in the Myrtaceae family; fruits, e.g. anthracnose and other fruit spots and stem end rots of golden apple in Grenada. Post-harvest diseases and pathogens resulting in twig and tree death are discussed. Disease management strategies include choice of commodities to be produced based on commercial considerations; germplasm introduction, evaluation and selection; propagation techniques; appropriate siting of orchards; employing appropriate crop husbandry and production practices.

Résumé
La littérature sur les maladies des fruits tropicaux mineurs de la Caraïbe est peu fournie. Les sources d'information consistent surtout dans les rapports des techniciens des services de vulgarisation. Ces maladies sont classées selon la partie de la plante qui est attaquée; a) fleurs: ex. brûlures sur fleurs d'anacarde, b) feuilles: ex. taches sur feuilles de sapotille et de manguier; rouilles en ce qui concerne la famille des Myrtacées, c) fruits: ex. anthracnose et autres types de pourriture sur prune de cythère. Les maladies de post-récolte et d'autres maladies des arbres sont discutées. Les stratégies de contrôle pour toutes ces maladies incluent le choix des espèces et variétés, l'introduction de germoplasme, l'évaluation et la sélection des cultivars, les techniques de propagation, le choix de l'emplacement des vergers et l'emploi de techniques culturales appropriées.

Resumen
Existe poca literatura sobre enfermedades de frutas ménores del Caribe. Se reporta aquí la información relativa a enfermedades según informes de funcionarios de los servicios de extensión agrícola. Las enfermedades se clasifican de acuerdo a las partes afectadas: a) flores: ex. quemaduras en marañon, b) hojas: ex. manchas de la hoja en níspero y mango, royas en la familia de las Mirtáceas, c) frutas: ex. antracnosis y otros tipos de pudrición en jobo de la India. Enfermedades de la post-cosecha y otras enfermedades de los árboles se discuten también. Las estrategias de manejo de las enfermedades incluyen la selección de especies y variedades basada en consideraciones comerciales, la introducción de germoplasma, la evaluación y selección de cultivares, técnicas de propagación, la selección apropiada de sitios para huertos y el uso de técnicas culturales apropiadas.

Introduction

The fruits which fall within the ambit of the group 'minor fruits' include a very wide range of commodities such as guava, West Indian cherry, sapodilla, the annonas, golden apple, plums, cashew, governor plum, jackfruit, pomerac, Java plum, barbadine, dunks, chenette and star apple, just to name a few. While these fruits may be very familiar to West Indians, very little organized research and other related studies have been carried out to explore their potential as foreign exchange earners or for import substitution.

Accordingly, the literature available on the major diseases of this wide range of fruits is sparse. This paper attempts to collate information on the diseases reported and by the extension to provide some guidelines on the disease management strategies that can be taken into consideration with crop expansion.

1. Major Diseases of the 'Minor Fruit' Group

Table 1 presents a comprehensive list of the major diseases reported on these fruits from around the world. A brief narrative of the diseases which are of importance such as leaf spots, fruit rots (both pre and post-harvest), tree death, etc. follows.

1.1 Seedling Death

In the propagation of these fruits, seedling death has been caused by several fungi. With guava (*Psidium guajava*), damping off caused by *Fusarium solani* and *F. oxysporum* has been reported from India. In Trinidad, *Rhizoctonia solani* has been reported causing a serious leaf blight on governor plum (*Flacourtia indica*) seedlings in the nursery while *Sclerotium rolfsii* (southern blight) was responsible for death of cashew seedlings.

In Puerto Rico, a seedling collapse, leaf fall and stem die back has been reported on the annonas, caused by *Glomerella angulata.*

1.2 Flower Blights

By far the most important disease recorded on cashew (*Anacardium occidentale)* is flower blight caused by several fungi, the major ones being *Glomerella cingulata* and *Phomopsis anacardii.* Blighting of the inflorescences results in flower abortion,

Table 1: Diseases reported on fruits within the minor group category

Botanical name	Venacular or common name	Disease and causal agents (or associate organism)		Reported from
Anacardiaceae				
Anacardium occidentale	Cashew	Fruit/nut rot spot:	*Glomerella cingulata*	Widely distributed (1)
		Fruit spot:	*Phomopsis anacardii;*	Widely distributed (1)
		Flower blight;	*G. cingulata; P. anacardii*	Widely distributed (1)
		Scab:	*Sphaceloma anacardii*	India (1)
		Tree death:	*Valsa eugeniae*	Tanzania (1)
		Powdery mildew:	*Oidium* spp.	Grenada (pers. comm)
		Southern blight:	*Sclerotium rolfsii*	Trinidad (2)
Spondias cytherea	Pomme cythere; Golden apple Ambarella; June plum	Fruit spot:	*Colletotrichum gloeosporioides*	Grenada (pers. comm)
			Phomopsis spp.	Grenada (pers. comm.)
			Botrysosphaeria ribis	Grenada (pers. comm.)
		Stem end rot:	*Phomopsis* spp.	Grenada (etiology to be confirmed)
			Botryosphaeria spp.	
		Gumming:	*Pestalotiopsis* spp.	Trinidad; Grenada
		Syndrome-trunk:	basidiomycete fungus	(unknown etiology)
Spondias purpurea var. *lutea*	Chili plum; Jamacian plum common plum	Fruit:	*Phytophthora palmivora*	Trinidad (2)
Passifloraceae				
Passiflora quadrangularis	Barbadine; Giant granadilla	Fruit rot:	*Colletoirchum gloeosporioides*	Trinidad (2)
		Stylar end fruit rot:	*Phoma* spp.	Trinidad (2)
		Stem end fruit rot:	*Lasiodiplodia* spp.	Trinidad (2)
		Leaf stem spot:	*Alterneria passiflorae*	Australia (1)
Rhamnaceae				
Zizyphus mauritiana	Dunks; Indian jujube	Powdery mildew:	*Oidium* spp.	Grenada
Sapindaceae				
Melicoocus bijugatus	Chennette; Genip; Skinup	Fruit rot:	*Colletotrichum gloeosporioides*	Trinidad (2)
Annonaceas reticulata	Custard apple; Bullock's heart	Leaf rot:	*Cercospora anonae*	Brazil (1)
		Fruit spot:	*Phomopsis anonacearum*	Trinidad (2)
Annonaceae squamosa	Sugar apple	Fruit spot:	*Phomopsis anonacearum*	Austrialia (1)
		Marginal leaf scorch:	*Phomopsis annonacearum*	
		Thread blight:	*Cortcium* spp.	Trinidad (2)
Annona	Soursop; Sugar apple; Custard apple	Fruit rots, seedling collapse, leaf fall, stem die-back;	*Glomerella cingulata*	Puerto Rico (1); India (1)
Flacourtiaceae				
Flacourtia indica	Governor plum; Cerise	Fruit rot:	*Colletotrichum gloeosporioides*	Trinidad (2)
		Thread blight:	*Corticium* spp.	Trinidad (2)
		Leaf blight:	*Rhizoctonia solani*	Trinidad (2)

Table 1: Concluded

Botanical name	Venacular or common name	Disease and casual agents (or associate organism		Reported from
Malpighiacae				
Malphigia glabra	West Indian cherry; Barbados cherry.	Root rot:	*Fusarium* spp.	Trinidad (2)
Moraceae				
Artocarpus heterophyllus	Jackfruit; Koa	Fruit rot:	*Rhizopus stolonifer*	Florida, USA
		Thread blight:	*Ceratobasidium* spp.	Trinidad (2)
Myrtaceae				
Psidium guajava	Guava	Grey leaf spot and fruit canker:	*Pestalotiopsis psidii*	
		Fruit rot:	*Maacrophomine allahabadensis*, *Glomerella cingulata*	India (1)
		Damping off:	*Fusarium solani* and *F. oxysporum*	
		Scab:	*Sphaceloma psidii*	Brazil (1)
		Twig/tree death:	*Physalospora psidii.*	India (1)
		Rust:	*Puccinia psidii*	Central & South America, Florida, West Indies (1)
Syzygium jambos				
Syzygium cumini	Rose apple; Java plum	Rust:	*Puccinia psidii*	Distribution as for guava.
		White pocket rot of roots:	*Rigidoporus zonalis*	India (1)
Syzygium malaccensis	Pomerac; French cashew; Otaheite apple; Plum rose	Rust:	*Puccinia psidii*	Distribution as for guava
		Leaf spot:	*Pestalotiopsis* spp.	Trinidad (2)
Sapotaceae				
Manilkara achras	Sapodilla	Fruit rot:	*Phytophthora palmivora*	India (1)
		Grey leaf spot/ fruit canker:	*Pestalotiopsis versicolor*	India (1)

(1) Holiday P. 1980. Fungus diseases of tropical crops. Cambridge: Cambridge University Press.
(2) Ministry of Agriculture. 1982–88. Plant pathology diagnostic reports, 1982–88. Central Experimental Station Annual Reports. Trinidad and Tobago: Ministry of Agriculture.

reduced fruit set, early fruit fall and fruit and nut anthracnose disease. *P. anacardii* also causes a leaf blotch, drying of shoots and mummification of young fruit in cashew.

In drier areas, blighting of the inflorescences is caused by powdery mildew (*Oidium* spp.) as recorded on dunks (*Ziziphus mauritiana*) and cashew in Grenada.

1.3 Leaf Spots

The fungus *Pestalotiopsis* sp. has been recorded as causing both leaf spots and fruit rots. On guava, *P. psidii* has widespread occurence as a grey leaf spot. However, this fungus also is responsible for a fruit canker on guava. While *P. psidii* is generally regarded as a weak and/or wound pathogen, its presence on the tree as a leaf spot can lead to heavy post-harvest fruit losses.

Other species of *Pestalotiopsis* have been recorded as leaf spotting diseases of:

Sapodilla	—	*P. versicolor*
Mango	—	*P. mangifera*
Cashew	—	causing leaf burning
Pomerac	—	leaf spot

In Brazil, *Cercospora annonae* has been recorded on custard apple (*Annona reticulata*) causing a leaf spot, while *Phomopsis annonacearum* causes a marginal leaf scorch of sugar apple (*A. squamosa*) in Australia. On barbadine (*Passiflora quadrangularis*) in Australia, *Alternaria passiflora* has been reported as a leaf and stem spotting agent.

Reported from Martinique on *Spondias dulcis* was a disease causing oily spots on leaves on non-lignified green twigs and as lethal cankers on branches. The causal agent was identified as *Xanthomonas campestris*.

1.3.1 Rusts

Another major disease of fruits is that commonly referred to as 'rusts'. In the family Myrtaceae, rust caused by *Puccinia psidii*, is a very important disease and occurs on guava, pimento, rose apple and pomerac. The pathogen *P. psidii*, is confined to parts of Central and South America, USA (Florida) and some of the West Indian islands where both pimento and guava are indigenous. While little research work has been done on this disease, attention was attracted when an epidemic on pimento in Jamaica around 1934 caused serious losses to the spice industry.

The fungus, *P. psidii*, infects young fruit, inflorescences, immature leaves and shoots; severe infestations may lead to defoliation and die back of stems. Several races of *P. psidii* have been reported. Sweet cultivars of guava are more susceptible to this disease.

1.4 Fruit Diseases

1.4.1 Anthracnose

A major disease of fruits in the tropics is anthracnose caused by the fungus *Glomerella cingulata* and/or its anamorphic state *Colletotrichum gloeosporioides*. This fungus may be solely responsible for the disease or may occur together with other fungi.

One of its most important and common forms is the latent infection in the tropical fruits. Incipient infection takes place on the tree while the fruit is young and green; this infection however is invisible to the naked eye. Under certain conditions which occur during ripening (on or off the tree), transport or storage, these incipient infections develop to cause necroses. These are typical sunken, black lesions with fungal spores of a pink or salmon colour.

Table 2 describes anthracnose-type disease caused by *G. cingulata* and/or *C. gloeosporioides* and other fungi.

1.4.2 *Phytophthora* spp.

Phytophthora palmivora has been reported as a fruit rotting pathogen on sapodilla (*Manilkara achras*) from India and chilli plum (*S. purpurea* var. *lutea*) from Trinidad. On plums, the disease is first observed on mature green fruit which turn brown, shrivel and become mummified. When environmental conditions are favourable, a dusty white bloom of fungal spores is visible on these fruit. Infection on a few fruit in a cluster will eventually lead to the entire cluster becoming mummified and spread to the fruit peduncles and stems. This disease has been observed during the rainy season in very wet and humid areas and occurs from year to year. The fungus *P. palmivora* is known to survive in the soil on decaying fruit and leaf material. Another species of *Phytophthora*, *P. nicotianae* var. *parasitica* has been reported on guava fruits in India.

1.4.3 *Phomopsis* spp.

The fungus *Phomopsis* is also an important fruit rotting pathogen in the tropics. On sugar apple and custard apple, *P. annonacearum* causes purple fruit lesions near the apical end; these lesions become hard and cracked with internal necrosis. On cashew, *P. anacardii* occurs on the inflorescences and causes lesions on young fruit and nuts.

Recent studies in Grenada, have revealed the presence of *Phomopsis* spp. associated with the fruit spot and stem end rot of golden apple.

1.4.4 Scab-like Diseases

Scab caused by the fungus *Sphaceloma* is another pathogen of importance on citrus and avocado in the tropics. *S. anacardii* has been reported on cashew

Table 2: Anthracnose-type disease on minor fruits caused by *Glomerella cingulata* and/or *Colletatrichum gloeosporioides*

Fruit species	Description of the disease	Pre-harvest	Post-harvest
Anacardium occidentale cashew	Fruit and nut rot on young tissue which follows after blighting of inflorescences. Heavy fruit fall. (*Glomerella cingulata*)	•	
Meliococcus bijugatus chennette	Fruit rot: brown stain on outer skin (shell) or fruit. (*Colletotrichum gloeosporioides*)	•	•
Flacourtia indica cerise	Fruit rot: results in spoilage of fruit; on both green and ripe fruit. (*C. gloesporioides*)	•	•
Passiflora quadrangularis barbadine	Brown sunken spots scattered over fruit surface result in heavy blemished fruit (*C. gloeosporioides*).	•	
Annonas Soursop, sugar apple; custard apple	Black fruit rots; also causes mummification of young fruit (*G. cingulata* or *C. glocospericides*)	•	
Psidium guajava Guava	On young fruit: corky scab-like cankers. (*G. cingulata*)	•	
Spondias cytherea Golden apple	Brown to black spots associated with pockets of gum (*C. gloeosporiodes*)	•	

in India on young susceptible leaf and fruit tissue. Infection results in raised lesions which crack leading to penetration by secondary organisms. *S. psidii* has been recorded from Brazil on guava.

1.4.5 Other Fruit Diseases

In India, another important fruit rotting disease of guava is caused by *Macrophomina allahabadensis.* Diseased fruit show a brownish and water-soaked discolouration of the skin; fungal mycelia eventually become dark brown to black covering the fruit surface on which pycnidia are borne.

On jackfruit (*Artocarpus heterophyllus)* in India, a serious disease caused by *Rhizopus stolonifer* has been recorded. Young fruit and male inflorescences are infected and this can take place without injury to the host. The disease is so severe that specific control by the use of fungicides has been effected.

1.5 Post-harvest Diseases

While many of the diseases reported on fruits during the pre-harvest stage do impact significantly on the post-harvest life of the fruit also, some diseases only occur after the fruit has been harvested or develop in storage.

Studies on *Passiflora quadrangularis,* (barbadine) in Trinidad recorded two diseases which occured on mature harvested fruit. In storage trials of barbadine, the fungus *Lasiodiplodia theobromae* occured as a stem end rot which turned the fruit into a black mass of mycelia and spores. *L. theobromae* is a weak pathogen which lives on the fruit peduncle (stem) and during storage under ideal conditions grows to completely envelop and rot the fruit.

Another fungus *Phoma* spp. was recorded on the blossom end of the barbadine fruit on the persistent style. This fungus caused a hard, black sunken lesion with abundant pycnidia but the entire fruit was not rotted. The fungus only infected the blossom end of the fruit and spread was very slow.

On guava *Pestalotiopsis psidii* not only causes a leaf spot but also a post-harvest fruit canker. This disease is regarded as one of the major post-harvest diseases of guava in India. The fungus being a weak pathogen does not penetrate deeply into the fruit tissue but heavily blemishes the fruit thus reducing its market value. The disease is favoured by temperatures of 25–30°C and high relative humidity.

1.6 Twig and Tree Death

The disease called thread blight caused by a basidiomycete fungus *Corticium* (or *Ceratobasidium*) is of major concern during the rainy season. The host range of this fungus is very wide and reports from Trinidad have included *A. heterophyllus* (jackfruit), *F. indica (cerise)* and *A. squamosa* (sugar apple).

In cashew, the disease *Valsa eugeniae* has been reported from Tanzania as causing death of mature trees. *V. eugeniae* is the pathogen of sudden death disease of clove.

The fungus *Physalospora psidii* causes a disease on guava in India which results in the cracking of the bark of young branches leading to death of the tree.

2. Disease Management Strategies

The issue of disease management is based on the premise that the production of fruits included within the grouping 'minor fruits' is from scattered, unselected cultivars in an unorganized manner. In order to proceed from this stage to a (semi-) commercial and organized orchard management system, a holistic approach to disease management is proposed. It should also be understood that concurrent with increased production of a crop in a monoculture orchard system, the incidence of both pests and diseases also increases.

The focus of disease management then is applied to and is part of a series of stages moving the crop into a commercial orchard phase.

The major areas are:

- *Choice of commodity*: Given the present information available on a particular commodity, other indicators such as economic analysis, cost of production, market intelligence and processing opportunities, should be first obtained and evaluated before a commodity is selected.
- *Germplasm introduction, evaluation and selection*: Based on the selection of a particular commodity, emphasis should be focused on germplasm introduction, evaluation and then cultivar selection. In order to achieve uniformity in quality, selection of cultivars with known characteristics is required. Criteria for cultivar selection will be guided by:
  - end-product, i.e. whether for fresh fruit market, processing or other uses.
  - disease identification/diagnosis and cultivar tolerances to major diseases.
  - appropriate crop husbandry practices.
- *Propagation techniques*: Success/failure with the propagation of plant material is to a large extent governed by the absence/presence of diseases. Accordingly, attention should be focused on effectively and efficiently propagating these fruits whether by true seed, cuttings, grafts or tissue culture so as to reduce losses due to diseases.
- *Appropriate siting of orchard*: The zoning of particular fruit crops to areas of low rainfall intensity, for example, cashew in dry marginal lands, will undoubtely reduce disease infection on inflorescences and young fruit. This zoning however, should be complemented with new technologies such as irrigation and fertigation techniques.
- *Crop husbandry/apporpriate technology*: Full knowledge of the crop selected, its physiology, flowering and fruiting patterns together with the use of appropriate technology will guide the disease management system used within an orchard-type setting.

DUNKS (Indian Jujube)

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Abstract
Indian jujube (*Ziziphus mauritiana* Lam.), often called dongs, or dunks in the Caribbean, is the only commercially suitable tropical species of *Ziziphus*. The fruits which are rich in vitamin C are eaten fresh green or ripe, candied, pickled; in Venezuela it is used to produce a liqueur. The plant is suited to dry tropical areas. In India where it is commercially grown, the tree does best on sandy loam, neutral or slightly alkaline soils. In the humid tropics, there may be several crops during the year with main crop at the begining of the dry season. Superior varieties selected in the Caribbean have fruits almost [illegible] in diameter with an apple or ellipsoid shape. Propagation by seed is not easy, however, a technique is described which ensures germination in 7 days. Vegetative propagation by cuttings or grafts is easy. Estimated yield for adult trees is 50–60 kg/yr. The recommend planting distance is 5 m × 5 m using grafted trees or trees from cuttings. No serious pests or diseases have been reported for this crop in the Caribbean.

Résumé
La jujube indienne (*Ziziphus mauritiana* Lam.) est originaire de Chine méridionale. L'espèce fut introduite à Taiwan en provenance de Thaïlande. Des croisements en pollinisation libre suivis d'une sélection et de multiplication ont donné naissance à quelques cultivars commerciaux populaires: "Pi yun", "Te kong" et "Huang kuan". Des distances de plantation de 6m × 5m donnant une densité de 300 plantes/ha sont utilisées. La taille de première année consiste à former un tronc de 30 cm d'oú partent 3–4 charpentières. Une deuxième taille en mai-juin permet d'éliminer les rejets et les rameaux faibles ou surnuméraires. A partir de la deuxième année les charpentières sont rabattues systématiquement à environ 80 cm du sol après la récolte. Une autre technique de taille — la taille longue — est aussi décrite. La première application annuelle d'engrais est recommandée dès l'apparition des nouvelles pousses, la seconde à la pleine floraison et la troisième au début de la récolte. L'utilisation de cultivars de caractéristiques différentes, la taille et l'illumination nocturne sont des techniques employées à Taiwan pour régulariser la saison de production. Des résultats préliminaires obtenus avec la jujube indienne à Ste Lucie et à Grenade montrent que des cultivars de Taiwan présentent un grand potentiel en termes de production et de commercialisation dans les Caraïbes. Prácticas culturales y regulación de la producción de jujube (Ziziphus mauritiana Lam.) en Taiwan y su aplicabilidad en el Caribe.
Lai-Sen Hsuing

Resumen
El jujube (Ziziphus mauritiana Lam.) es originario de China del sur. Se introdujo a Taiwan a partir de Tailandia; subsecuentes cruzamientos abiertos seguidos de selección y propagación dieron orígen a varios cultivares comerciales muy populares. Distancias de 6m × 5m (300 plantas/ha) se usan. La poda consiste en recortar el tronco a una altura de 30 cm después del primer año y dejar 3–4 ramas principales. Una poda más ligera se hace luego en mayo o junio, para eliminar los chupones, las ramas débiles ó sobrenumerosas. A partir del segundo año el tronco se poda a una altura de aproximadamente 80 cm inmediatamente después de la cosecha. Otro tipo de poda larga se describe. Se recomienda hacer la primera aplicación anual de fertilizante al inicio del crecimiento de los nuevos brotes, la segunda a la plena floración y la tercera al principio de la cosecha. El empleo de cultivares con características de producción diferentes, la poda y la iluminación nocturna son unas de las técnicas empleadas en Taiwan para regular las estaciones de producción. Resultados preliminares de ensayos en Sta Lucia y Grenada muestran que cultivares de jujube de Taiwan tienen un gran potencial en cuanto a producción y mercadeo en el Caribe.

Indian jujube (*Ziziphus mauritiana* Lam.)

Indian jujube of the family Rhamnaceae is called by several names in the Caribbean:

English	Indian jujube, dongs, dunks.
Spanish	jujube, azufaifo.
French	jujube, pomme surette.
Dutch	olijf.

This is the only species of *Ziziphus* which is commercially suitable for tropical conditions. Mature fruits have a nice orange-brown colour, a crispy pleasant flesh and are rich in vitamin C. They are eaten fresh either ripe or green with salt; they also can be candied by dipping the unripe fruits into a syrup and used as a dessert similar to dates. Sometimes acidic fruits are made into pickles. In Venezuela a jujube liqueur is made and sold as 'Crema de ponsigue' (Morton 1987).

Origin and Botany

The plant is a thorny evergreen shrub or small tree growing up to 8–10 m in height and is native from the province of Yunnan in Southern China to Afghanistan, Malaysia and Queensland, Australia (Morton 1987). It is grown commercially in India.

The young branches and the under-surface of the leaves are densely pubescent. Leaves are small,

elliptic, with three well-marked veins from the base; fruits are spherical to ovoid or ellipsoid, varying from 1.5 to 6 cm in length and from 1 to 4 cm in width.

Because of its thorns the tree is often used to make live fences and corrals to keep goats and sheep.

Although the trees and the fruits are quite similar, this species must not be confused with the Chinese jujube (*Ziziphus jujuba* Mill.) which originated in China and has been cultivated there for more than 4000 years. The dense silky hair on the under-side of the leaves of the Indian jujube is a very distinctive character (Morton, 1987). The Chinese jujube is adapted to extreme continental climatic conditions: very low temperatures in the winter and hot dry weather in the summer. It is a deciduous tree.

Ecology

The plant is well suited for the dry tropical areas. In fact its resistance to drought is due to its rapid-developing tap root. This makes it a good candidate for reafforestation in tropical arid areas; in very dry years the plant may not bear fruits but will not die and will be able to bear the following year. It can also adapt to humid conditions and does well under an annual rainfall of up to 2500 mm with a short dry season.

The plant is not very exacting for soil composition but prefers well-drained conditions although it can tolerate some waterlogging. "In India, the tree does best on sandy loam, neutral or slightly alkaline. It also grows well on laterite, medium black soils with good drainage, or sandy, gravelly, alluvial soil of dry river-beds where it is vigorously spontaneous. Even moderately saline soils are tolerated." (Morton 1987). In the Caribbean it can form dense thickets in dry areas on coral soils. The tree can grow on very heavy clay soils, but generally does not live very long.

Flowering and Fruiting

The tiny whitish hermaphrodite five-petalled flowers appear in small clusters at the axil of the leaves during the rainy season. Pollination is entomophilous. In dry areas fruits generally mature at the beginning of the long dry season, i.e. from November to January in the northern hemisphere.

In the humid tropics there may be several crops during the year: a large one at the beginning of the dry season from December to January; a small one sometime during the wet season, around August/ September. Fruits are roundish and generally contain a single elongated seed, the second one being aborted.

Varieties

In India, numerous cultivars have been described and some very outstanding selections have been developed, some even thornless. The characters that are generally looked at are: size of the fruit, flavour, sweetness or acidity depending on the final destination (fresh fruit or pickles), juiciness, early or late in season, good yield and absence of thorns (Morton 1987).

Superior varieties have been selected in the Caribbean; some of them have fruits almost 5 cm in diameter, either with an apple or an ellipsoid shape. Colour of the fruits may vary from yellow to pink-red; with age they turn brown and wrinkle and at the same time the flesh becomes spongy.

Propagation

Propagation by seed is not very easy; seeds are very hard and may take a long time to germinate or not germinate at all. Morton (1987) describes a technique to ensure a better success: "To select seeds for growing rootstocks, the stones must be taken from fruits which have fully ripened on the tree. They are put into a 17 to 18% salt solution and all that float are discarded. The stones that sink are dipped into 500 ppm thiourea for 4 hours, then cracked and the separated seeds will germinate in 7 days. Seeds in uncracked stones require 21 to 28 days".

Plants grown from seeds may also have undesirable characters such as the presence of many thorns.

Vegetative propagation is easy to perform, either through cuttings or grafts. Cuttings with one pair of leaves root easily under plastic cover or under mist. Side and cleft grafts on rootstocks of the same species also give good results. Both methods allow production of early bearing plants with the true characters of the mother plant.

Commercial Production

There are no organized orchards in the Caribbean. Production comes from scattered backyard and sub-spontaneous trees. Morton (1987) mentions that planting distances may vary from 7–8 m to 11–12 m depending on whether trees are being pruned or not. She also reports that application of manure has been traditional in India but some advanced farmers are now using commercial fertilizer (NPK) twice a year, at the rate of 110 kg/ha for the first application and 172 kg/ha for the second.

As an estimate, adult trees may bear up to 50–60 kg of fruits. This is consistant with the figures given by Morton (1987) for India: 5,000 to 10,000 small fruits/ tree per year for seedling trees, and up to 3,000 fruits for superior grafted trees (77 kg).

If some commercial production were to be developed, planting distances could be set at 5 m × 5 m using grafted trees or trees from cuttings.

Pests and Diseases

In the Caribbean no serious pests or diseases have been reported. Leaves are sometimes affected by sooty mould and a kind of rust. Trees may be invaded by parasitic vines (*Phtyrusa* sp.).

In India the fruits may be severely attacked by fruit flies (*Carpomya vesuviana* and *Carpomya incompleta*). Leaves are also subject to attacks by leaf-eating caterpillars while the fruits may be affected by various kinds of fungi (Morton 1987).

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PRODUCTION OF LOW ALCOHOLIC BEVERAGES WITH FRUITS OF ANACARDIACEAE FAMILY

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Abstract
Fruits of several species of the Anacardiaceae family are processed for food or agro-industry in different parts of the world. The world trade market is, for some of those fruits (especially for mangoes and cashew fruits), of particular importance. In the West Indian islands, there are no real orchards except for mangoes and golden apple (in Grenada). The processing of fruits of the Anacardiaceae family is very limited. From a home made process, we worked on production of sparkling beverages with fruits of the Anacardiaceae family as raw material. A yeast of the genus Hanseniaspora was used as the fermentation agent. As the results for sparkling beverages making were satisfying, it was pursued with the deposit of a patented process.

Résumé
Les fruits des espèces de la famille des Anacardiacées font l'objet de nombreuses transformations, soit dans le domaine agro-alimentaire soit dans le domaine agro-industriel. Le commerce mondial de certains de ces fruits et de leurs produits intermédiaires est significatif (mangue, cajou). Au niveau de la Caraïbe, la production existe (mis à part la mangue et la pomme cythere (à la Grenade)) à l'état de cueillette. Ces fruits sont peu transformés. Partant d'un procédé domestique, nous avons travaillé sur la production de boissons pétillantes où les matières premières sont des fruits de la famille des Anacardiacées et où l'agent principal de la fermentation est une levure du genre Hanseniaspora.

Resumen
Fruitas de varias especies de la familia *anacardiaceae* son utilizadas como alimento o por la agroindustria para su procesamiento en diferentes partes del mundo. El comercio mundial de estas frutas es particularmente importante, en especial para mango y maranon (*anacardum acidentale*). En las islas del caribe no hay huertos como tales de etas frutas, excepto para mango y *spondias citherea* pomecithere, jobo de las india, golden apple (en Grenada). El procesamiento de estas frutas es limitado, y solo se hace un procesamiento casero, sim embargo, trabajamos en la produccion de bebidas pumosas de frutas de esta familia. Para ello usamos un fermento del genero hanseniaspora como agente de fermentacion. Debido a que los resultados fueron satisfactorios, optamos por patentar el proceso.

Low-alcohol beverages are made using costly sophisticated physical techniques. Similar beverages are also made on a domestic scale as is the case with alcoholic beverages made with the fruit, golden apple (*otaheite* apple or pomme-cythere) the *Spondias cytherea* Sonn. specie of the Anacardiaceae family.

The process which will be discussed was tested on a laboratory scale at INRA-CRAAG, Guadeloupe and on a pilot scale at Station Experimentale de Pech Rouge-Narbonne, France. The fruit used was golden apple.

There are 70 to 100 genera with 600 species, belonging to the Anacardiaceae family. Among these genera, those with significant food value are *Mangifera*, *Anacardium*, *Spondias* and *Bouea*, with a fruit, a pseudo fruit or an edible berry. Twenty-five of these genera are considered to be toxic or poisonous. Anacardiaceae oleoresins are responsible for more or less severe dermatitis and hypersensitive reactions. However, possible uses of *Toxicodendron* and *Semecarpus* (two very toxic genera) exist in fighting cancer. It should be noted that a genus may, at the same time, be of food value and toxic.

Spondias mombin (yellow mombin or hog plum) is of particular pharmacological interest. The marmalade has a curative effect on diarrhoea. The infusion from the stalk or of the crushed seeds is used as an eye salve in the treatment of ophthalmia. The leaves have a high bactericidal spectral activity. The leaves and stems contain caffeoylic esters which possess antiviral properties against coxsackie virus and herpes simplex virus.

An antifilarial principal has been shown with *Anacardium occidentale* and the balm of *A. occidental* confers insecticidal properties. The same balm (CNSL or cashew nut shell liquid) may serve as raw materia for making synthetic resins.

Anacardium occidentale

One of the most important species of *Anacardium* i *A. occidentale* which bears two kinds of fruits; a re one and a yellow one.

The false fruit is particularly rich in vitamin C (234 371 mg/100 g), i.e. five times more than for lemon The nut is rich in lipids (45%) and particularly hig in unsaturated fatty acids. Numerous vitamins a

also represented (A, B_1, B_2, B_6, PP, E) and the B vitamins are significant. Minerals such as phosphorus and potassium are well represented and a good balance of essential amino acids with 23% protein.

The cashew apple is commonly used in the production of desserts, jams and beverages. The shell of the nut contains a vesicant oil. The nut is the major product of cashew used and it has international acceptance.

Mangifera indica

Numerous cultivar selections have been made for *Mangifera indica*. The improvements in pro-duction which were made by increasing the size of the fruit or reducing the size of the seeds should be noted.

Mango fruit has a high nutritive value. It is a good source of vitamin C and a very rich source of vitamin A, associated with a high carotenoid content. It has a strong characteristic flavour.

The ripe fruits, contain a high level of fermentable sugars which is important in the production of alcoholic beverages. During ripening, mangoes show a substantial loss of acidity which makes the addition of organic acid(s) to the must necessary prior to the onstart of fermentation.

A wide range of products is prepared from the green or ripe fruit. Ripe mangoes are used as slices in syrup, nectar, squash, juice, ready to serve (RTS) beverages, syrup, jam, fruit bar, powder, strained baby foods, cereal flakes, (aroma) concentrate. The green mangoes are used for pickles, chutneys, slices in brine, amchar, dehydrated slices or powder, raw mango beverages.

The stone is used for the extraction of starch and fat (oils).

***Spondias* spp.**

Two species of the genera, *Spondias cytherea* and *Spondias mombin*, are presented.

Spondias cytherea: No genetic selection has been done for *Spondias* except pruning of the tree for *S. cytherea*. Trees from Trinidad and Tobago have been recently planted in an experimental plot at CIRAD Guadeloupe.

The level of fermentable carbohydrates is low and in wine making it is necessary to add sugar before fermentation. The fruit is a good source of vitamin C. It is eaten fresh or cooked. In the French West Indies, the green fruit is crushed and diluted to make a RTS beverage.

Spondias mombin: No cultivar selection has been done. It has a strong aroma. The fruit is not eaten fresh because of the pests that are often found within. It is used for the production of syrups, flavoured alcoholic beverages and jams.

***Bouea* spp. (Scheme 5)**

In the genus *Bouea*, two species of importance can be distinguished. The fruit of *Bouea macrophilla* is 3–5 cm long. Some cultivar selection has been done. There remains a need to increase the fruit size. The fruit of *Bouea macrophilla* is 2.5 cm long and no selection has been effective.

The fruits are rich in vitamins A and C and in carbohydrates. The green fruit is used for salads. *Bouea macrophilla* is also cooked.

Economic Aspects of the Edible Fruits of the Anacardiaceae family

In 1990, the world production of mango as fresh fruit, pulp or juice represented 15 million tonnes. The main producers and exporters are in Africa and Latin America.

In 1990, the world production of cashew-apple as fresh fruit, pulp or juice was 4 million tonnes.

No proper orchards exist for the other fruits of the Anacardiaceae family except for golden apple in Grenada.

Production of Alcoholic Beverages

Two processes will be presented.

The first one is a traditional process for the production of sparkling beverages (scheme 1). Ripe and sound fruits are macerated mixed with water to which sugar to 100 g sucrose is added and left to stand for 24–36 hours. A spontaneous fermentation is continued at 4°C for 12 hours. This gives rise to a sparkling product.

The second one (Scheme 2) is the patented process. Major differences with the traditional process are that only one fermentation is carried out and a selected apiculate yeast ferments the must. Pectin esterases are used to help in the clarification process. Two kinds of fermentation take place in closed tanks. After fermentation, the product is stabilized and clarified to optimize storage.

Must Preparation

The patent has been applied to *Spondias cytherea* Sonn. In the preparation of the must, the specific gravity and the dilution rate of the must are two important parameters. The initial specific gravity is 1.050 and 300 g of pulp are diluted with water in a total volume of one litre.

Fermentation

On the must prepared as reported above, the fermentation (Scheme 3) is conducted at 30°C for

36 hours until a 15 points fall of the specific gravity has been reached. For both products (open tank or a closed tank), different clarification methods were tested (tangential ultrafiltration gives the best results) and after gasification or not, the fermented product is stabilized by heating at 65°C for 20 minutes.

Starter Culture (Scheme 4)

An apiculate yeast (*Hanseniaspora uvarum*, strain No. 5) is used as the starter culture. The yeast was first collected on the surface of a tropical fruit, characterized and tested for the fermentation of several fruits of the *Anacardiaceae* family. The yeast is stored on a solid medium (Malt Wickerham) at 4°C. Activation of the yeast is done on the liquid medium of Malt Wickerham. After 24 hours, the suspension of the yeast is poured into a larger quantity of the same liquid medium. After 24 hours, a cream of yeast is obtained that is used at a pitching rate of 100 mg/litre.

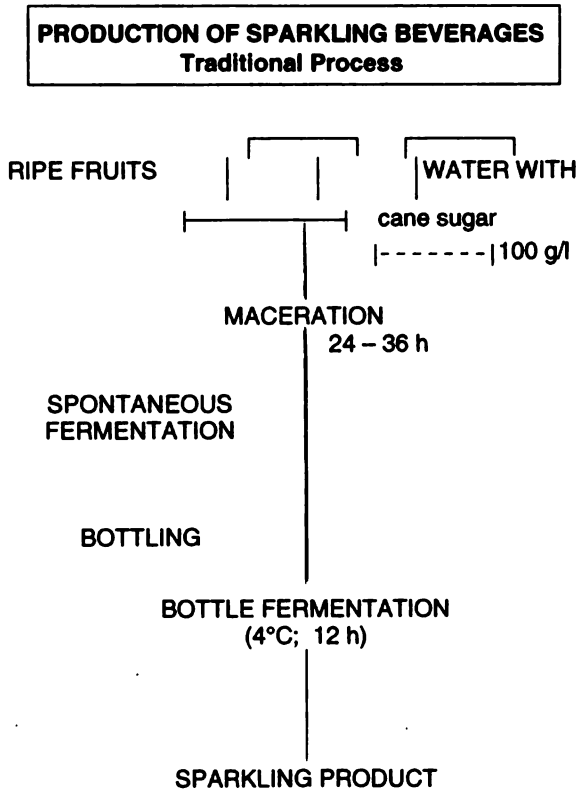
Composition of the Beverages

Table 1 indicates the composition of three of the major fermented products obtained on a pilot scale with golden apple. The composition of samples A and B, obtained by closed tank fermentation are similar.

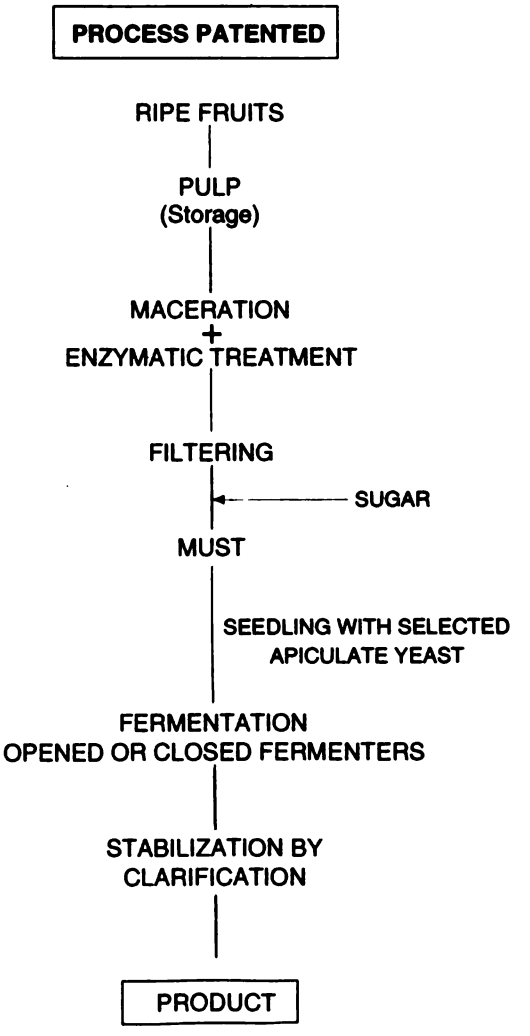
The major differences appear in the ethanol content (which is higher with the open tank fermentation), the residual sugar content (more of the sugar is metabolized in an open tank fermentor than in a closed tank fermentor) and more fusel oils are present in the beverages resulting from closed tank fermention. The concentrations of the residual sugars are almost similar to the concentration of sucrose added to the must before fermentation. The explanation is that *Hanseniaspora uvarum* is not able to ferment sucrose. Only fructose and glucose present in the fruit are responsible for the level of ethanol in the fermented beverage.

The levels of butanol, propanol and ethanol in the sparkling beverage indicate that there is no contamination by other micro-organisms. The low level of ethyl acetate is contrary to what is generally expected with apiculate yeasts. The beverage has a bright appearance and a slightly green and transparent color. The taste evaluation indicates that the beverage is well appreciated by the consumers.

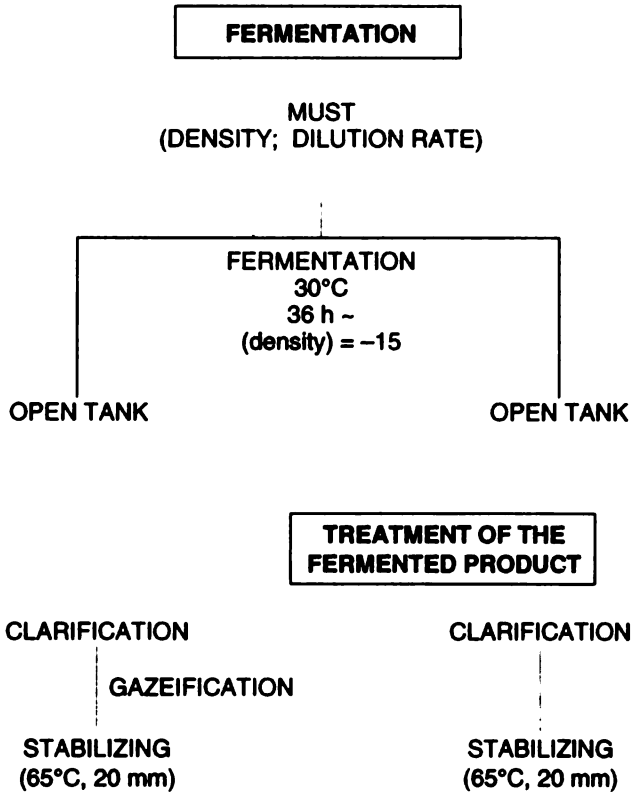
Scheme 1



Scheme 2



Scheme 3



Scheme 4

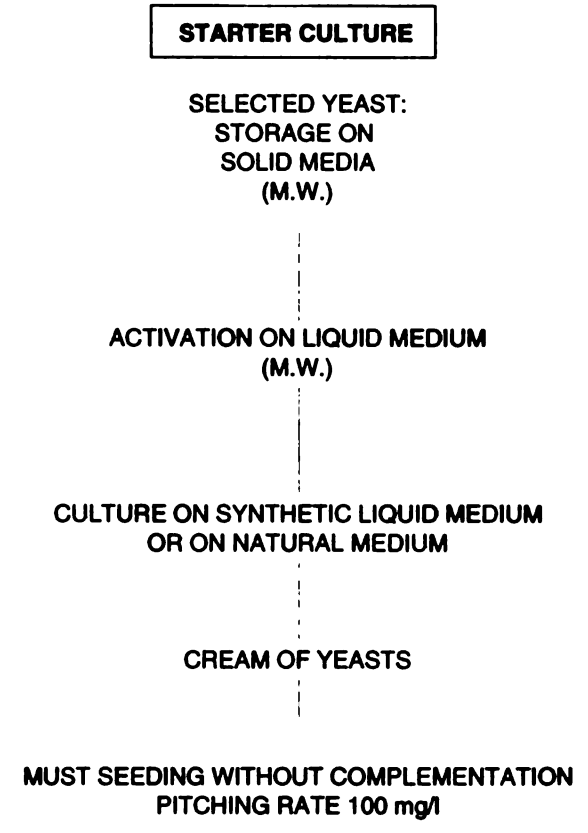


Table 1: Characteristics of the pomme cythere sparkling beverage:

	Ethanol (%V/V)	CO_2 bar	E. A. (mg/l)	Ethanal (mg/L)	Propanol (mg/l)
A	1.5	2.40	17.50	13.3	15.8
B	1.5	2.18	16.65	11.2	13.25
C	2.0	1.86	20.65	10.5	13.50

(E.A. = Ethyl acetate)

	1-Butanol (mg/l)	Isobutanol (mg/l)	Isopentanol (mg/l)	Fusel Oils (mg/l)
A	0	11.3	37.40	64.45
B	0	10.3	39.95	63.50
C	0	11.6	30.55	55.65

	Total Acidity (g/l H_2SO_4)	pH	Sugars (g/l)
A	1.83	3	98.66
B	1.90	3	98.00
C	2.06	3	86.65

A: obtention with closed tank; stabilization by pasteurization
B: obtention with closed tank: stabilization with hydroxybenzoic acid.
C: obtention with opened tank; stabilization by pasteurization.

GOLDEN APPLE PRODUCTION

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Abstract
Golden Apple (*Spondias dulcis* syn. *Spondias cytherea*) is a member of the Anacardiaceae family. This minor fruit crop is rapidly gaining in importance in Grenada. Propagation is usually by seed which requires 4 weeks for germination. However, large hard woodcuttings and grafting can also be used. A spacing of 9 m × 9 m is recommended. Optimum fertilizer requirements are not known but better growth is observed when fertilizers are applied. The major pests and diseases in Grenada are scales, mites/thrips and sooty mould. Other diseases include stem end rot of fruits, internal gumming in fruits, gummosis of trunk and branches. Yields of up to 900 kg have been recorded with trees between 5 and 7 years producing 200–250 kg and mature trees giving 300–350 kg. Post-harvest studies have indicated that as much as 50% of harvested fruits can be rejected.

Résumé
La prune de cythère (*Spondias dulcis* syn. *Spondias cytherea* Sonner) appartient à la famille des anacardiacées. Cette espèce mineure prend rapidement de l'importance à Grenade. La propagation se fait habituellement par graine, laquelle requiert 4 semaines pour germer; cependant de grandes boutures de bois aoûté et le greffage peuvent aussi être employés. Une distance de plantation de 10 m × 10 m est recommandée. La fertilisation optimale n'est pas connue mais une meilleure croissance est observée quand des engrais sont appliqués. Les maladies et parasites les plus importants à Grenade sont les cochenilles, acariens, thrips et la fumagine. Parmi les autres maladies il convient de signaler la pourriture de la base des fruits, des gommoses internes sur fruits, des gommoses sur tronc et branches. Des rendements de jusqu'à 900 kg ont été enregistrés; des arbres de 5 à 7 ans produisent en moyenne de 200 à 250 kg et des arbres adultes 300–350 kg. Des études de post-récolte ont montré que les écarts de triage peuvent atteindre 50%.

Resumen
El jobo de la India (Spondias dulcis syn. Spondias cytherea) pertenece a la familia Anacardiaceas. Esta fruta menor gana rápidamente en importancia en Grenada. La propagación es usualmente por semilla la cual requiere 4 semanas para germinar, sin embargo se puede reproducir también por medio de grandes estacas e injertación. Distancias de 10 m × 10 m se recomiendan.
No se conocen los requisitos óptimos de fertilización pero se observa un mejor crecimiento cuando se aplican fertilizantes. Las plagas y enfermedades mayores en Grenada son los ácaros, los thrips y la fumagina. Otras enfermedades incluyen la pudrición de la base de frutas, la gomosis interna en frutas, y gomosis en el tronco y ramas. Cosechas arriba de 900 kg por árbol se han obtenido; árboles de entre 5 a 7 años de edad producen de 200 a 250 kg. Arboles adultos dan un promedio de 300–350 kg. Estudios de pos-cosecha han indicado que hasta 50% de la cosecha puede ser rechazada.

Golden Apple

Family: Anacardiaceae
Botanical name: *Spondias dulcis* Forst. syn. *Spondias cytherea* Sonn.
Common names: Golden apple, Jew plum, June plum, pomme cythere, ambarella.
Origin: Islands of the South Pacific; Melanesia, Polynesia.

General Description

Leaves: Pinnate, glossy and finely toothed towards the edges.
Flowers: Small white inconspicuous, borne in terminal panicles and assorted male, female, entire.
Trunk and branches: Smooth, rounded brittle. Canopy diameter varies from 10 to 14 m, trunk diameter from 19 to 25 cm, and tree height from 9 to 14 m.
Fruit: Oval, round or pear-shaped. Four to eight in a cluster of varying maturities. Average fruit weight is 150–240 g sometimes 450 g.

Propagation

From seed germination takes 4 weeks, varies with growing medium and situation at higher elevation, under shade may take up to 6 months. Open bins with Perlite and peat moss are very good, >90% germination.

Cuttings: Large hardwood cuttings.
Grafting: Wedge (cleft graft) on stocks about 3 months old. Side grafting can also be done. Dwarf types can also be successfully grafted with large types; no incompatibility with take.

Polyembryony: It is not sure if this exists; seedlings seem to orginate from the same point. The dwarf types tend to come true from seed.

Growth Cycle

Leaf fall:	January–March
Flowering:	February–April 3 weeks after leaf fall.
Flushing:	February–April;
Fruit setting:	March–May
Fruit maturity:	August–September
Fruit ripening and fall:	September–January.

Site Selection

Avoid shallow infertile, acid soils; windy areas; areas with a prolonged dry season after fruit set since this results in small fruits.

Pruning

Topping has been tried on both 1-year and 5-year-old plants. Tendency is for the plant to produce one or two strong leaders which continue apical dominance. Trees do not bush.

Chances of rotting are high in young plants where most of the growth is soft.

Planting and Post-planting Care

Spacing:	9 m × 9 m ; 120 trees /ha.
Fertilizing regimen:	Not known but trees show better growth when fertilizer is applied.
Weed control:	Important, especially in first 2 years after planting.

Shade and Intercropping

Plants seem to benefit from both practices. In cases where plants were intercropped with plantains and vegetables, plants reached heights of 4.5 m and gave marketable yields of up to 90 kg in 3 years.

Pests and Diseases

The major pests and diseases are listed in Table 1.

Other diseases affecting golden apple are:
- Stem end rot of fruits
- Black lesions on fruits
- Internal gumming in fruits
- Gummosis of trunk and branches

Table 1: Major pests and disease of golden apple

Pest/disease	Area affected	Symptoms
Scales	Shoulder and peduncle of young fruit	Spotting and sooty mould development
Mites/thrips	Fruit	Deformity; rough sand-paper affect, sometimes sunken
Sooty mould	Fruit & leaves	Blackening of fruits

Yield

Young trees 5–7 years: 175–225 kg/tree
Mature, full bearing: 350–450 kg/tree

Trees have produced yields of 900 kg in Grenada.

Harvesting and Post-harvest Handling

Harvesting is done at the mature green stage using a pole and bag. In Grenada fruits are transported by open-back van to the packhouse, graded, washed and packed.

Post-harvest studies have indicated that much as 50% of the harvested fruits in Grenada can be rejected. The major causes are pests and diseases, immature fruit and mechanical damage.

Fruits under ambient conditions take 6–8 days to ripen and 9–10 days to overripen. By putting them into a household refreigerator shelf-life can be increased by 10 days.

Grade I standards used for export fruits are:
- 6.5 cm in diameter or larger
- 150 g or heavier
- < 15% of surface damaged
- Free of pests and diseases.

Marketing

At present golden apples are sold to:

Canada	$1.17/kg
Holland	$1.00–2.28/kg
USA	$2.49–3.85/kg
UK	$2.53–3.34/kg
Trinidad	not available

Payments to farmers range from a low of EC$0.44 to $1.10/kg, depending on the season.

Best prices are obtained in April/June and December to February.

AN INTEGRATED APPROACH FOR THE PRODUCTION AND PROCESSING OF MINOR FRUITS IN MARTINIQUE (FWI)

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Abstract
Banana grown on about 800 ha in Martinique is the dominant crop but is seriously affected by hurricanes and market fluctuations. Guava is now being promoted in an integrated approach involving government, farmers and processors, since avocado and lime which were the main crops of the diversification programme started in 1970, failed. Several processing plants were set up to process pineapple, another major crop on the island, but had to diversify to remain viable. Local production of guava allowed for a 'quality' and 'standard' processed product by carefully standardizing the cultivars and level of maturity at which the fruits are harvested. The cultivars chosen were Beaumont, Centeno Prolific, Red Supreme Ruby and Red Hybride. These are highly productive with pink to dark pink pulp, right acidity, fruit of good size and yielding over 35 t/ha under experimental conditions. Propagation is by stem cuttings using a hormone mixture (Rootone F) under a mist system which allows for the production and transplanting of trees in the field by 3–4 months. The growers involved in this programme receive a subsidy for the first 3 years and are assured a market for their produce. This guava programme is the first of its kind but a similar programme is recommended for other minor fruit crops such as tamarind *(Tamarindus indica)*.

Résumé
La banane qui couvre environ 800ha en Martinique est la culture dominante mais elle est sévèrement affectée par les fluctuations de marché et les ouragans. La goyave est maintenant promûe dans le cadre d'une approche intégrée qui inclut le gouvernement, les agriculteurs et les transformateurs, ceci depuis l'échec du programme de diversification à base d'avocats et de limes commencé dans les années 70. Plusieurs usines transforment de l'ananas, une autre culture majeure sur l'île, mais doivent diversifier pour rester viables. La production locale de goyave permet d'avoir des produits de "qualité" et " standards" grace à un strict choix des variétés et du niveau de mâturité auquel les fruits sont récoltés. Les variétés retenues sont "Beaumont", "Centeno Prolifique", "Rubis Suprême Rouge" et "Rouge Hybride". Elles sont hautement productives, à fruits de bonne taille, pulpe de couleur rose à rose sombre, acidité parfaite; les rendements atteignent 35t/ha en conditions expérimentales. La propagation se fait par boutures de tige sous mist, ce qui permet d'obtenir des plants prêts à être transplantés au bout de 3–4 mois. Les agriculteurs impliqués dans ce programme reçoivent des subventions durant les 3 premières années et ont un marché assuré pour leur produits. Ce programme goyave est le premier de son genre mais un programme similaire est recommandé pour le tamarin (*Tamarindus indica*).

Resumen
Banana es el cultivo predominante en Martinique con 800 ha, pero es seriamente afectada por huracanes y las fluctuaciones del mercado. El cultivo de aguacateros y limeros, promovidos desde 1970,no dieron los resultados esperados dentro del programa de diversificación Por ello el cultivo del guayabo se promueve ahora como una propuesta integral que envuelve varios sectores, gobierno, productores y procesadores. Varias plantas procesadoras de frutas se establecieron en la isla para procesar piña, otro cultivo importante en la isla, pero estas plantas deben diversificar las frutas que procesan para ser rentables. La producción local de guayaba permite estandars de calidad y de procesamiento de la fruta por una cuidadosa estandarización de los cultivares y el nivel de madurez al cual los frutos son cosechados. Los cultivares seleccionados fueron Beaumont, Centeno Prolific, Red Supreme Ruby y Red Hybride. Esos cultivares de pulpa de color rojo o rojo obscuro son altamente productivos, con una acidez adecuada, frutos de buen tamaño y una productividad experimental de 35 t/ha. La propagación es por estacas usando una mezcla de hormonas [Rootone F] bajo nebulizador, que permite la producción de plantas para el trasplante a campo a los 3–4 meses. Los productores involucrados en el programa reciben un subsidio por los primeros tres años y se le a segura el mercado para su producto. El programa de guayaba es el primero de una serie de programas similares recomendados para algunos frutales menores como por ejemplo tamarindo.

Introduction

Martinique is a small French Caribbean island of 1,100 km and 365,000 inhabitants. A large agricultural activity has been developed with sugar cane, banana and pineapple. Banana, with about 8,000 ha, is the main fruit crop but is highly susceptible to hurricanes and market fluctuations. For this reason, different diversification programmes were put in place in 1970 with avocado or Tahiti lime, both for the export market to France and Europe, but failed due to technical and mainly commercial problems. Also several fruit processing plants were developed, based on the processing of pineapple (600 ha). The necessity for diversification required these plants to process local minor fruits or to import pulps and concentrates. Guava nectar is now one of the first products but the quantity of fruits available for processing is now insufficient for the increased demand. Rather than purchasing and importing

guava pulp, the heads of the different plants in Martinique and the politicians decided, in 1991, to favour the increase of guava production.

This programme is very interesting because it is the first diversification programme for which the outputs are fully for the local processing market. Because of the cost of living and the cost of labour, the price of our products is often too expensive and not competitive on the fresh fruit export market. Therefore this new opportunity is expected with great interest.

For the fruit processing industry, 'quality' and 'standard of production' are the two key phrases. By using local fruits, the fruit processors are able to select the varieties and the harvest stage for maturity, and thus develop standard products of quality.

The use and the processing of local fruits are, anyway, cheaper for them than importing pulps or concentrates because of high costs of transport.

Developing a fruit-tree crop has been possible with financial help from the EEC for the unproductive or low productive first 3 years of pure-stand orchards. This subsidy reaches about US$7,000/ha.

After evaluating the quantity of pulp needed an economic area has been determined for the two main fruit processing plants of Martinique. This area of 75 ha was provided in two steps: 20 ha in 1992 and 55 ha in 1993/94.

CIRAD-FLHOR, the French fruit research institute, is involved in this programme and is responsible for the selecting varieties, propagation and technically supervising the orchards.

The choice of the varieties was done in collaboration with the processing industries which need:

- Highly productive selected cultivars (25 t/ha)
- Pink to dark-pink pulp
- Acidity
- Fruit of good size

The final choice was: Beaumont, Centeno Prolific, Red Supreme Ruby and Red Hybride.

These cultivars have the required characteristics and have given yields of over 35 t/ha under experimental conditions. The expected yield in intensive cropping is 25 t/ha.

Propagation is done by stem cuttings which allows us to produce plant trees in 3–4 months. The first step is done under a mist system where the humidity is controlled. A very well-drained medium is necessary to avoid excess water and a complex of hormones, Rootone F by CFPI, is used to enhance rooting. Three to five weeks later, when the roots begin to appear, the cuttings are transplanted into bags with a soil medium for 3 to 4 weeks in a greenhouse and finally for 1 month in the sunlight. They are then ready to be planted.

According to the cost of labour, to the buying price proposed by the processing plants and to the kind of plots (generally sloping and non-mechanizable) some management operations have to be reduced to a minimum. This is the case with pruning and that is why the suggested planting density is only 280 trees/ha (7 m × 5 m or 6 m × 6 m).

For their part, the growers involved in this programme receive a subsidy shared among the first 3 years and they are assured of outlets for their production.

The guava programme is the first of its kind but should be extended to some other minor fruits like mammey apple *(Mammea americana)*, soursop *(Annona muricata)*, golden apple *(Spondias dulcis)*, Tamarind *(Tamarindus indica)*, etc .

THE CULTURAL MANAGEMENT AND REGULATION OF PRODUCTION SEASON OF INDIAN JUJUBE (ZIZIPHUS MAURITIANA LAM.) IN TAIWAN AND THEIR APPLICABILITY TO THE CARIBBEAN

LAI-SEN HSUING

Abstract
Indian jujube (*Ziziphus mauritiana* Lam.), also known as dunks or Chinese apple among other names, is a native of southern China. From an initial introduction to Taiwan from Thailand followed by open polycrossing, the selection and propagation of high yielding plants have resulted in a few popular commercial cultivars. A spacing of 6 m x 5 m giving 300 plants/ha was used. A pruning regime was employed where the trunk was cut back to a height of 30 cm after the first year and three to four shoots kept as primary branches. A second, lighter, pruning was performed to cut off water shoots, weak or overcrowded shoots, in May or June. From the second year onwards the trunks were immediately cut back after harvesting to keep the trunk height to about 80 cm . Another pruning regime — long shoot pruning — is described. The first annual fertilizer application is recommended at the sprouting of new shoots, the second at the peak flowering stage and the third at the beginning of harvesting. Employing cultivars with different bearing characteristics, pruning and light enhancement at night are techniques employed in Taiwan to regulate the production season. From preliminary results of trials in St Lucia and Grenada for the Indian jujube, cultivars from Taiwan showed great potential in terms of production and marketing in the Caribbean.

Résumé
La jujube indienne (*Ziziphus mauritiana* Lam.) est originaire de Chine méridionale. L'espèce fut introduite à Taiwan en provenance de Thaïlande. Des croisements en pollinisation libre suivis d'une sélection et de multiplication ont donné naissance à quelques cultivars commerciaux populaires: "Pi yun", "Te kong" et "Huang kuan". Des distances de plantation de 6m x 5m donnant une densité de 300 plantes/ha sont utilisées. La taille de première année consiste à former un tronc de 30 cm d'oú partent 3–4 charpentières. Une deuxième taille en mai-juin permet d'éliminer les rejets et les rameaux faibles ou surnuméraires. A partir de la deuxième année les charpentières sont rabattues systématiquement à environ 80 cm du sol après la récolte. Une autre technique de taille — la taille longue — est aussi décrite. La première application annuelle d'engrais est recommandée dès l'apparition des nouvelles pousses, la seconde à la pleine floraison et la troisième au début de la récolte. L'utilisation de cultivars de caractéristiques différentes, la taille et l'illumination nocturne sont des techniques employées à Taiwan pour régulariser la saison de production. Des résultats préliminaires obtenus avec la jujube indienne à Ste Lucie et à Grenade montrent que des cultivars de Taiwan présentent un grand potentiel en termes de production et de commercialisation dans les Caraïbes.

Resumen
El jujube (Ziziphus mauritiana Lam.) es originario de China del sur. Se introdujo a Taiwan a partir de Tailandia; subsecuentes cruzamientos abiertos seguidos de selección y propagación dieron orígen a varios cultivares comerciales muy populares. Distancias de 6m x 5m (300 plantas/ha) se usan. La poda consiste en recortar el tronco a una altura de 30 cm después del primer año y dejar 3–4 ramas principales. Una poda más ligera se hace luego en mayo o junio, para eliminar los chupones, las ramas débiles ó sobrenumerosas. A partir del segundo año el tronco se poda a una altura de aproximadamente 80 cm inmediatamente después de la cosecha. Otro tipo de poda larga se describe. Se recomienda hacer la primera aplicación anual de fertilizante al inicio del crecimiento de los nuevos brotes, la segunda a la plena floración y la tercera al principio de la cosecha. El empleo de cultivares con características de producción diferentes, la poda y la iluminación nocturna son unas de las técnicas empleadas en Taiwan para regular las estaciones de producción. Resultados preliminares de ensayos en Sta Lucia y Grenada muestran que cultivares de jujube de Taiwan tienen un gran potencial en cuanto a producción y mercadeo en el Caribe.

Introduction

Indian jujube (*Ziziphus mauritiana* Lam.) is also known as dunks, Chinese apple, ber or liane croc chien (French). It is native of the province of Yunnan in southern China. In 1944, several cultivars of Indian jujube were introduced into Raiwan, and the planted area reached about 1,600 ha in 1992. The production area is mainly located in the south. The ripe fruits are mostly consumed fresh. They are also candied and made into date-type preserves, rum, jam and jelly.

Cultivars

In 1966, some Indian jujube seeds from Thailand were introduced into Taiwan. Two varieties were selected from them, Thailand Sweet and Thaishon Sweet. Farmers conducted open polycrossing and selected high-yielding and good quality plants for multiplication. Therefore, the varieties have been improved rapidly in Taiwan. The most popular commercial cultivars currently are Pi Yun, Te Long, Huang Kuan (Table 1) and Wu Shih.

Table 1: Characteristics of cultivars of Indian Jujube

Cultivar	Weight (g)	Length (A) (mm)	Width (B) (mm)	Shape index (A/B))	Brix (%)
Pl Yun	5.7	50.5	44.3	1.6	14.6
Te Long	8.6	57.6	50.8	1.13	12.1
Huang Kuan	140	59.0	62.0	0.95	11.4

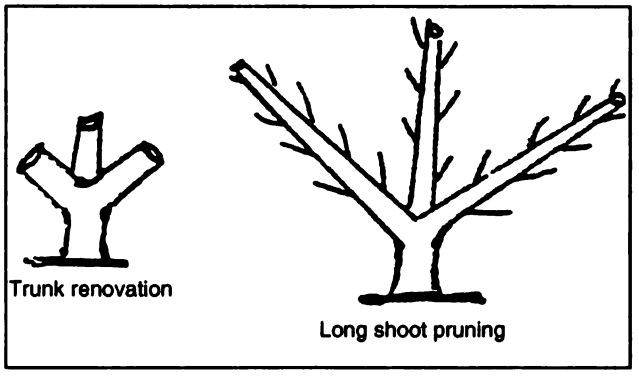

Figure 1: Pruning of Indian jujube

Cultural Practices

Spacing: 6 m x 5 m (300 plants/ha)

Pruning: (See Figure 1)

Trunk renovation: The plants were cut back to a height of 30 cm in the first year and three for four shoots kept as primary branches. A second, lighter, pruning was performed to cut off water shoots, weak and overcrowded shoots, in May or June. These plants flowered during August to October. From the second year, the trees were cut back immediately after harvesting.

Long shoot pruning: The primary branches were cut back to keep a lenth of 1–5 m after harvesting; all shoots on the branch were cut off. The new shoots were topped 30 days later and kept at a length of 50 cm . These plants flowered from April to May and had a second flowering during August to October.

Fertilizing: Table 2 shows the accumulative amount of fertilizers recommended for Indian jujube in Taiwan.The first application is recommended at the sprouting of new shoots; the second at the peak flowering stage, and the third at the beginning of harvesting.

*Thinning flowers and fruits:*The flower clusters of the tip of new shoots were pinched off in October. Usually one fruit in one to three nodes was kept, and overcrowded small fruits or flower clusters might be pinched off.

Table 2: Fertilizer recommendations for Indian jujube in Taiwan.

Fertilizer	1st	2nd	4th	6th	8th	10th
	g/plant/year					
N	190	300	380	460	640	610
P_2O_5	90	160	180	210	260	280
K_2O	230	360	460	660	640	730

Staking: Keeping the primary branch from the previous year as a stake (Figure 2). The primary branch of the harvested plant was cut back to a length of 1.5 m , and ring-barked at the base. All side-shoots on the branch were cut off when new shoots sprouted from the base of the primary branch, a healthy and strong shoot was kept as the new primary branch, and the other shoots pinched off. Then new growing shoots were trained along the old primary branch. Bamboo poles were also used as stakes.

Regulation of production season: In Taiwan, the regular flowering time of Indian jujube is from August to October, and harvesting from December to March. Like other agricultural produce, usually the earlier harvest can get a higher price in the market. Techniques for regulating the production season were therefore developed as follows:

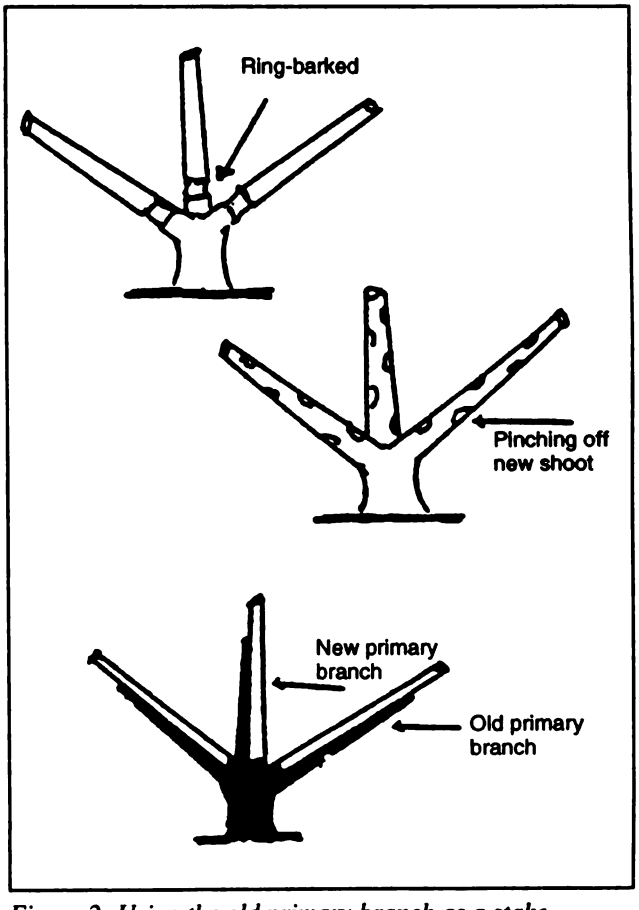

Figure 2: Using the old primary branch as a stake

Cultivars:

Early varieties: Chia Lao Chi and Li Tzu Cho are harvested from September to January.

Medium varieties: Au Lien Yuan, Hung Yun and Te Long are harvested form November to February.

Late varieties: Pi Yun, Huang Kuan and Chung Chia are harvested from December to March.

Pruning:

Long shoot pruning: Makes the harvesting period from September to December.

Trunk renovation: Makes the harvesting period from November to March.

Light enhancement during the night:

It was pointed out by Chow in 1992 that light enhancement for Indian jujube during the night might increase the income of farmers. In her trial the harvesting date of Indian jujube was advanced by 60 days and the yield was increased by 50% when Indian jujube plants were given fluorescent light for 12 hours during the night, for 45 days starting from 4 months after pruning. However, there was no significant difference in fruit quality between plants with enhancement and check plants.

Conclusion

Indian jujube is a minor crop in Taiwan. However, it is getting more popular. Preliminary results from trials in St Lucia and Grenada with the Indian jujube cultivars from Taiwan showed that it has a great potential, in terms of production and marketing, in this region. The improvement of variety, cultural practices, pest control and manipulation of the production season of Indian jujube is being studied continuously in Taiwan. The main purpose is to have better quality, higher yields, a longer supply season and lower production costs of Inidan jujube. The achievement of these efforts should be applicable to other tropical areas such as Caribbean countries. The agricultural technical missions of the Republic of China in this region will be pleased to transfer these techniques.

MARKETING OF SELECTED MINOR FRUIT CROPS

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Abstract
The demand for the minor fruit crops such as West Indian cherry, guava, soursop, sapodilla, and tamarind is increasing in markets both regionally and internationally. The reasons for this include dietetic and tourism concerns, as well as a better advertising and promotion of these fruits both in the fresh and processed state. The successful marketing of fruits produced in the Organization of Eastern Caribbean States (OECS) countries is dependent on production, which is largely unorganized, and packaging for fruits; fruits marketed by competing countries are well packaged and attractive to the consumers. Little or no exports of West Indian cherry, guava, sapodilla, soursop or tamarind are made from the OECS where there is a local demand. The paper concludes that the problem of inadequate production with respect to volumes, consistency of supplies and quality must be addressed in order to satisfy the demand which exists in several markets for some of the minor crops.

Résumé
La demande pour des fruits mineurs tels que cerise des Antilles, goyave, corossol, sapotille, et tamarin s'accroît sur les marchés régionaux et internationaux. Cela obéit a des raisons diététiques, touristiques et aussi à une meilleure publicité et promotion de ces fruits tant en frais que transformés. Le succés de la commercialisation des fruits produits dans la Caraïbe orientale (ECS) dépend de la production, qui est largement désorganisée, et des emballages qui doivent compétir des emballages attractifs de pays concurrents. Il y a peu ou pas du tout d'exportations de cerise des Antilles, goyave, sapotille, corossol ou tamarin à partir des pays ECS, par contre il y a une demande locale. Une liste, fournie par USDA, détaille les fruits et légumes admissibles aux Etats-Unis, ce pour chaque pays de l'ECS. L'article conclut qu'il existe de sérieux problèmes quant aux volumes de production, régularité des expéditions et qualité des produits pour pouvoir satisfaire la demande.

Resumen
La demanda para frutas ménores tales como acerola, guayaba, guanábana, níspero, y tamarindo aumenta en los mercados regionales e internacionales. Esto obedece a razones dietéticas, turísticas, y también a una mejor publicidad y promoción de estas frutas tanto al estado fresco como procesadas. El éxito de la comercialización de las frutas producidas en el Caribe oriental (ECS) depende de la producción — la cual está generalmente inorganizada — y del embalaje que tiene que competir con empaques atractivos en los países competidores. Hay poca ó inguna exportación de acerola, guayaba, níspero, guanábana o tamarindo de los paises ECS, sin embargo hay una demanda local. Se incluye una lista detallada, suministrada por USDA, de frutas y verduras admisibles en los Estados Unidos, por cada país del Caribe oriental. El artículo concluye que existe un serio problema de producción con respecto a volumenes, inconsistencia de suministros y calidad para poder satisfacer la demanda.

Introduction

The objective of this paper is to give participants an idea of the consumption trends for the minor crops produced in the eastern Caribbean. Some indication will be given with respect to the requirements of various markets; competing countries and suggested strategies to access various international markets.

In recent years, the demand for some of the crops identified in this workshop has been experiencing steady growth in major markets, both regional and international. The apparent reasons for this can be attributed to the following factors:

- Consumers worldwide take specific interest in their daily diet; as a result, fruits make up an important ingredient of their daily food intake. This health conscious factor has caused consumers to increase their overall fruit intake.
- Persons tend to travel more to various exotic countries, whether on vacation or otherwise. During those visits they are encouraged to try the local products and when they return home, they try to prepare those foods for their own use.
- Producing countries have increased their frequency of participation in various international trade exhibitions in North America and Europe. The International Fancy Food Show in the United States and the International Food and Drink Exhibition in the United Kingdom have provided opportunities to promote their products, thereby educating consumers on their preparation and use. This has resulted in increased demand for most of these fruits.
- There has been a general increase in advertising and promotion of these fruits (both in the fresh and processed form) and also as an ingredient in several sauces, juices, jams, etc., for food preparation. This development has further expanded the consumption of several fruits.

The factors listed above are by no means exhaustive and are only some of the influencing factors for overall fruit consumption. I am sure you can identify some other factors responsible for this increased demand.

Market Outlooks: Factors to Facilitate Crop Supply

The successful marketing of fruits produced in the countries of the OECS is dependent on several factors. They include:

- Production: In the OECS countries there are hardly any organized fruit crop orchards or commercial orchards. Production is scattered; minor crops grow wildly without any form of crop management, crops are harvested when available. This lack of crop management seriously inhibits the production of good quality fruits, especially fruits marketed in the fresh form where appearance is one of the major purchasing influencing factors. Therefore, several fruits are seen covered with scale insects, sooty mould and scars as a result of insect attacks. Any programme which seeks to produce fruit crops for commercial purposes must, very early, deal with the production issues which also include planting in the best locations.
- Packaging for fruits is very important because it forms an integral component of the product presented to the consumer. Competitors with Caribbean producers invest extensively using packaging which appeals to consumers. Some of those countries include Thailand, India, Pakistan and Malaysia. It is important for regional producers and exporters to use similar designs and appearance.

Markets

West Indian cherry (*Malpighia glabra*)

This fruit is very high in vitamin C (ascorbic acid). Weight for weight, it is much richer in specific nutritional aspects than most citrus fruits. The fruit is hardly exported by any OECS country. It is used locally for fresh juice and jams. Generally, local markets absorb local production. Exporting West Indian cherry in the fresh form requires the application of stringent post-harvest handling practices.

Guava (*Psidium guajava*)

Production of guavas for use in the fresh form is not very extensive in the subregion. There are selected varieties for the fresh fruit market; these are eaten raw and used in fruit salads and served as a dessert. Major producing countries are Thailand and Malaysia. I would suggest that the countries of the subregion should concentrate mainly on producing varieties suitable for processing, i.e. for producing juices, jams, jellies and nectars. At the moment, there is a very good market for guavas in the local processing industry which is under-supplied by local production. As a result, large amounts of guava paste or juice concentrate are imported into the subregion for the processing industry. It is used extensively as flavouring for ice-cream and yogurts.

Soursop (*Annona muricata*)

There has been a steady growth in demand for soursop in most international markets, particularly into North America. The Canadian market is under-supplied and this provides an opportunity which should be exploited. There are exporters in all OECS countries who can be contacted for marketing these fruits. Within the Caribbean itself, the increased consumption of fresh fruit juice has expanded the domestic demand. In preparing fruits for export they should be size-graded and adequately packaged. Fruits should be full mature to ensure that they can ripen. Low temperatures can prevent proper ripening. The fruit should be air-freighted because it can deteriorate rapidly after it ripens.

Unfortunately, not many Caribbean countries can export fresh soursop to the United states due to plant quarantine restrictions. However, the juice can be exported in fresh form because it retains its flavour even after deep freezing.

Sapodilla (*Manilkara achras*)

Uses: Generally, the ripe fruit, unchilled or preferably chilled, is merely cut in half and the flesh is eaten with a spoon. It is an ideal dessert fruit as the skin, which is not eaten, remains firm enough to serve as a shell; care must be taken not to swallow the seed. The flesh can also be added to fruit salads.

There is a general demand for sapodilla in most international markets, but prices must be competitive to attract importers. Within the Caribbean itself, the domestic demand has been quite high due to low volumes available. It is considered a luxury fruit and in some markets prices may vary considerably depending on country and supplies.

Tamarind (*Tamarindus indica*)

The fruits are flattish, bean-like, irregularly curved and bulged pods. They are borne in great abundance along the new branches. The pods may be cinnamon-brown or greyish-brown externally and at first are tender-skinned with green, highly acid flesh and soft, whitish, underdeveloped seeds. The mature flesh is a very acid pulp which turns brown or reddish-brown.

Food uses: There are many food uses. In India, the tender, immature, very sour pods are cooked as seasoning with rice, fish and meats. The pulp is made into a variety of products. It is an important ingredient in chutneys, curries and sauces, including some brands of Worcestershire and barbecue sauce. Tamarind pulp is made into jams, ice-cream and juices. Within the Caribbean, the demand for pulp is

quite high. Processing plants is the OECS are under-supplied and are continually looking for supplies. This suggests that there is a very good market in the region. However, local production is very limited and processors must seek extra-regional supplies.

Demand has also increased in the North American market.

Conclusions and Suggestions

An attempt has been made in this paper to identify some of the issues which affect the marketing of minor fruit crops produced in the region. The problem of inadequate production with respect to volumes, consistency of supplies and quality must be addressed. The commercial orientation of research must form an integral part of the activities of CARDI and other institutions. The commercial production of 'minor' crops has not been a major activity in the OECS countries and as a result, current production is scattered which makes the application of various crop husbandry practices very difficult and harvesting costly. There should be an effort to take care of the existing trees to improve current production.

There are several markets which exist for some of the minor crops. The food processing industry is very important and must be exploited, particularly for guava, tamarind, soursop, etc,. Prices must be competitive and supplies must be consistent.

PRODUCTION OF MINOR CROPS SAPODILLA, TAMARIND, GUAVA AND GENIP

LENNOX ANDREWS
CARONI (1975) LTD, TRINIDAD

Abstract
Guava *(Psidium guajava)*, sapodilla *(Manilkara achras)*, tamarind *(Tamarindus indica)* and genip *(Melicocca bijugata)* are minor crops in the Caribbean. A brief outline on their ecological requirements, culture, bearing characteristics, pests and diseases, fruit characteristics and post-harvest aspects is given.

Résumé
La goyave (*Psidium guajava*), la sapodille (*Manilkara achras*), le tamarin (*Tamarindus indica*) et la chénette (*Melicocca bijuga*) sont des espèces mineures dans les Caraïbes. L'exposé présente un rapide rappel des exigences écologiques, de la culture, des caractéristiques de fructification, des parasites et maladies, et des aspects de post-récolte pour chacun de ces différents fruits.

Resumen
La guayaba (*Psidium guajava*), el níspero (*Manilkara zapota*), el tamarindo (*Tamarindus indica*) y el mamón (*Melicocca bijuga*) se consideran frutas ménores en el Caribe. Se da una breve reseña de sus requisitos ecológicos, técnicas de cultivo, características de producción, plagas y enfermedades, características de las frutas y aspectos de pos-cosecha.

Introduction

Guava *(Psidium guajava)* belongs to the family Myrtaceae. Notable relatives are:

Syzygium malaccensis:	pomerac
Syzygium cumini:	jamun, Java plum
Myrciaria cauliflora:	jaboticaba

Sapodilla *(Manilkara achras)* belongs to the family Sapotaceae. Notable relatives are:

Calocarpum sapota:	mammey sapote
Chrysophyllum cainito:	caimite, star apple
Pouteria campechiana:	canistel, egg fruit
Manilkara bidentata:	balata

Tamarind *(Tamarindus indica)* belongs to the family Leguminosae. Notable relatives are:

Coumarouna odorata:	tonka bean
Inga laurina:	pois doux

Genip *(Melicocca bijugata)* belongs to the family Sapindaceae. Notable relatives are:

Litchi chinensis:	lychee
Nephelium lappaceum:	rambutan
Blighia sapida:	akee

Some characteristics of these minor crops are given in Tables 1 and 2.

Guava

The main producers of guava are Brazil, Mexico, Venezuela, Pakistan, India and Egypt. Many cultivars have been selected in these countries and in other parts of the world. Some of the well-known one are:

Centeno Prolifi	Trinidad
Beaumont	Hawaii
Cayenne	Puerto Rico
Ruby	Florida

Guavas are also commonly distinguished by flesh colour — white, yellow, red.

Production Cycling

Production of flowers occurs on young vegetative flushes which can be stimulated by various means to cause several crops per year. Methods used are:

- Defoliation
- Pruning
- Fertilizer timing
- Growth regulators
- Irrigation, usually in combination with one of the above

Spacing

The traditional spacing used varies from 9 m × 9 m (125 trees/ha) to 6 m × 6 m (270 trees/ha); 3 m × 6 m is also recommended with thinning out as crowding occurs. High density plant spacings were tried by researchers at Centeno, Trinidad — 2 m × 1.5 m (3,300 trees/ha) gave best results on a hillside site. Other spacings as dense as 1 m × 1 m (12,500 trees/ha) or 0.5 m × 0.3 m (66,667 trees/ha) were tried at the Central Experiment Station (CES) and the University of the West Indies(UWI) respectively. The need for pruning has been the major problem with high density plantings. However this should be alleviated by the use of new dwarf cultivars coming out of Cuba.

Pests

Guava is attacked by a range of fruit flies (*Anastrepha* sp.) but the species occurring in highest concentration

Table 1: Some characteristics of guava, sapodilla, tamarind and genip

Fruit	Ecological conditions	Origin	Propagation	Pollination	Flowering	Yield (t/ha)	Main problems
Guava	Adapts well to different soils. pH 4.5–8.5. Rainfall of 1000–2000 mm/yr., well distributed is desirable Elevation <1500 m Grows in a wide range of environments.	Tropical America	Root cuttings; stem cuttings; grafting; seed (2–3 wk germination)	Insects—bees; cross-pollicated (self fertile); visited by bees	Singly or in groups 2–3 (cymes)	35–40	Fruit fly
Sapodilla	1200-2500 mm/yr. rainfall; 0–900 m altitude. Does well in coastal regions	Tropical America	Seeds; air layers grafting	Insect and wind pollinated	Bisexual; some self-imcompatability cross pollinated	6–20	Shelf-life; Maturity Index; Fruit fly
Tamarind	Tolerates a wide range of soils. Does best on deep soils but can flourish on poor soils. Is hurricane-resistant.	Dry savannas of tropical Africa	Seed; budding; cutting	Best set with cross-pollination; insect pollinated; visited by bees	Bisexual	12–16	Harvesting; Demand small; Mature pods damaged by moulds and insects
Genip (chenette)	Tropical lowlands. Tolerates a wide range of conditions of soil and rainfall. Drought-tolerant.	Tropical America	Seed (short viability)	Visited by bees	Dioecious; occasional hermaphrodite polygamous?		Fruit quality variable; Demand small

Table 2: Quality characteristics of guava, sapodilla, tamarind and genip

Fruit	Size range	Shape	Brix (0)	Acidity (%)	Seeds	Pulp(%)	Time of harvest	Characteristics
Guava	2.5–10 cm in length; 50–120 g	Round, ovoid or pyriform	10–12	0.5–1.0	100–500	55–80	April/May September/October	Stone cells; Vitamin C content is five times that of citrus
Sapodilla	5–9 cm diam; 90–360	Round, oval, conical	17–24	0.15	1–7	60	April/June October/December	Stone cells in some cvs
Tamarind	2 cm × 5-10 cm	Oblong and curved		10	1–10	50	April/June	Pulp is rich in vitamin B and calcium
Genip (chennette)	2–3.5 cm diam; 10–25 g	Globose		(rarely 2)	1	50	June/September	

are *A. striata*, guava fruit fly, Trinidad; *A. suspensa*, Caribbean fruit fly, Jamaica, theDominican Republic and Florida. Control is effected by use of an insecticide with systemic or translaminar action, e.g. Lebaycid 50% EC or Actellic in two sprays at fortnightly intervals or 1% solution of Sevin weekly. Application is done at colour break or at three-quarters size. Field sanitation, i.e. fruit removal and burying is also important.

Other common pests are:

Red alga:	*Cephaleuros viriscens*
Mites	
Sooty mould:	*Capnodium* sp.
Black mildew:	*Irene* sp.
Mealybugs:	*Pseudococcus citri*
Red-banded thrips:	*Solenothrips rubrocinctus*

Tamarind

This crop is exploited mainly in India where over 25,000 t are harvested annually of which 3000 t are exported to Europe and North America for use in meat sauces and beverages. Sweet and acid types exist and can be maintained as separate seed populations. Both Costa Rica and Puerto Rico produce canned tamarind pulp and juice.

The tree is slow-growing and may take as much as 6–8 yr to yielding. A dry spell is required for bearing. Leaf and bark extracts have shown wide antibiotic activity. The root system is deep and most of the fibrous roots are below the 40 cm depth and 2–3 m from the trunk in an 8-year-old tree in sand or sandy clay soils. These roots live in a micorrhizal relationship that increases growth rate. Also, as a legume, tamarind roots can fix nitrogen by association with rhizobia.

Sapodilla

Major producers are India (>2,000 ha) and Mexico (>1,500 ha). Varieties have been selected, e.g.

Florida:	Russel, Brown Sugar
Trinidad:	Demellac
Sri Lanka:	Cricket Ball

Culture

Traditional spacing is 7 m × 7 m to 9 m × 9 m . A high density plot with 'Dermellac' and 'Early Prolific' was established at the CES, Centeno around 1987. Yielding has been light so far. Fertilizer recommendation has been 2-1-2 NPK application as for other fruits, but N has the greatest effect on yield. Fertilizer use in India is N 1,000 g; P_2O_5 500 g; K_2O 500 g/tree/yr.

Harvesting of the largest fruit is done when ripe fruits begin to fall.

Fruiting

Metaxenia is apparent in sapodilla as the pollenizer (pollen source) influences fruit shape, set and size. Self-pollinated flowers tend to set oval fruit and cross-pollinated ones set round fruit (Faroogi and Rao1976). Fruit set and fruit size can be increased by the use of Planofix (NAA) at 300 ppm (Dass and Mahapatra 1975) and fruit drop reduced by use of GA at 10–100 ppm (Pramik and Bose 1974).

Pests

Fruit flies (*Anastrepha* sp.) infest mature fruit. The most common fruit fly is the sapodilla fruit fly, *A. serpentina*. Control is similar to that for guava.

Mealybug (*Nepaecoccus impae*) infestations occasionally occur.

Post-harvest

Shelf-life at room temperature is 5–8 days and this can be extended a further 2–3 days using GA (300 ppm). Refrigeration at 12 °C gives more than 20 days shelf-life and storage at 0°C is possible for fully ripe fruit. Work at CES, Centeno suggested that fruit with grit gave more uniform ripening than smooth-fleshed varieties.

The Fruit Subsector — A Development Mode

The individual fruit crops may be viewed as having achieved one of four developmental phases:

Phase 1: Plant introduction up to the stage of establishment for backyard level production. A good example is the common plum *Spondias* sp. A few trees may be unsystematically planted and some fruit sold at the local market place or processed for home consumption.

Phase 2: This phase is characterized by the existence several small orchards (0.25–2 ha). Fruit is readily available on the local market with the presence of small-scale processing plants and export of low volumes.

Phase 3: The total area under production is extensive usually due to the presence of large orchards (> 10 ha). Export volume is high and processing plants may be medium or large in scale.

Phase 4: The production/marketing system is well organized, e.g. marketing board, producer organization. The distinguishing feature of this phase is the support of R & D by the commodity industry.

While it is obvious that all commodities do not fit easily into this scheme, e.g. guava and breadfruit,

the value of the concept lies in its use for planning phased development. This is particularly critical when one considers the uncertainty of the market and the need to act cautiously in the investment of limited resources and the raising of farmer expectations

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THE RED PITAYA, A NEW EXOTIC FRUIT[1]

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Abstract
The red pitaya (*Hylocereus undatus* Britt. & Rose) also called strawberry pear is a spiny tropical cactus which originated in Central America, where it has been cultivated for decades. It is now cultivated in organized orchards where the crop receives all the required attention. Vegetative propagation has favoured the selection of outstanding plants, which vary markedly in type of stem segment, colour and shape of fruits, skin thickness and scale expression. The characteristics of the fruit as well as the biology of the plant, the cultural practices, the main pests and diseases are described. In the south Caribbean, there is a similar species growing wild: *Hylocereus lemairii*. There may be a resource to be tapped here.

Résumé
La pitahaya rouge (*Hylocereus undatus* Britt. and Rose) est une cactacée tropicale originaire d'Amérique centrale, oú elle est cultivée depuis longtemps. La production est maintenant organisée en vergers oú les plantes reçoivent tous les soins nécessaires. La propagation par fragments de tiges a favorisé la sélection de clônes supérieurs, lesquels diffèrent par la forme des tiges, la couleur et la forme des fruits, l'épaisseur de la peau et la forme des écailles. Les caractéristiques du fruit ainsi que la biologie de la plante, les soins culturaux, les principaux parasites et maladies sont décrits. Dans le sud de la Caraïbe, il existe une espèce similaire à l'état sauvage: *Hylocereus lemairii*. Il y a peut-être là un capital à exploiter.

Resumen
La pitahaya roja (*Hylocereus undatus* Britt. and Rose) es una cactácea tropical, originaria de América central, en donde se cultiva desde hace mucho tiempo. La producción está ahora organizada en huertos en donde las plantas reciben todos los cuidos necesarios. La propagación por fragmentos de tallos ha favorecido la selección de clones superiores, los cuales difieren por la forma de los tallos, el color y la forma de los frutos, el espesor de la cáscara y la forma de las escamas. Las características de la fruta así como la biología de la planta, los cuidos culturales, las principales plagas y enfermedades se describen. En el sur del Caribe, existe una especie similar al estado silvestre: *Hylocereus lemairii*. Podría haber allí un capital que explotar.

Introduction

The red pitaya (*Hylocereus undatus* Britt. & Rose), also called strawberry pear, is a spiny tropical cactus which originated in Central America. It is cultivated in Nicaragua over a 150-ha area on the western and southern slopes of the Mount Santiago volcano, about 20 km from the capital city, Managua.

The fruit of the cactus is very attractive, with a distinctive appearance and a vivid red colour. In recent times, several consignments of this fruit have been exported to European countries.

[We are describing this species here since it is very similar to others growing wild in the Caribbean (seen in Grenada, Tobago, Trinidad, Guyana and Suriname) and classified in Trinidad as *Hylocereus lemairii*. These have slender stems, the same type of flowers, the same flowering pattern and the same type of red fruits, although smaller in size and some with a white flesh. These characteristics may indicate that these species are not much different to the one grown in Central America, but since they have not yet been domesticated, they can not express their complete potential. In Central America the pitaya has been cultivated for several decades now and plants have been brought from the trees to be planted in organized orchards where they get more sunlight and nutrients, resulting in shorter and stronger stems and bigger fruits. Vegetative propagation has also favoured selection of outstanding plants. Even plants growing wild in the trees are exposed to more sunlight than those in the Caribbean since the dry season is much longer. In fact in Central America plants with slender stems and small fruits are also found which might confirm this theory.]

The Fruit

The pitaya bears a large fruit which is pink, red, or purple in colour, weighing around 250–350 g. The oval or rounded fruits have skins on which strongly or weakly expressed scales appear: these scales correspond to the bracts of the flower. The flesh is dark red, approaching purple in colour, and contains numerous tiny shiny black seeds. Between the flesh and the skin there is a thin mucilaginous layer.

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NOTE: New paragraphs are included as [.....].

The fruit is pulped for juice, used in ice-cream, or added to fruit salads. It does not have a strong taste, so lime juice is often added to bring out the flavour.

According to Incer (1959), the fruit is useful in combating anaemia. In Colombia, Becerra (1986) has noted that the pitaya (in this instance the yellow-fruited variety, *Cereus triangularis* Haw.) contains the heart tonic, captine; whether this is also true of the red pitaya of Nicaragua is yet to be determined.

The skin and the mucilaginous layer together make up 30–50% of the fruit weight, with this proportion varying with variety and fruit size. A Nicaraguan study (Campos-Hugueney 1986) has shown that the pulp contains 84.4% water, 0.4% fats, 1.4% protein, 11.8% carbohydrates, 1.4% cellulose, and 0.6% ash. It also detected the presence of vitamin C (8 mg/100g) and traces of vitamin A. The pulp colour is due to anthocyanins.

Ecology

The red pitaya is a species of dry tropical climates. Its heat requirements are high; the average temperature should be 21–29°C, while the maximum can go up to 38–40°C without the plant suffering any apparent harm. Water requirements are modest (600–1300 mm), with alternating wet and dry seasons. Excessive rain leads to flower drop and rotting of immature fruit. For good production, the plants need a lot of sunshine.

The pitaya is a species which has been shown to have resistance to the sulphurous gases emitted by the Mount Santiago volcano. This explains the location of its present area of production, as growers in that area have hardly any other feasible alternative apart from pineapple.

Plant Development

The plant grows in the form of jointed stem segments. Each segment can reach a length of 2 m and be 3–7 cm across. Each segment has three, or occasionally four, longitudinal ridges, along which lie small swellings equipped with spines.

The segments easily form aerial roots, which they use to attach themselves to supports. These can be living or dead, such as trees, wooden or cement posts, stone walls, or volcanic rocks. These roots can extend down to the soil to extract nutrients from it.

The pitaya is found wild over most of Nicaragua. Seeds are spread by birds, and may be found germinating high up in tall trees, such as *Pithecolobium saman, Enterolobium cyclocarpum,* and *Crescentia cujete.*

In cultivation, pitaya is propagated by stem cuttings, put directly in place at the end of the dry season. Usually three segments are placed around a living tree support; in current plantings, these supports are on a 3 m × 3 m grid.

The best living posts are leguminous trees which root easily from large cuttings, such as *Erythrina* species and *Gliricidia sepium.* Other species used include *Bursera simaruba, Spondias purpurea, Crescentia cujete,* and *Cordia* species. The living posts must be pruned regularly so that they do not shade the pitayas too much.

Flowering

Flowering is initiated at the end of the dry season, in April, and continues through the wet season, to October. It seems to have a dependence on daylength (photoperiodism); irrigating plants during the dry season does not initiate flowering unless it is already close to the normal flowering time.

Flowers appear individually on the lateral stem ridges. They are large, perfumed, ivory white in colour, with a great many stamens. They open at nightfall and close at daybreak, with each flower lasting only one night.

Flowering in cultivated plants goes according to well-defined cycles, with all the flowers of the same plant, and all the plants of the same clone, developing according to three phases. Phase 1 is the appearance and development of flower buds, lasting 15–16 days; Phase 2 is flowering, lasting 3–5 days; and Phase 3 is the development and ripening of the fruit, which takes 30–35 days from flowering.

Flowering may have barely ceased when the flower buds of the following cycle appear. So it is possible to find flower buds, young fruits, and almost ripe fruits on the same plant at any given time.

Theoretically it would be possible to have seven to nine separate fruiting cycles during one wet season. In practice, five or six cycles occur, probably due to climatic or nutritional limitations. Fruit drop in immature fruit is an important occurrence, but its cause is not known.

[Plants growing wild in trees have only one or two fruiting cycles at the beginning of the season. That may indicate that as soon as the rainy season starts and leaves develop, the cactus plant does not get enough sunlight. The same happens with the wild pitaya from Trinidad.]

Varieties

There are no varieties in the proper sense, only clones which differ markedly in such things as type of stem segment, colour and shape of fruits, skin thickness, and scale expression. One clone is spineless. Other plants differ in flowering season, some being late, others early. It will be of interest to find out if these variations have a genetic basis or are more due to environmental factors. In either case, these variations offer the possibility of extending the production season.

Growers have assigned descriptive names to some clones, such as 'Rosa' (pink), 'Mariposa' (butterfly), and 'Orejona' (big-ears).

Cultural requirements

During the 3 years of first establishing a pitaya plantation, it is possible, and even desirable, to intercrop, as long as the low intercrop does not compete with the pitaya cultivation. Kidney beans are the commonest intercrop. In recent years, some growers have interplanted with pineapple. These plants have the advantage of better resistance to sulphurous gases from the volcano, and allow earlier recovery of the initial investment. However, it is desirable that the pineapples be eliminated after two harvests.

No formal fertilizer trials have been carried out. Growers will apply urea or a complete fertilizer if this is economically worthwhile to them. Some have applied fertilizer as a foliar spray; this can bring out flowering several weeks earlier and reduce immature fruit drop.

Each year, rotted support posts must be replaced and weak ones reinforced. Maintaining the supports is one of the biggest costs to the grower.

Pruning living posts is an ongoing cost in pitaya culture; a balance needs to be maintained between growth of the living posts and that of the pitaya, which must not be excessively shaded. The pitayas themselves must also be trimmed to keep their volume down and permit movement along the interrows.

Pitayas have only superficial roots, and so are very vulnerable to damage if the soil is worked. In mature plantations the recommendation is to avoid working the soil, and control weeds with a herbicide instead.

Pests and Diseases

As a cultivated plant locally selected from the wild, the pitaya is subject to attack by numerous locally evolved pests and diseases. According to Urbina (1989), the most important problems are due to:

- The larva of a beetle, *Cotinus mutabilis*, which chews the stem segments and favours infestation by pathogenic fungi.
- A winged insect, *Leptoglossus zonatus*, which sucks the sap of the stems and fruits, leading to marks and deformations. This is also suspected of transmitting fungal and bacterial diseases.
- Ants, particularly leaf-cutting ants of the genus *Atta*, which can cause great damage to fruits. The ants attack the scales and also the fruit skin, weakening the fruit and rendering it liable to disease attack and skin splitting when ripe.
- Often some stem segments show symptoms of a watery rot, which may be limited to a single segment without affecting those above and below. The segment later dries out, leaving only the main veins. The problem is due to a bacterium, *Xanthomonas campestris*.
- A fungus problem, called 'fish-eye', where a fungus of the genus *Dothiorella* causes brown circular spots, 1–3 mm across, to appear on the stems. When the infection is severe, the spots can join up, and the surface available for photosynthesis is greatly reduced.

Finally, mention should be made of damage caused to ripening fruits by birds, lizards, and rodents.

Yields and Post-harvest Factors

The first harvest can be expected 18 months after planting. Using local measures, a yield of 3,500 fruits/ha can be expected in the second year, equivalent to 0.8–1.0t/ha. Yields increase progressively up to 36,000 fruits (10–12 t/ha) by the fifth year, which corresponds to the mature stage of establishment.

Each clump of adult plants produces about a dozen fruits per cycle between June and November, that is 60–70 fruits per year. Production records show a number of peaks, corresponding to the different flowering cycles.

Fruits can be harvested once the colour of the skin starts to change from green to red. They are then held in a shaded spot which is sheltered from birds and rodents. The fruit should be cut off with secateurs, since it has no real fruit stalk and if it is just twisted off, this tears the fruit skin at the point of attachment and makes it unsaleable.

Preliminary studies on fruit keeping have shown that:

- Fruits harvested green, 2 days before the expected colour change, ripen normally at ambient temperatures (25–30°C) and have a keeping life of 9–11 days.
- Fruits harvested at the colour change keep for 7–8 days.

- Fruits harvested fully ripe, that is when the skin has become fully red, remain good for eating for 5–6 days at ambient temperatures.
- Ripe fruits left on the plant keep for 8 days after the colour change, provided they are not eaten by birds.
- Fruits kept in cool storage (10–12°C) for a week continue to ripen, but more slowly, and colouration is less intense. After removal from cool conditions, ripening is accelerated:
  - After 4 days, fruits harvested just ripe begin to rot. Those harvested at colour change or green remain presentable for 5–7 days.
  - So cool storage slows ripening of green or turning fruit, and can prolong its life. While a little skin colouration may be sacrificed, the pulp colour does not seem to be affected.

The influence on self-life of higher and lower temperatures, and of different clones, remains to be evaluated.

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PLUMS

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Abstract
Jamaica plum (*Spondias purpurea* L.), chili plum (*Spondias purpurea* var. *lutea*), yellow mombin (*Spondias mombin* L.) and govenor plum (*Flacourtia indica* Merr.) are among the fruit species known as plums. The botany of these fruit crops and the ideal ecological conditions for successful cultivation are reported. Flowering and fruit characteristics such as time of flowering, time taken to mature and harvesting season are discussed. Propagation techniques for the establishment of these crops are critically assessed. Commercial production techniques are discussed and common pest and diseases are highlighted.

Résumé
Prunes des Antilles (*Spondias purpurea* L., *Spondias mombin* var. lutea), mombin jaune (*Spondias mombin L.)* et prune de Madagascar (*Flacourtia indica* merr.) sont communément regroupés sous le nom de prunes tropicales. Le présent exposé met l'accent sur les différences qui existent entre ces espèces sur le plan botanique, écologique, au niveau de la biologie florale, des techniques de propagation, des caractéristiques du fruit et de la période de maturité. La production en vergers est discutée ainsi que l'incidence des maladies et parasites.

Resumen
Las diferentes ciruelas coloradas, jocotes, hobos ((*Spondias purpurea* L., *Spondias mombin* var. lutea, *Spondias mombin L.)* así como la ciruela gobernadora (*Flacourtia indica* merr.) son comunmente agrupadas bajo el nombre de ciruelas tropicales. El presente artículo pone el accento sobre les diferencias que existen entre estas especies en cuanto a botánica, ecología, al nivel de la biología floral, de las técnicas de propagación, de las características de las frutas et del período de maduración. Se discute la producción en huertos así como la incidencia de plagas y enfermedades.

Introduction

Among the fruit species known as plums two of them originated in tropical America: the red mombin or Jamaican plum (*Spondias purpurea* L.) and the yellow mombin or yellow plum (*Spondias mombin* L. syn. *S. lutea* L.).

Other fruits classified as plums are the governor plum (*Flacourtia indica* Merr.) and occasionally the Indian jujube , dunks or dong (*Ziziphus mauritiana* Lam.) which are both native to Asia (India).

Sometimes the pitanga or Suriname cherry (*Eugenia uniflora* L.), a native to tropical America, is also marketed as a plum, although the more generally accepted term is cherry.

1. Jamaican Plum and Chili Plum

Jamaican plum (*Spondias purpurea* L.); Anacardiaceae:
English: Jamaican plum, Spanish plum, red mombin.
Spanish: ciruela colorada, hobo colorado, jocote.
French: mombin rouge, prune des antilles, prune café.

The Jamaican plum or sweet plum is a common fruit tree in Central America and the Caribbean and the very appealing red fruits are eaten fresh, still green with salt, or ripe, and sometimes made into drinks and sorbets.

Chili plum (*Spondias purpurea* var. *lutea*); Anacardiaceae:
English: chili plum, yellow plum, plum
Spanish: jocote amarillo, jobo, hobo
French: mombin jaune, prune des antilles

The chili plum is also a common fruit-tree in the Caribbean and parts of Central and South America. The green-yellow fruits are eaten fresh or made into a variety of preserves (sweet plums, pepper plums, etc).

Botany

Both species have medium size trees with a pronounced spreading habit which limits their height to 3–6 m. The main branches tend to grow horizontally and secondary shoots develop on their upper part giving rise to some vertical growth. Pennated leaves are made up of 10 to 20 pairs of elliptic alternated lealets, 3–6 cm long. The fruit is a smooth and shiny ellipsoid drupe.

Ecology

These species grow from sea-level up to an altitude of 1500 m above sea-level, in tropical dry areas with temperatures as high as 42°C and a 6-month dry season. They are quite resistant to drought; the whole productive cycle of the Jamaican plum takes place during the dry months when the trees have dropped their leaves.

The trees grow well in many kinds of soils from heavy dark clays to sandy loams.

Spondias purpurea is a biotope companion for other fruit trees such as cashew, mango or tamarind, which do equally well in the same conditions.

Flowering and Fruiting/Varieties

Jamaican plum: The polygamous (male, female and hermaphrodite) tiny red flowers appear in small clusters or as single flowers along the branches, at the beginning of the main dry season. Generally fertilization and fruit setting are very good and the trees bear a profusion of fruits every year.

Fruit production is continuous for up to 2–3 months, which means for the northern hemisphere: flowering from January to April/May and production from March to June/July (beginning of the rainy season), depending on the reserves of the tree (depth and fertility of the soil) and also the length of the dry season. Fruits, 3 to 5 cm long, contain a large fibrous endocarp inside a yellow pulp. As soon as the heavy rains come, production stops.

More than 30 varieties are known in Central America and the Greater Antilles where this fruit is very popular; the most important have Spanish names ('Tronador', 'Guaturco', 'Chichita', `Dulce'). They can also be found in the Lesser Antilles but there they are not given any specific names.

Chili plum: The tiny yellow-reddish flowers appear in April/May (northern hemisphere). Fruits mature during the rainy season, from July to September. They may differ in size and shape and also in the intensity of the yellow colour which can vary from a dirty green to deep orange.

Local names are given according to the different types, especially in the Spanish-speaking countries, e.g. 'Lapa', 'Job', 'Moyo' 'Sta Roseño', 'Jismoyo', 'De Cocer', etc. The variety 'De Cocer' is boiled in water and eaten when still hot. However most of them are eaten fresh or made into preserves.

Propagation

Seeds generally are not fertile. The species is mainly propagated through large cuttings, 60–180 cm long, which are also used as posts for barbed-wired fences. The cuttings are selected among the most vertical new growths, 1–2 years old, at the end of the dry season, and planted in the dry soil without irrigation. Excess of water at planting time may jeopardize the work since the wounds do not seal and the cuttings begin to rot. With this technique, production begins the following year and may reach its climax after 4 to 5 years since the growth is quite fast.

Commercial Production

On the Pacific coast of Honduras and Nicaragua there are numerous small compact plantings of the red type with an average of 15–20 trees. Planting distances vary generally from 5–7 m in a square pattern. Commercial production comes also from the numerous trees planted in the fences dividing the pastures for cattle. Fruits are regularly found in the markets.

The yellow type is quite common, scattered in back-yard gardens and fences, all over the Caribbean Basin, but not in organized orchards, even small ones. An abundant production comes from these isolated trees and can be found in the m arkets when the fruit is in season. Trees generally develop a little bigger than the hog plum and if some recommendation for commercial planting had to be given, spacings not less than 7 x 7 m should be preferred.

Adult trees of both the red and yellow types produce several thousand fruits which in terms of weight can mean around 40 to 50 kg. Alternancy does not seem to occur with these species, at least when grown in the ideal climatic conditions.

Fruits of the red type have to be harvested either green for eating with salt or mature for eating ripe or making juices. Fruits of the yellow type are harvested either green for making preserves or mature for eating fresh. The maturing process is very quick; green fruits turn red or yellow in a couple of days and mature fruits do not last more than 1 day.

Pests and Diseases

Fruit flies (*Anastrepha* spp.) are the main enemy of the Jamaican plum. Fruits are severely attacked both in Central America and in the Caribbean, except in Grenada and St Vincent. The chili plum seems to be less susceptible to this pest; at least in the context of the Lesser Antilles the fruits are generally safe.

Other important pests can be mites and birds. Some attacks of fungi have been noted; fruits become covered with a grey ash-like dust and the disease spreads quickly along the branches.

2. Yellow Mombin (*Spondias mombin* L.), Anacardiaceae

English: yellow mombin, plum, hog plum
Spanish: ciruela amarilla, hobo, jobo, jocote amarillo
French: mombin jaune, prune mombin, prune myrobolan
Dutch: mopé

The yellow plum is common in the Caribbean where the fruits are eaten fresh (green or ripe), cooked, and made into home-made drinks. Fruits are very juicy and fragrant when ripe.

Botany

The tree has an upright natural growth habit; the trunk is often thorny and the bark thicker and more corky than in the other species. The pinnate leaves are made of 20–30 leaflets and may reach 50 cm in length. The yellow mombin is part of the flora of the rain forests in the Caribbean Basin. Wild trees found in those conditions may be very tall. Fruits are borne in large clusters; they are ellipsoid-elongated yellow drupes, 2.5 to 4 cm long, with sometimes a rough skin.

Ecology

This species does better in the humid tropics where there is a short dry season and annual rainfall is above 2,000 mm. It grows from the sea-level up to 1,200 m above sea-level in a wide variety of soils, even in heavy clay soils with an occasional high water-table and limited drainage.

Flowering and Fruiting

The tiny polygamous (male, female and hermaphrodite) white-yellowish flowers are found in large terminal inflorescences, 20–40 cm long, at the beginning of the rainy season; (which means in the northern hemisphere, from May to July). Contrary to the other plums the entire cycle takes place during the rainy season. Fruits begin maturing several months later, which means from August to November.

As for other plums, the pollination and fruit setting seem to be very good and alternancy is not common for this species. The pulp is soft, juicy and very aromatic.

Varieties

There are no identified varieties, however, local names are given according to different types.

Propagation

Contrary to the Jamaican and chili plums, the seeds of the yellow mombin are fertile; this species is generally propagated from seeds. Seeds germinate in 35–75 days.

Commercial Production

There are no organized orchards but fruits are widely collected in some countries (Guyana and Suriname) to make juices.

Production per tree can be estimated at 30 to 60 kg of fruits.

Pests and Diseases

Hog plums are very often attacked by larvae of fruit flies and other insects.

3. Governor Plum (*Flacourtia indica* Merr.), Flacourtiaceae

English: governor plum, ramontchi
Spanish: ciruela gobernadora, ramontchi
French: prunier de chine, de madagascar
Dutch: babykers

This species produces an abundant crop of roundish purple fruits, 2.5–3.5 cm in diameter. The yellow fresh and pleasant pulp is eaten fresh, in jellies and jams, or made into preserves.

Botany

The species grows into a dense shrub or small tree up to 6 m with the trunk and large branches sometimes covered with huge thorns (another species — *Flacourtia inermis* — has no thorns). The alternate elliptic leaves have teeth along the edges and are a bright glossy green on the upper surface and paler on the lower surface. Fruits are roundish, 2.5 to 3.5 cm in diameter and dark red in colour; they contain five to six small flat seeds.

Ecology

The trees grow in the hot, humid tropical lowlands. This species has moved from India to south-east Asia, Africa and America. It is tolerant to a variety of soils, even heavy clay soils. However, good drainage is recommended.

Flowering and Fruiting

The flowers are borne on elongated clusters at the axils of the leaves; they are greenish-white and generally either only female or male. It is considered a dioecious species; meaning that male and female flowers are borne on different trees. However they can be found on the same tree (monoecious) since hybridizations may have occurred in the past with other related species (*F. inermis* is hermaphrodite). Flowering takes place in April–June in the northern hemisphere. Fruits mature during the rainy season in August–September, i.e. 60 to 90 days after flowering. The fruits have several small seeds.

Varieties

No special varieties are known. However fruits may vary greatly in size from one tree to the other.

Propagation

The species can be easily propagated from seeds, but this method may result in the production of many thorns on the trunk and the main branches (juvenile character) and a non-desirable flowering pattern. It is preferable to use cuttings which root very easily and reproduce the true characters of the mother plant.

Commercial Production

The trees are used mainly as backyard plants for home consumption. Due to the abundance of the crop, the excess of production is sold on the markets or processed into sweet or pepper-plum preserves.

If the plant is to be cultivated in small orchards, the same spacings used for the West Indian cherry (5 m × 3 m or 4 m × 4 m) should be applied. Also the plant would need some regular pruning and fertilization.

Pests and diseases

No serious enemies of this species are reported.

POST-HARVEST HANDLING OF MINOR EXOTICS

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Abstract
The example of the kiwi fruit is used to demonstrate that a fruit is only as good as its best variety. Varietal selection is crucial to the success of exotic fruits as a good quality product cannot be made out of one which is inherently poor and/or variable. Fruit structure, fruit size, weight and shape govern harvesting, handling and packaging techniques. Fruit physiology (climacteric, ethylene producer, sensitivity to chilling, shelf-life) affects the handling system. Fruit structure, fruit physiology and the primary causes of quality loss at market for soursop, sugar apple, sapodilla, plums and tamarind are reported. Flow charts describing optimum handling procedures for soursop and sapodilla are provided.

Résumé
L'exemple du kiwi est souvent utilisé pour démontrer que les meilleurs fruits sont issus des meilleures variétés. La sélection variétale est cruciale pour le succès des fruits exotiques car un produit de qualité ne peut pas reposer sur une variété pauvre ou variable. La structure du fruit, sa taille, son poids et sa forme influencent les techniques de récolte, stockage et emballage. La physiologie du fruit (caractère climatérique, production d'éthylène, sensibilité à la réfrigération, durée de conservation) a un impact sur le système de manutention. Le papier présente pour les fruits suivants : corrosol, pomme cannelle, sapotille, prunes et tamarin, leur structure, leur physiologie et les principales causes de pertes de qualité sur le marché. Un organigramme décrivant les procédures optimales de manutention pour le corrosol et la sapotille est fourni.

Resumen
El ejemplo del kiwi es usado para demostrar que una fruta es tan buena como su mejor variedad. La selección varietal es crucial en el éxito de una fruta exótica, por que un producto de buena calidad no se pude hacer de uno que es intrinscamente pobre y/o variable. La estructura de la fruta, tamaño, peso y form a gobiernan las técnicas de cosecha, manejo y empaque. La fisiologia (climatérico, productor de etileno, sensibilidad al frio, tiempo de almacenamiento) afectan el sistema de manejo. Se señala que la estructura y fisiología de la fruta son las prinicpales causas para la perdida de calidad en el mercado de la guanábana, anón níspero, spondias y tamarindo. Se suministra un cuadro donde se describe el procedimiento óptimo de manejo para guanabána y níspero.

Introduction

It has been said before that a fruit is only as good as its best variety. The kiwi fruit story is a good example. This fruit arrived on markets in the 1960s but did not become a success until the 1980s. Early samples of kiwi were of the Hayward variety but the bulk of the crop which arrived in US markets was of the less sweet Bruno, Abbott and Montgomery varieties. Once variety was sorted out, kiwi boomed. The same could be said of the more recent development of the carambola.

Varietal selection is therefore crucial to the success of any of these exotics. A good quality product cannot be made out of one which is inherently poor and/or variable. This applies to all exotics and some of the minor exotics in the region.

Market Quality = Field Quality + Post-harvest System.

Once we have a good variety optimum post-harvest management depends on two main factors — fruit structure and fruit physiology as indicated in Tables 1 and 2. Fruit structure, fruit size, weight and shape govern harvesting, handling and packaging techniques. Fruit physiology (climacteric, ethylene producer, sensitivity to chilling, shelf-life) affects the handling system devised and this would have implications for air and sea transported commodities.

Table 1: Fruit characteristics of minor exotic fruit tree crops

Fruit	Size (cm)	Weight (g)	Shape	Skin	Edible flesh (%)	Water content (%)
Soursop	12–35	400–2600	Irregular	Thick/spiny	65–80	
Sugar apple	6–10	150–500	Rounded	Carpels separate readily	35	75
Sapodilla	4–10	75–300	Round/ellipitical	Smooth/intact	85	74
Plum	2.5–5	15–30	Ellipitical	Thin/delicate	50–70	83
Tamarind	6–15	25–80	Flattened pod	Woody/delicate	30	22–34

Table 2: Fruit physiology of minor exotic fruit tree crops

Fruit	Wks to maturity	On-tree storage	Ripens after harvest	Ethylene producer	Brix (°)	Acid ()	Chill (°C)	Shelf-life Ambient (days)	Shelf-life Cool (days)
Soursop	10–17	no	yes	yes	12–23	0.3–1.4	<12	3–6	8–12
Sugar apple	15–18	no	yes	yes	10–15	0.1	<15	2–3	4–5
Sapodilla	25–35	no	yes	yes	12–25	1.2–2.3	<10	6–9	10–14
Plum	15–16	no	yes	yes	15	0.06	<12	3–5	7–10
Tamarind	42–50	yes	no	no	54–70	12–24	<12	14–21	25–35

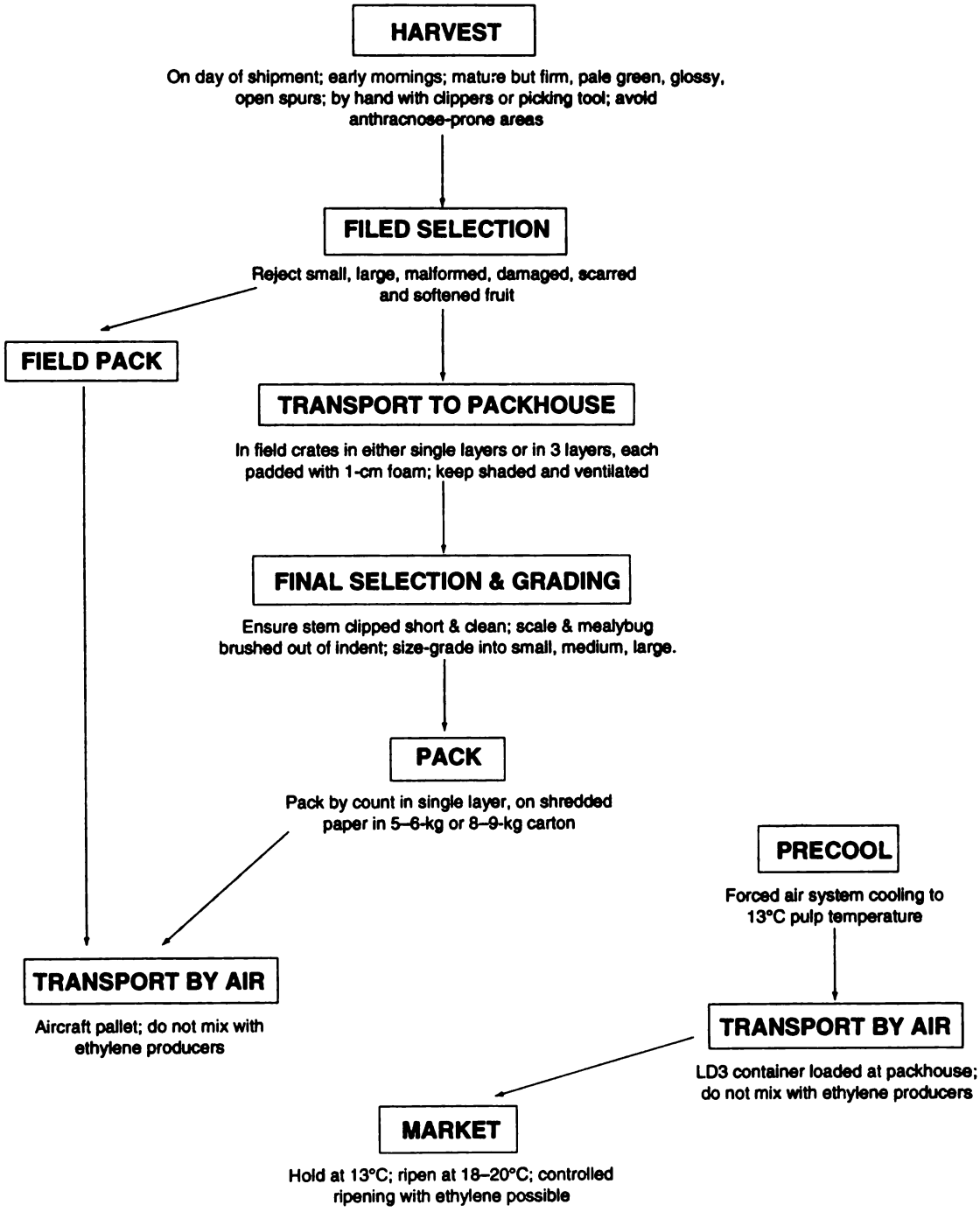

Figure 1: Soursop handling flow diagram

Based on structure and physiology, it is not difficult to predict the sort of quality problems seen on the market as expressed in Table 3. A number of minor exotics are currently being exported out of the OECS. Some of the more important handling techniques are illustrated in Figures 1 and 2 for soursop and sapodilla.

Table 3: Primary causes of quality loss at market of minor exotic fruit tree crops

Fruit	Cause of quality loss				
	Immaturity	Premature ripening	Bruising Bruising	Breakage	Pathological
Soursop	Frequent	Frequent	Frequent	No	Frequent
Sugar apple	Frequent	Frequent	Frequent	Yes	Occasional
Sapodilla	Frequent	Frequent	Occasional	No	Rare
Plum	Occasional	Frequent	Occasional	No	Occasional
Tamarind	Rare	No	No	Yes	Rare

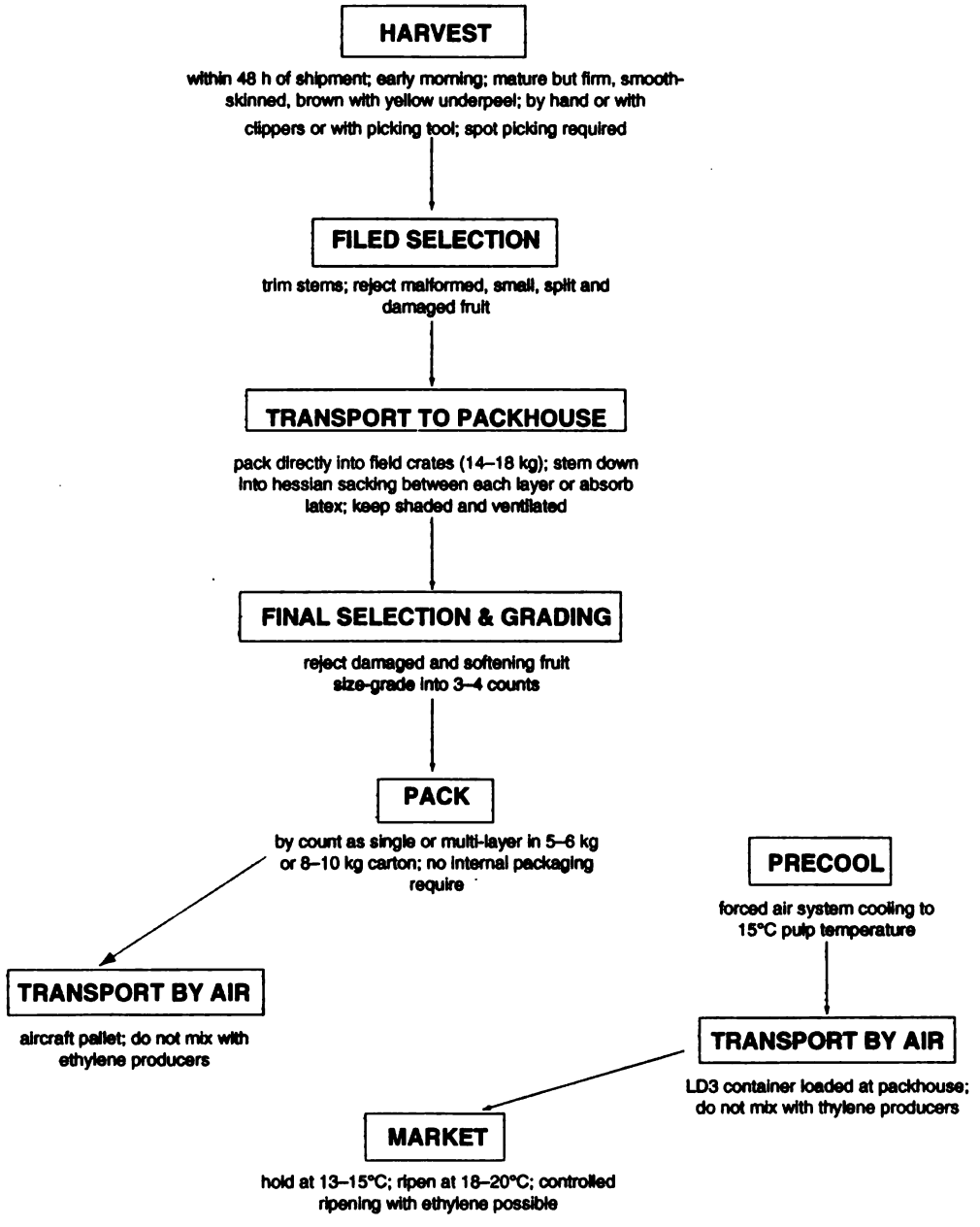

Figure 2: Sapodilla handling flow diagram

PROCESSING OF WEST INDIAN CHERRY, GUAVA, TAMARIND, PLUM AND DUNKS

LINDA SAMMY

Abstract
The minor fruits of the Caribbean, namely West Indian cherry, guava, tamarind, plum and dunks are well known and appreciated as fresh fruits with a high demand during the brief 2–6 months when they become available. The relative unavailability of these fruits, particularly the West Indian cherry and dunks accounts for their minor processing significance. The guava, tamarind and plum being available in slightly greater quantities are processed into beverages, jellied products, pickles and confectionery. The general causes of spoilage and various processing techniques are given. Processed products from minor fruits are discussed: high sugar products, such as jam, jelly, fruit cheese, preserve, candy, cordials and squashes; high salt products; fruit wines; dried/dehydrated products. The processing of canned and bottled products (heat processed) is also detailed. Storage of these perishable fruits is also discussed. The paper concludes that the lack of knowledge on processing techniques is not a limiting factor to processing but rather the availability of fruits.

Résumé
Les fruits mineurs de la Caraïbe, notamment la cerise des Antilles, la goyave, le tamarin, les prunes mombin et les jujubes sont bien connus et appréciés comme fruits frais; la demande est élevée durant les 2 à 6 mois que dure leur disponibilité. L'indisponibilité relative de ces fruits, particulièrement cerise des Antilles et jujube justifie l'importance de leur transformation. Goyave, tamarin et prunes mombin sont disponibles en quantités légèrement plus grandes; ces fruits sont transformés en boissons, gelées, fruits au vinaigre et fruits confits. Les causes générales de détérioration ainsi que diverses techniques de transformation sont présentées. Les produits transformés consistent en: a) produits à haute teneur en sucre, tels que confitures, gelées, pates de fruits, conserves, fruits confits, liqueurs et pulpes; b) produits à haute teneur en sel, c) vins de fruit, d) fruits séchés / produits déshydratés et e) produits embouteillés et conserves (traitement à la chaleur). La conservation des produits transformé est aussi discutée. L'article conclut que la disponibilité de fruits est plus un facteur limitant que le manque de connaissances techniques.

Resumen
Las frutas ménores en el Caribe, a saber la acerola, la guayaba, el tamarindo, las ciruelas (hobo)) y el jujube son bien conocidas y apreciadas como frutas frescas y tienen una alta demanda durante los escasos 2 a 6 meses cuando llegan a ser disponibles. La relativa no-disponibilidad de estas frutas, particularmente la acerola y el jujube explica la importancia de su procesamiento. Guayaba, tamarindo y ciruela (hobo) estan disponibles en cantidades un poco más grandes y se procesan en bebidas, productos gelatinosos, encurtidos y frutas confitadas. Las causas generales de pérdidas así como varias técnicas de procesamiento se discuten. Los productos procesados a partir de frutas ménores se detallan: a) productos con alto contenido de azúcar: mermeladas, jaleas, frutas confitadas, dulces, cordiales y pulpas, b) productos con alto contenido de sal, c) vinos, d) frutas secadas/ deshidratadas, y e) productos enlatados ó embotellados. Se discute también su almacenamiento. El artículo concluye que la falta de conocimientos técnicos en cuanto a procesamiento no es un factor limitante sino la disponibilidad de frutas.

Introduction

West Indian cherry, guava, tamarind, plum and dunks are well known and appreciated as fresh fruit; They are highly sought after during the brief 2–6 months of the year when they become available. The relative unavailability of these fruits, particularly the West Indian cherry and dunks accounts for their minor processing significance.

Guava, tamarind and plum, being available in slightly greater quantities, are processed into beverages, jellied products, pickles and confectionery. In 1990, Grenada recorded an availability of 40,000 kg of guava and 175,000 kg of tamarind (Rahim 1991). The guava is perhaps the fruit most utilized in processing by kitchen-scale operators and large-scale manufacturers alike. The commonest processed products of guava are the jellied products such as jams, jellies and cheeses.

Interestingly, although some of these fruits may be grown in stands on experimental plots, none is actually cultivated to any great extent on an orchard scale. In Puerto Rico 200 ha of West Indian cherry was reported 10 years ago. Orchards of guava are to be found in Florida, Guyana and Brazil, and Barbados claims to have a high availability of dunks.

Guava, tamarind and plum which are used in processing are gathered largely from trees growing in the wild, from backyard trees and the occasional experimental plot. This limited supply of fruit is used

not only in processing but also furnishes the fresh market.

1. Nomenclature

Table 1 shows the botanical name and common names used in the region for West Indian cherry, guava, plum, dunks and tamarind.

Table 1: Botanical and common names of minor fruits grown in the Caribbean

Botanical name	Common name
Malpighia glabra	Barbados cherry, West Indian cherry, cerise, acerola, cherry Ann
Psidium guajava	guava, guayava, goyave
Tamarindus indica	tamarind, imli, tambrun, bamtrand
Spondias purpurea	plum, Spanish plum, chilli plum
Ziziphus mauritiana	dunks, Indian jujube, dumps, dunk tree, crab apple, codie plum

Sources: Devi Persad (1986); Stutrock (1940)

2. Seasonality

West Indian cherry, guava, tamarind, plum and dunks are highly seasonal becoming available for periods ranging from 2 to 6 months during the year as shown in Table 2.

There is some variation in bearing period amongst countries allowing for inter-island trade to offset shortfalls in supply. There is already some degree of inter-island trade in tamarind (shelled and unshelled). Raw materials can also be accessed from the South American mainland countries of Guyana and Venezuela.

Table 2: Seasonality of some minor fruits

	Yielding period	
Fruit	Trinidad	Barbados
West Indian cherry	May–August	July–December
Chilli plum	July–August	
Tamarind	OctoberJune	
Guava	February–March; September–October	All year
Dunks	July–October	November–February

Sources: Devi Prasad (1986); Gooding (1991)

3. Status of Present Utilization

Table 3 gives an indication of the types of products which are manufactured from the various fruits and the countries in which processing is taking place.

Table 3: Current status of processing of minor fruits in the Caribbean

Fruit	Commonly manufactures products	Country
Guava	Candied, jellied products, beverages	Grenada, Guyana, Jamaica, Trinidad, Dominica Bahamas
Tamarind	Flavouring, beverages, confectionery	Grenada, Trinidad, Bahamas
Dunks	Candy, pickle	Guyana, Trinidad, Barbados
West Indian cherry	Jellied products, beverages	Barbados
Chilli plum	Pickle	Trinidad

Source: FAO (1992)

4. Spoilage of Fruits

Fresh fruits are highly perishable and spoil within a matter of days. Storage life is particularly reduced under conditions of poor handling of the raw fruit and storage conditions (temperature and humidity).

Spoilage is the deterioration of the food which makes it taste or look bad and/or makes it a carrier of disease-causing organisms.

Fruits are considered spoiled if they:
- Have an offensive smell
- Have a mouldy surface
- Have a different colour
- Have a slimy surface
- Are 'gassy'
- Have a strong or sharp uncharacteristic flavour
- Cause sickness such as vomiting, diarrhoea and stomach cramps

5. Common Causes of Spoilage

Spoilage can be caused by:
- The growth and activity of spoilage micro-organisms such as yeasts, moulds and bacteria
- A contamination of the various life processes in the fruit, for example, ripening and respiration
- Chemical and enzymic reactions in the food itself leading to changes in colour and flavour.

These spoilage factors must be controlled in order to prolong the life of the raw fruits.

6. Processing Techniques

Preservation/processing techniques are used to prolong the storage or useful life of raw fruits.

Preservation is also used to store excess foods available at certain times, for consumption during times of scarcity.

The range of processing techniques commonly used in the preservation of fruits is described below:

6.1 Use of High Osmotic Pressure

- — High concentration of sugar (60–70%) such as in the manufacture of candied products, jellied products and cordials.
- — High concentration of salt (15–25%) such as in the manufacture of pickles and storage as salt-stock.

6.2 Use of Heat

6.2.1 Pasteurization

The application of temperatures between 80 and 100°C to cause destruction of all major spoilage and pathogenic micro-organisms. Storage time is limited and products must be stored under refrigeration (0–4°C).

6.2.2 Sterilization

The application of temperatures higher than 100°C (usually 121°C) to cause destruction of all micro-organisms. Some heat-resistant spores may still survive sterilization conditions.

6.3 Application of Fermentation

Fermentation is used in the production of wines (alcoholic fermentation), vinegar (acetic acid fermentation) and some types of pickles (lactic acid fermentation).

6.4 Application of Drying and Dehydration

Drying and dehydration are used to remove 80–90% of the water from the fruit.

6.5 Use of Chemical Preservatives

Chemical preservatives such as sulphur dioxide, sodium benzoate and potassium sorbate are commonly used as aids to other methods of fruit preservation. Dosage levels of these preservatives is under strict legal control as stipulated by relevant food standards.

6.6 Use of Low Temperatures

- — Refrigeration (2–4°C; relative humidity 85–90%) for a shelf-life of 4–7 days.
- — Freezing (–20°C) for a shelf-life greater than 7 days.

The exact choice of preservation method depends on:

- — The characteristics of the raw material
- — The desired properties of the processed product
- — The availability of alternative energy sources
- — The availability of appropriate storage facilities
- — The availability of appropriate packaging
- — The relative costs of the alternative processing/ preservation methods

Sometimes a combination of methods may be used, for example, the addition of acid followed by heat treatment.

7. Processed Products from Minor Fruits

Technically feasible processed products which can be manufactured from West Indian cherry, guava, tamarind, plum and dunks are shown in Table 4.

8. Processing of High Sugar Products

Products such as jams, jellies, fruit cheeses, preserves, candies, cordials and squashes are prepared with a high concentration of sugar (60–70%) which through its osmotic effect, prevents the spoilage of these products by micro-organisms.

8.1 Definitions

Jams, jellies, fruit cheeses, preserves and candies are prepared by combining fruit pulp, juice or pieces with sugar, pectin and acid and cooking to achieve a soluble solids concentration of usually not less than 65%. To meet full fruit standard, these products must contain not less than 40–45% fruit.

Table 4: Technically feasible processed products of minor fruits

		Jellied products			Preserves and	Cordial/	Ready to		Confection		Canned in syrup	Dried/ dehydrated	
Fruit	Pickles	Jelly	Jam	Cheese	candy	squash	serve	Wine		Sauce	or brine	Leather	Whole
Plum: ripe		✔	✔		✔		✔	✔			✔		✔
Plum: green	✔				✔						✔		
Dunks: ripe		✔	✔	✔	✔		✔	✔			✔	✔	✔
Dunks: green	✔				✔						✔		
West Indian cherry		✔	✔		✔		✔	✔			✔		
Guava		✔	✔	✔	✔	✔	✔	✔			✔	✔	✔
Tamarind		✔	✔		✔	✔	✔	✔	✔	✔	✔		✔

8.1.1 Jam

A jam is made from crushed, ground or pureed fruit. The product is not clear and while it is firm enough to hold its shape, it is generally less firm than a jelly. It must be easily spread with a knife.

8.1.2 Jelly

A jelly is made from the clarified juice of the fruit. The product is clear and firm enough to hold its shape when turned out of the container or when cut.

8.1.3 Fruit Cheese

A fruit cheese is prepared as for a jam, however, the product is usually moulded and is firm enough to be sliced.

8.1.4 Preserve

A preserve consists of large pieces or whole fruits in a thick syrup which may be slightly jellied.

8.1.5 Candying

Candying is conducted by syruping the fruit to a final sugar content of not less than 60% as for a preserve. The syruped product may be further dried to obtain a low moisture product or it can be given a glazed, crystallized or sanded finish.

8.1.6 Cordials and Squashes

Cordials and squashes are prepared by combining a fruit extract with sugar and acid to give a finished product of usually not less than 60% soluble solids. Such a product has to be diluted with water (usually one part cordial or squash to four parts water) to produce a ready-to-serve drink. A cordial differs from a squash only by its content of insoluble fruit pulp. A cordial is usually sparkling clear while a squash is pulpy.

8.2 Ingredients

The ingredients required for making jellied products (jams, jellies, cheeses), preserves and candied products and high-sugar beverages (squashes, cordials) are as follows.

8.2.1 Fruit

Fruit for jellied products must be fully mature, ripe and flavourful. Overripe fruits should be avoided as these are poor in pectin. The fruit may be used whole, in pieces, as a pulp or puree or as clarified juice.

Fruit for preserve making and candying must be mature and firm with good colour and flavour. Ripe as well as unripe fruit can be candied. For example, green as well as ripe chilli plums and dunks can be candied.

Fruit for making cordials and squashes should be fully mature and ripe with good colour and flavour. Overripe and immature fruit should be avoided. A pulp or puree is needed to prepare a squash while a clarified juice is necessary for a cordial.

8.2.2 Sugar

White granulated sugar is recommended for these products. Invert syrup or corn syrup may be necessary in these high-sugar products to prevent sucrose crystallization.

8.2.3 Citric Acid

Citric acid in granulated form or as lime or lemon juice is used to adjust the acidity of these products. For jellied products, an optimum pH of 3.2 is essential for jelly formation.

Citric acid is also required for taste, preservation and to bring about the partial inversion of sucrose which prevents its crystallization under high sugar conditions.

8.2.4 Pectin

Pectin is necessary in the formation of the jelly structure. Pectin can be purchased as a commercial preparation in dry or liquid form or can be extracted from raw materials such as citrus, passion fruit and papaya. Fruits such as dunks, plums and particularly guavas are naturally rich in pectin.

Interestingly, an extract from the tamarind seed (tamarind seed jellose), though it differs from fruit pectins, can be used with or without acids to form excellent jellies (Rao 1949). This opens an attractive avenue for the utilization of waste from tamarind processing.

8.2.5 Preservatives

Preservatives such as sodium benzoate, potassium sorbate, sodium or potassium metabisulfite are permitted in regulated amounts in high-sugar products.

8.3 Processing Techniques

8.3.1 Jellied Products (Jams, Jellies, Cheeses)

The processing steps for jellied products are shown in Figure 1.

(a) Select fully ripe fruit having good colour, flavour and aroma.
(b) Wash the fruits thoroughly in fresh water. Remove stems and leaves. Trim bruised and blemished portions.
(c) Prepare an extract of the fruit. A pulp is needed for jams and cheeses. A clear juice is required for jellies.

Preparation of a pulp:
Tamarind — Remove pod shells. Agitate the shelled

pods in water using a 1:2 fruit to water ratio. Pass the pulp through a paddle finisher fitted with a 0.02-in screen to separate the pulp from the seeds.

Guava — Chop the fruit into small pieces. Add an equal quantity of water and boil until the fruit pieces become soft. Use a paddle finisher fitted with a 0.02-in screen to separate the pulp from seeds and skin.

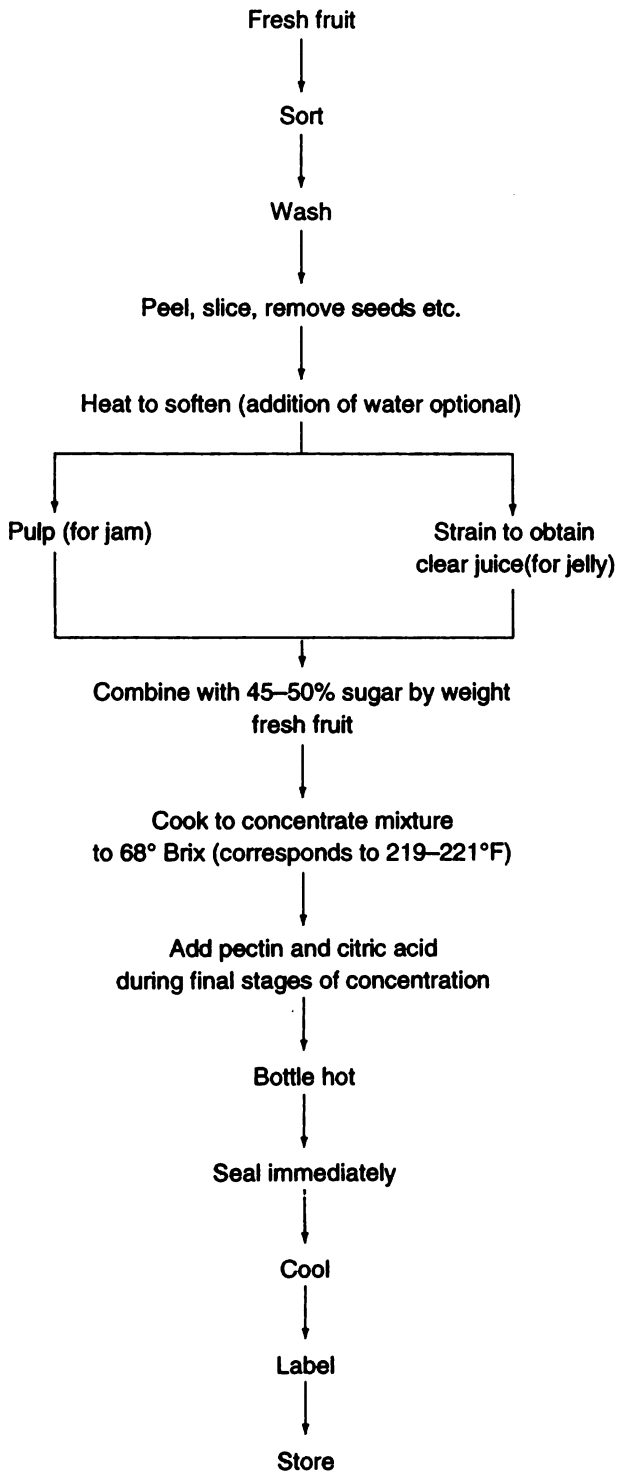

Figure 1: Processing steps in the manufacture of jams and jellies

Dunks — Prepare pulp as for guava.

Plum — Combine the fruit with an equal quantity of water and boil until the fruits are soft. Use a paddle finisher fitted with a 0.02-in screen to obtain a pulp free from seeds and skin.

West Indian cherry — Feed the juicy fruits through a paddle finisher fitted with a 0.02-in screen to separate the pulp from seeds and skin. The fruit can also be hand-crushed and heated briefly in its own juices before pulping.

Preparation of a Clarified Juice:
Tamarind — Agitate the tamarind pulp with 0.12-0.15% gelatin. Leave the mash to stand undisturbed for 10–15 days under refrigeration (6–10°C). When sedimentation has taken place, remove the clarified juice by decanting or siphoning.

Guava — Cut the fruit in pieces. Add an equal quantity of water and add 1.5–2 g citric acid/kg of fruit. Boil for about 30 min. Strain through a coarse cloth to separate the clear extract. Take one more extract in a similar way, combine the two extracts and leave standing undisturbed to settle. Decant or siphon the clear juice.

Dunks — Prepare as for guava.

Plum — Prepare as for guava except that the fruits are used whole as the large seed does not allow for chopping.

West Indian cherry — Hand-crush the fruits. Heat with a small quantity of water (two parts fruit to one part water) for 10–15 min. Place in a cloth or jelly bag and allow the juice to drip without pressing or stirring.

(d) Test the extract for pectin using the alcohol test. Mix equal volumes of the fruit extract with methylated spirit or 70% isopropyl alcohol and note the formation of clots.

Results:
high in pectin — a single strong clot
medium pectin — several weak clots
poor pectin — no clotting

(e) If the extract shows poor pectin, then concentrate the extract by heating until it gives a positive test for medium or high pectin. Alternatively a commercial pectin can be used at a level of 0.05-0.1% by weight.

(f) Mix the extract with white sugar.
- If the extract is sopur, add an equal quantity of sugar by weight.
- If the extract is sweet, add only three-fourths

sugar by weight and also citric acid at a rate of 1.5–2 g/kg fruit extract.

(g) Work the mixture until it falls in the form of sheets from a spoon or until the temperature of the mixture reaches 105.5 °C (219–221 °F) or a soluble solids content of 68% (by refractometer) is obtained.

(h) Pour the hot product into sterilized, warm, glass jars.

(i) Cap the jars immediately and invert to sterilize the covers. Turn upright and leave to cool.

(j) For cheese making, lightly smear a shallow tray with butter. Pour the hot product to about 0.6 cm thickness. Allow to cool and set. Cut into desired size pieces and/or shapes and wrap in plastic. Cheese pieces may be chocolate coated or sugar coated.

8.3.2 Preserves and Candies

The processing steps for preserves and candies are shown in Figure 2.

(a) Select fully mature, green, turning or firm ripe plums and dunks, firm ripe West Indies cherries and guavas and ripe tamarind for making preserves. Plum, dunks and guava are firm enough to be further processed into candy.

(b) Wash the fruits thoroughly in fresh water.

(c) Prepare the fruits for syruping:

Tamarind — Remove pod shells. Seeds may be removed but this is optional.

Guava — Trim tops and bottoms. Cut in halves or quarters and remove seeds. Peeling of the fruits is optional. Blanch the segments for 3 min in boiling water or a weak (20–30% strength) syrup. Drain and cool quickly.

Dunks — Destone the fruit using a pitting tool. The fruits may be left whole or cut into smaller pieces. Blanch the fruit as for guava. The flesh may be pricked using a stainless steel fork to facilitate penetration of the syrup during later processing.

Plum — Removal of the stone is difficult so the fruit is left intact. Prepare as for dunks.

West Indian cherry — Remove stems and leaves. Blanch the fruits for 1 min in boiling water or a weak (20–30% strength) syrup. Drain and cool immediately.

(d) Syrup the fruit using either of two methods:

Method A:

(i) Take white sugar equal to or half the weight of the fruit.

(ii) Pack the fruit and sugar in alternate layers starting and ending with sugar. Allow to stand

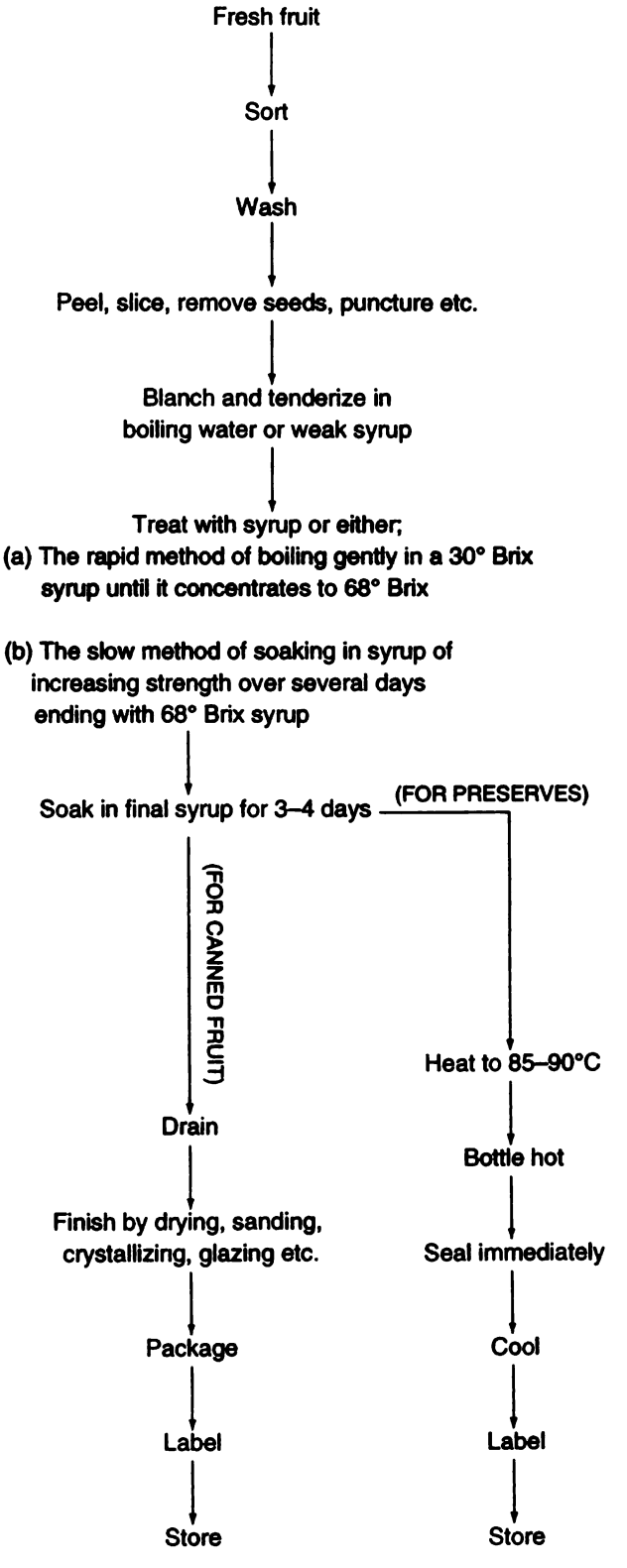

Figure 2: Processing steps in the manufacture of preserves and cannied fruit

for 24 hr. The juice exuding out of the fruit dissolves the sugar.

(iii) Next day, drain the fruit from the syrup and add enough sugar to raise the strength of the syrup to about 50° brix (measured with a refractometer). For the sweeter fruits, add also 5–10 g citric acid for every 1 kg of sugar used at the start. This is not necessary for tamarind, nor West Indian cherry. If colour is used (e.g. red in green plums and dunks), this is also added at this stage using a level of 0.03% of the weight of fruit.

(iv) Return the fruit pieces to the syrup and boil for 5–10 min. Leave to soak for 24 hr.

(v) On the following day, drain the syrup and again raise the strength of the syrup by adding enough sugar so that when drawn between the fingers, the syrup spins two to three threads. If a refractometer is available, a soluble solids content of 68–70° brix should be obtained.

(vi) Return the fruit pieces to the syrup and boil for 5–10 min. If preservative is to be used, this is added at this stage using a level of 0.1% sodium benzoate or potassium sorbate or 0.03% potassium metabisulfite based on the weight of the fruit.

(vii) Leave the fruit to soak for 3–4 days in this syrup before finishing.

Method B (particularly suited to preserve making):

(i) After blanching the fruit pieces, gently cook them in a 30% strength syrup (one part sugar to two parts water). Use twice the volume of syrup to fruit.

(ii) Continue gently heating the fruit in the syrup until the syrup thickens sufficiently to the end point described in Method A, step (v).

(iii) Continue as for Method A, step (vi).

(e) **For a preserve**, heat the syrup and fruit mixture to a temperature of 85–90 °C. Pack the fruit and syrup into clean, warm bottles. Clean the rims of the bottles and seal with clean caps. Invert the bottles for about 1 min to sterilize the underside of the cap. Return to the upright position and cool as quickly as possible.

(f) To finish **as candied fruit**, drain the fruit from the syrup. Rinse briefly in warm water to remove the surface syrup. Spread on a rack and dry for about 8–10 hr at 65–70 °C.

8.3.3 Cordials and Squashes

Tamarind and guava because of their intense flavour are well suited to making cordials and squashes. The processing steps for cordials and squashes are shown in Figure 3.

(a) Select fully ripe fruits.

(b) Wash the fruits thoroughly in fresh water. Trim to remove blemishes and bruised areas.

(c) Prepare an extract of the fruit. A pulp is needed for squashes while a clarified juice is required for a cordial. Follow the directions as detailed under jellied products — Section 8.3.1 (c).

(d) Combine the fruit pulp or clarified juice with water, sugar and citric acid according to a predetermined formulation. Approximately 25% fruit extract makes an acceptable product.

(e) Heat the mixture to dissolve the sugar. Continue heating at a temperature of 85–90 °C for 10 min. Potassium sorbate at a level of 0.1% (w/w) finished product or potassium metabisulfite at a level 0.03% (w/w), can be added at this stage.

(f) Pour the hot product into clean, warm bottles.

(g) Clean the rims of the bottles and seal them immediately. Invert for 1 min to sterilize the underside of the caps.

(h) Return to the upright position and cool as quickly as possible.

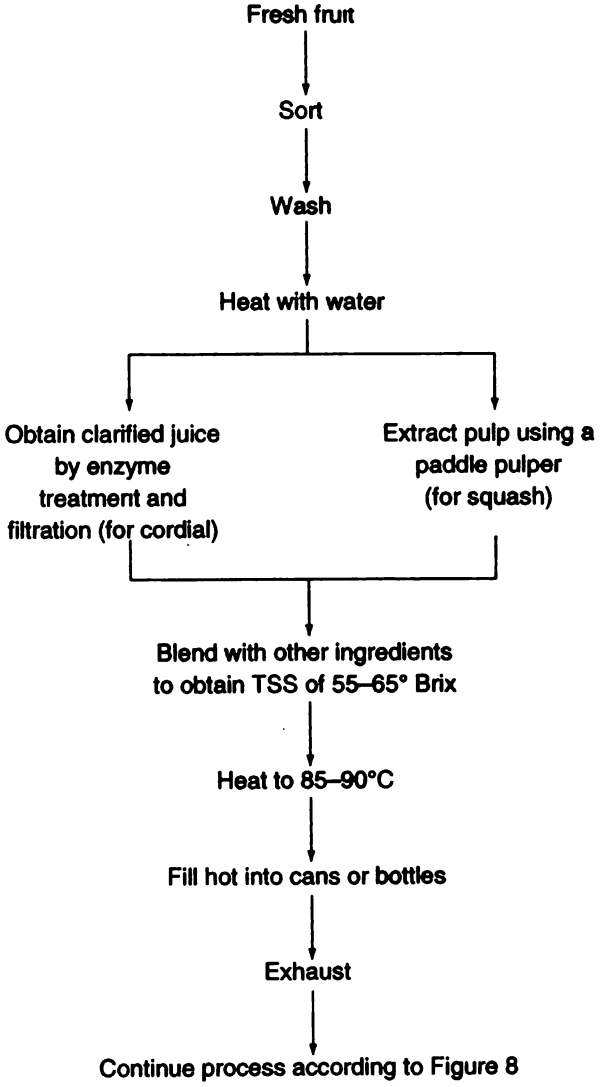

Figure 3: Processing steps in the manufacture of cordials and squashes

9. Processing of High Salt Products

Green plums and dunks are particularly well suited to pickle making. Pickles prepared in salt are preserved because of the strong osmotic effect of the salt. Salt may be used as a storage medium so that raw fruit can be stored from one bearing season to the next. Salt is also used as a selective agent facilitating the growth of lactic acid bacteria during the preparation of fermented pickles.

9.1 Definitions

Pickled products are classified on the basis of the ingredients that are used and the method of preparation (Figure 4).

9.2 Ingredients

The main ingredients for pickle making are:

9.2.1 Fruit

Plums and dunks must be mature, firm and preferably slightly underripe. Plums are best pickled whole, while dunks may be pitted and stuffed with herbs and spices as in olives. Pitted dunks may also be cut or chopped into smaller pieces.

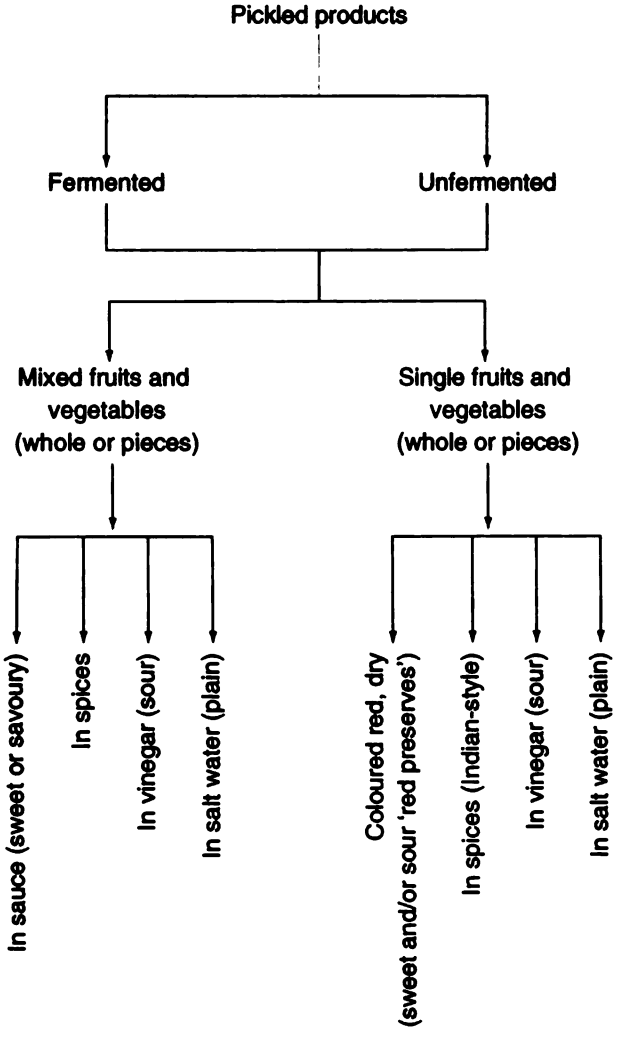

Figure 4: Range of pickled products

9.2.2 Vinegar

White distilled vinegar or other speciality vinegars containing 4–6% acetic acid are used for flavour and preservation.

9.2.3 Salt

Pure, granulated uniodized salt is important for flavour (1–3%), for preservation (15–25%) and in controlling lactic acid fermentation of certain pickles (2.5–8%).

9.2.4 Sugar

White granulated or brown sugar is used mainly for taste.

9.2.5 Herbs and Spices

A wide range and combination of herbs and spices are used for flavouring (Table 5).

Table 5: Herbs and spices used as flavouring

Herb/spice	Flavour	Common use
Hot spices:		
Capsicum Cayenne pepper Chilli pepper	Pungent	Most pickles and sauces
Black pepper White pepper	Mildly aromatic	Sauces
Ginger	Pungent	Sweet pickles
Mustard	Sharp, hot, pungent	Mustard sauce; salad cream
Mild spices:		
Coriander	Mild	As a blend with cloves, sage, nutmeg and mace in sauces; whole in pickled vegetables for attractiveness
Paprika	Mildly pungent	Used for colour in mayonnaise; used in spice bags for flavouring brines and vinegars
Aromatic spices:		
All spice Jamaican pimento	Aroma like a mixture of clove, nutmeg and cinnamon; slightly warm flavour	Sauces and pickles in general
Celery seeds		Adds fullness of flavour to pickled vegetables.
Cloves	Strong, pungent aromatic	Pickles and sauces in general
Cumin	Strong, faintly pungent flavour	Indian-type pickles and sauces associated with curry
Dill	Pleasant odour	Pickled cucumbers and mixed vegetables.

9.2.6 Vegetable Oil

Mustard, soya bean and corn oils are used in traditional Indian-style pickles. These oils are used for taste, texture and preservation against aerobic spoilage micro-organisms.

9.2.7 Preservatives

Permissible preservatives such as sodium benzoate used at not more than 0.1% (w/w) in the finished product can be used to inhibit spoilage micro-organisms.

9.3 Processing Techniques

The processing steps in the manufacture of pickles are shown in Figure 5.

9.3.1 Bulk Storage in Salt (20–25%)

Select green, mature plums and dunks. Wash thoroughly in clean water and sanitize using a chlorine dip (50 ppm). Follow either Method A or Method B below, to bulk store the fruit.

Method A (Dry salting; 20–25%)

(i) Select green, mature fruit. Wash thoroughly in clean water and sanitize using a chlorine dip (50 ppm).
(ii) Pack the fruit with dry salt in alternate layers at the rate of 200–250 g salt per kg of fruit. Begin and end with a layer of salt.
(iii) Complete filling of the packed container with a brine prepared by dissolving 200–250 g salt per litre of water.
(iv) Clean the rim of the container and seal securely. Store in a cool, dry area.
(v) Roll the containers occasionally to ensure even mixing and distribution of the brine.

Method B (Brining: 20–25%)

(i) Select green, mature fruit. Wash thoroughly in clean water and sanitize in a chlorine dip (50 ppm).
(ii) Prepare a brine by dissolving 200–250 g salt and 65 ml vinegar (5% acetic acid strength) per litre of water.
(iii) Pack the fruit into clean containers and fill with prepared brine. The required quantity of brine is about half of the volume of fruit. It may be necessary to use a pressure plate on the surface to keep the fruit submerged beneath the brine.
(iv) Sprinkle dry salt on the surface of the pressure plate at the rate of 200–250 g dry salt per kg of fruit.
(v) Clean the rim of the container and seal securely. Store in a cool, dry area.

Sulphur dioxide may be included in the pack where it performs as an antimicrobial agent as well as a bleaching agent. The chemical is added in the form of one of its salts such as sodium metabisulfite or potassium metabisulfite at the dosage level of 0.05–0.1% by weight.

A firming agent such as calcium chloride can also be added which ensures that the texture of the fruit remains firm during storage. A level of 0.05% is recommended.

Fruits removed from brined storage must be refreshed before undergoing further processing into a finished product. Excess salt is leached from the fruit by washing in several changes of water. Slightly warm water is more effective but the procedure must be carefully monitored because of the risks of spoilage and softening of texture.

9.3.2 Fermented Pickles

(a) Select green, mature fruit. Wash thoroughly in clean water and sanitize using a chlorine dip (50 ppm).
(b) Prepare a brine by dissolving 25–50 g salt and 50 ml vinegar (5% acetic acid strength) per litre of water.
(c) Pack the fruit into clean containers and fill with prepared brine. The required quantity of brine is approximately half the volume of fruit. It may be necessary to use a pressure plate on the surface to keep the fruit submerged beneath the brine.
(d) Clean the rims of the containers and store in a cool, dry area. Leave for about 2–3 weeks for fermentation to take place. At the end of fermentation, the fruits are of a crisp texture and olive-coloured.
(e) Process the fermented fruits into finished products by repacking in fresh brine which may be flavoured and acidified. Preserve the final product by pasteurizing (85 °C/15–20 min) or by using a combination of chemical preservation (such as sodium benzoate (max. 0.1% w/w) or potassium sorbate (max. 0.1% w/w) or potassium metabisulfite (max. 0.03% w/w) and pasteurization.

10. Processing of Fruit Wines

Ripe plum and dunks, guava, West Indian cherries and tamarinds are all suitable for wine-making. The alcohol produced during the yeast fermentation preserves the product.

10.1 Definition

A fruit wine is the beverage which is obtained from the alcoholic fermentation of fruits other than grape. Fermentation and alcohol production is brought about by yeast organisms of the species *Saccaromyces cerevisiae*. Fruit wines of varying alcohol content and sweetness can be prepared.

10.2 Ingredients

The ingredients needed for wine-making include:

10.2.1 Fruit

Fruit for wine making must be fully mature and ripe, with good colour and flavour. The fruit is prepared into a must by juicing, crushing or pulping.

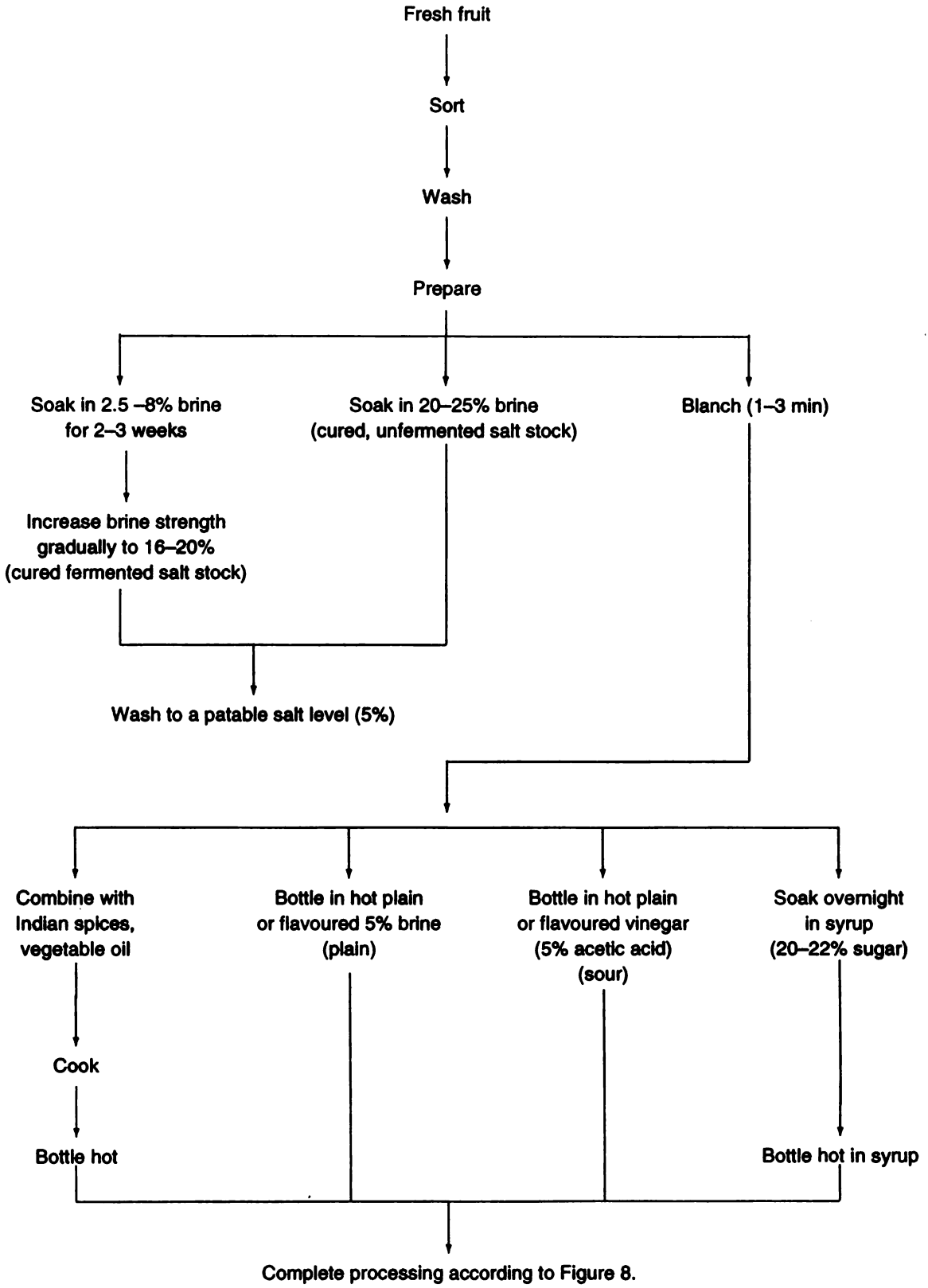

Figure 5: Processing steps in the manufacture of pickled fruits

10.2.2 Sugar

White sugar is preferred over brown sugar as the latter imparts undesirable odour and flavour to the wine and is also a carrier of undesirable 'wild yeasts' which may interfere with the activity of the wine yeast.

Sugar is converted by the wine yeast into alcohol.

10.2.3 Yeast

While traditionally, the only yeast easily accessible for home-scale wine-making may have been baker's yeast, there are hundreds of varieties of yeast specifically suited to wine fermentations. Yeast is responsible for converting the sugar in the must into alcohol.

10.2.4 Yeast Nutrient

Yeast requires a source of nitrogen in order to grow and ferment optimally. Some fruits contain adequate amounts of nitrogen while others do not and in such cases, a nitrogen-containing yeast nutrient such as ammonium phosphate is added to the must.

10.2.5 Acids

Acids such as citric, malic and tartaric are used for adjusting the acidity of the must to within the optimum range for good yeast growth (pH 3.2). A total acidity of 0.3% is also essential for good taste.

Some fruits naturally contain these acids for example the predominant acid in tamarind is tartaric acid.

10.2.6 Preservatives

Potassium or sodium metabisulfite is used as a sterilizing and preserving agent for equipment, the general processing area and in the final product during all stages of preparation and bottling of the wine.

10.2.7 Clarifying Agents

Chemicals such as bentonite, gelatine and isinglass are sometimes essential as fining agents which aid in clarifying the wine prior to bottling. Enzymes such as pectinases are used to assist in clarification during the initial stages of the wine-making process.

10.3 Processing Techniques

The processing steps for the manufacture of fruit wines are shown Figure 6.

(a) Select fully ripened fruit, soft but not rotting fruit can be used.
(b) Wash the fruits thoroughly in clean water.
(c) Ensure that all containers and equipment are sanitized. A 10% solution of sodium or potassium metabisilfite can be used for sanitizing.
(d) Prepare the fruit into a must:

Tamarind — Prepare a pulpy extract as described in Section 9.3.1(c). Because of the high acidity of the tamarind, the extract has to be diluted with water to achieve a total acidity of 0.3%.

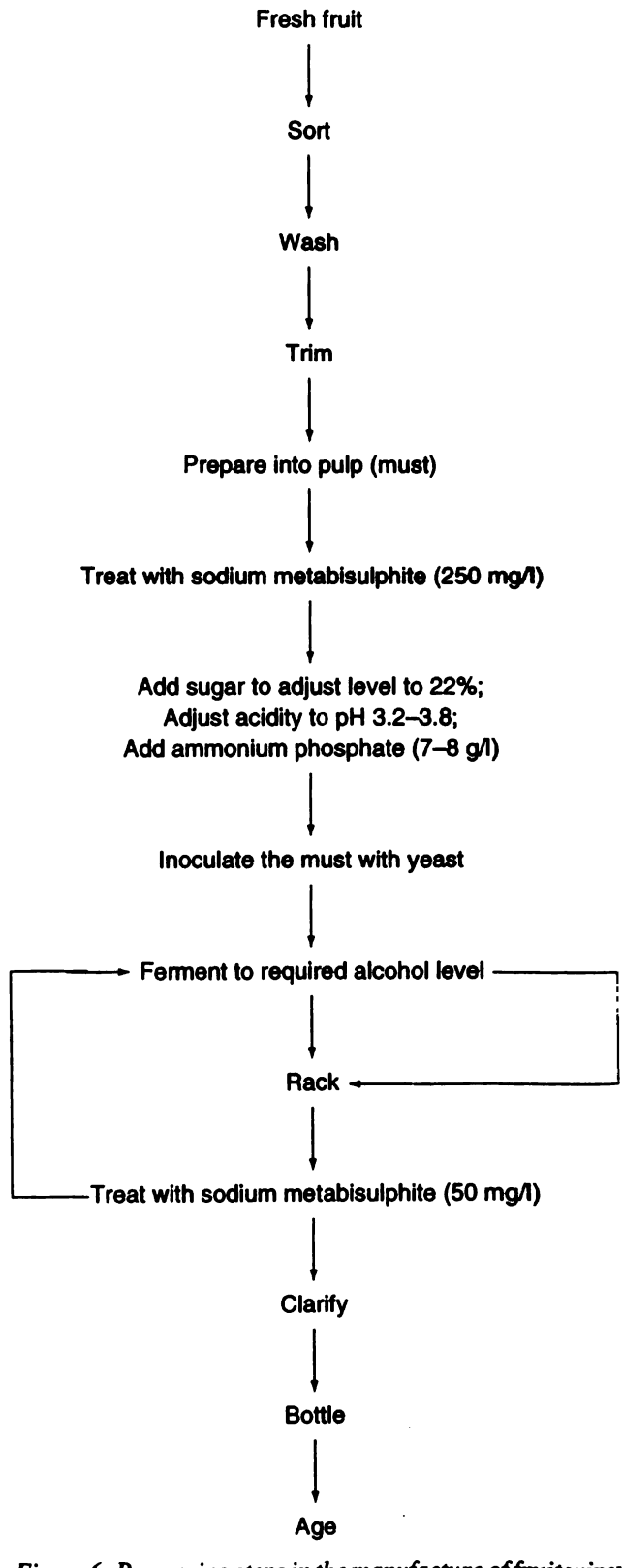

Figure 6: Processing steps in the manufacture of fruit wines

West Indian cherry — Hand-crush the fruits to obtain a pulpy mass of seeds, flesh and skin.

Guava — Chop or hand-crush the fruits.

Dunks — Chop or hand-crush the fruits. If possible remove the hard, tough seeds using a sieve of suitable mesh size.

Plum — hand crush the fruits. As the seeds are large and tough, if possible, separate the seeds from the pulp using a suitable size sieve.

(e) Place the crushed, chopped or pulped fruit into a clean, sanitized container such as a bucket. On average about 2 kg of the sweeter fruits such as West Indian cherry, dunks, guava and plum maybe used to prepare 4 litres of fruit wine. For the highly acidic tamarind, considerably less is required.
(f) Prepare a syrup by dissolving about 0.75 kg sugar in 2 litres of boiling water. Pour the hot syrup over the fruit and allow to cool with the container securely covered.
(g) When cool, add about half a teaspoonful of wine yeast or about 200 ml of a starter culture and cover the container with a clean cloth or a lid. Take the precaution of keeping fruit flies away from the container.
(h) Leave the fruit to ferment on the pulp for about a week stirring occasionally about once or twice per day. Ensure that precautions are taken to use a sanitized stirrer.
(i) Separate the fermented liquid from the pulp by straining through a cloth. Place a wine trap and bung into the mouth of the bottle or plug loosely with cotton wool.
(k) Leave in a cool place for fermentation to continue. When bubbling has slowed, add another 0.5 kg sugar and water to fill the bottle to below the neck. Replace the wine trap or the cotton plug and leave to ferment.
(l) When a sediment appears, siphon the clear liquid into a second bottle or a bucket and discard the sediment. Taste the wine; if it is too dry, add 100 kg sugar dissolved in sufficient water to fill the bottle to below the neck. Replace the trap or the cotton plug and leave for 2–3 months.
(m) Repeat siphoning or racking the wine as new sediment forms.
(n) When no more sediment forms, after 6 months or more, bottle the wine into sanitized bottles.
(o) Leave the wine to age in a cool area for at least 3–6 months before drinking.

11. Processsing Dried/Dehydrated Products

Dried or dehydrated products such as leathers, whole fruit or pieces can be prepared from ripe plums and dunks, guavas and tamarinds. Shelled tamarind is usually stored as a semi-processed, dried product for further processing.

A range of drying and dehydration systems can be used such as sun drying, solar drying and electrical and gas-fired mechanical dehydrators.

Dried and dehydrated products are resistant to spoilage due to their low moisture content (1–5%).

11.1 Definitions

Dried and dehydrated products are considered the result of sun drying and mechanical drying respectively. Mechanical drying uses electrically operated or gas-fired kilns, ovens, drum driers and spray driers.

The term 'fruit leather' is used to describe the product which is obtained by drying or dehydrating thin sheets or layers of the fruit pulp. The product is best suited to pulpy fruits such as dunks and guava.

11.2 Ingredients

The main ingredients used in the processing of dried/dehydrated products are:

11.2.1 Fruit

Fruits must be fully mature and ripe, of good flavour and colour and with a firm texture.

11.2.2 Sugar

White granulated sugar or alternative sweeteners such as honey or corn syrup may be used to enhance the natural sweetness of the fruit, to prepare a sweetened product or in the osmotic dehydration process.

11.2.3 Additions

Citric acid and sulphur dioxide (as sodium or potassium metabisulfite) are used as antioxidants to prevent darkening or discolouration of the product. Sulphur dioxide also acts as a preservative in the prevention of spoilage.

11.3 Processing Techniques

The processing steps for the manufacture of dried and dehydrated fruits are shown in Figure 7.

11.3.1 Fruit Leathers

Ripe dunks and guavas which yield pulps with distinctive flavours and reasonably good pectin levels can be processed into fruit leathers.

(a) Select fully ripened fruit. Trim blemished and bruised areas. Wash thoroughly in clean water.
(b) Prepare a pulp as described in Section 9.3.1 (c)

(c) Add 3 g of potassium metabisulfite per kg of fruit pulp.
(d) Spread the pulp on a lightly greased stainless steel tray to about 1.25 cm thickness.
(e) Dry in the sun or in a drying oven at 50–60 °C until the product is dry to the touch and leathery in texture.
(f) Remove the product from the tray and cut into pieces or roll up into scrolls. Wrap or store the product in a moisture-proof, airtight package to prevent absorption of moisture.

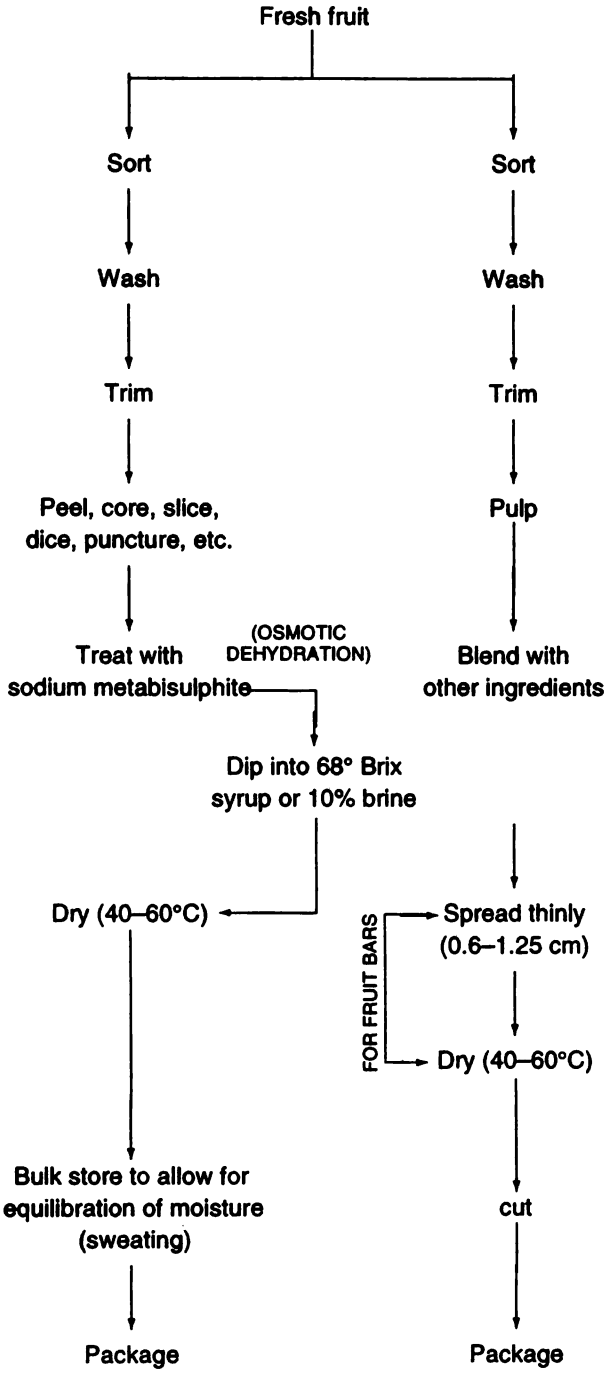

Figure 7: Processing steps in the manufacture of dried and dehydrated fruit products

11.3.2 Dried Whole Fruit

Ripe plums and dunks may be processed into dried whole fruit. Dried dunks have been likened to dates.

(a) Select freshly harvested, fully mature, ripe, firm fruits.
(b) Wash the fruits thoroughly in clean water. Dunks may be pitted.
(c) Blanch the fruits for 5–15 seconds in boiling lye (10–20 g sodium hydroxide/litre of water) to roughen the skin and speed the drying procedure.
(d) Immediately, cool the blanched fruit in cold water. This washing removes excess lye. A small amount of lemon or lemon juice may be added to the water to help neutralize the lye.
(e) Dip the lye-treated fruit for 10–15 min in a 0.5% sodium metabisulfite solution (5 g/litre water). This helps prevent browning discolouration of the fruits and assists in preservation.
(f) Soak the fruits for 12–18 hr in a sugar solution containing two parts sugar and one part water by weight. The strong sugar solution draws moisture out of the fruit by osmosis. The brief soaking period does not significantly affect the sweetness of the product.
(g) Drain the fruits from the syrup and rinse briefly in warm water to remove surface syrup.
(h) Spread the fruits on a rack and dry to a moisture content of 12–14%. Drying is complete when the juice cannot be pressed from the product with the fingers.
(i) Cool the dried product.
(j) Pack the dried fruit into airtight containers and leave for 24–48 hr for 'sweating' to occur. During this period, the moisture content of the individual fruit pieces reaches equilibrium.
(k) Package the final product in moisture-proof, airtight bags or containers. Seal securely and store in a cool, dry area.

12. Processing of Canned and Bottled Products (Heat Processed Products)

Preservation of fruits using heat is used in the preparation of products such as canned/bottled, syruped and brined fruit (whole, pieces), beverages and sauces.

12.1 Definitions

Canned/bottled syruped fruit consists of whole fruit, uniform pieces or crushed fruit contained in a syrup. The syrup may be light (33% sugar or less), medium (40% sugar) or heavy (50% sugar or more) and is usually acidified to pH 3–3.5. The syrup may also contain fruit juice.

Canned/bottled brined fruit consists of whole fruit or uniform pieces contained in a brine of not more than 2–3% salt which is acidified with citric acid.

Canned/bottled ready-to-serve (RTS) beverages include nectars which are usually pulpy, viscous and

sweet, single strength juices which may be sweetened or unsweetened and drinks which generally contain a certain percentage of single strength juice.

Canned/bottled fruit sauces are generally thick or viscous and highly spiced. The product may be smooth and homogenous or particles of spices and/or fruit may be visible. The taste may vary from savoury to sweet. All fruit sauces contain vinegar.

12.2 Ingredients

The major ingredients used in the preparation of canned and bottled products are:

12.2.1 Fruits

Syruped fruit requires the use of fully mature, ripe or slightly underripe fruits which are firm and of good colour and flavour.

Brined fruit requires the use of fully mature, green fruits. Fruit for beverage making should be fully mature and ripe with good colour and flavour. Overripe and immature fruit should be avoided. The fruit is prepared into a single strength juice or a puree/pulp which is then used in the respective beverages.

Fruits for sauce making should be mature and may be used ripe or green. The fruit is usually prepared into a pulp.

12.2.2 Salt

Uniodized, pure granulated salt is used in the preparation of brines and for flavouring of sauces.

12.2.3 Sugar

White granulated sugar is used in the preparation of syrups and for sweetening beverages and sauces. Alternative sweeteners such as honey and corn syrup can also be used.

12.2.4 Acidulant

Citric acid in granulated form or as lemon or lime juice is used for acidifying syrups, brines, beverages and sauces for a pH of 3–3.5.

12.2.5 Additives

Preservatives (sodium benzoate, potassium sorbate and potassium or sodium metabisulfite), colourings and flavourings within recommended limits may be used to enhance the keeping quality and acceptability of the products.

12.2.6 Herbs and spices

A range of herbs and spices can be used for flavouring sauces. Many of these are similar to those used in pickle manufacture (Table 5).

12.2.7 Vinegar

Vinegar (4–6%) acetic acid is used in fruit sauces for taste and preservation.

12.2.8 Thickeners

Starches, gums and pectin are used in some beverages and sauces for enhanced viscosity, texture and mouthfeel.

12.3 Processing Techniques

The general processing procedure used in the manufacture of canned/bottled products is shown in Figure 8.

(a) Prepare the products according to formulation.
(b) Preserve the product using either of Methods A or B below:

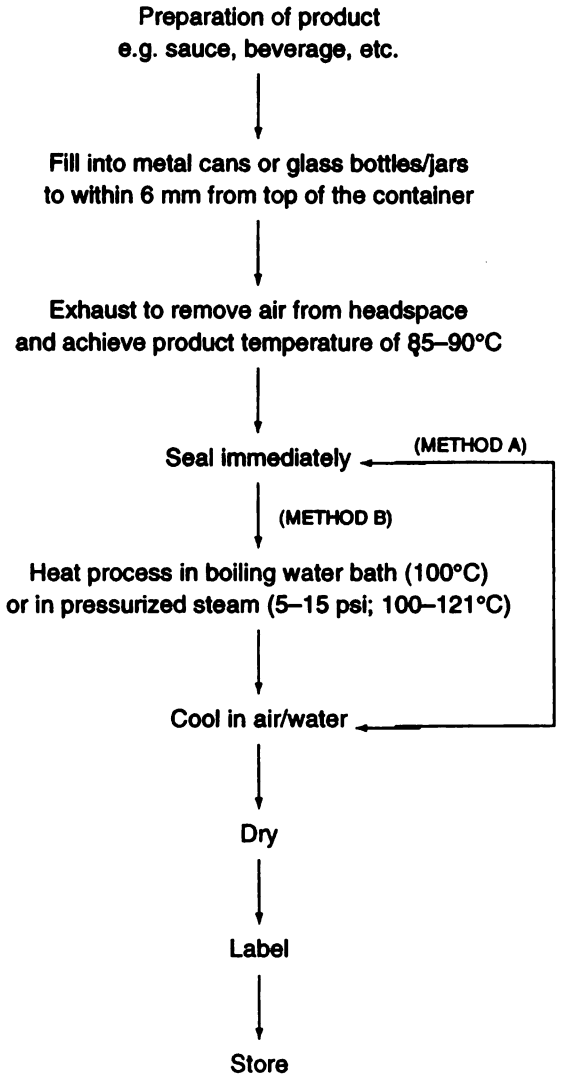

Figure 8: Processing steps in the manufacture of canned/bottled products

Method A: Filling after heat processing

(i) Wash and sanitize cans or glass bottles and covers or caps. Keep bottles warm by placing in an oven at 70–80°C.
(ii) Heat the product to 85–90°C and maintain the product at this temperature for 10 min to pasteurize.
(iii) Pour the pasteurized product at a minimum temperature of 85°C into the cleaned cans or bottles. Avoid frothing during filling and fill to the rim to minimize the headspace volume.
(iv) Quickly clean the rims of the cans or bottles and seal immediately. Invert the sealed can or bottle for 1–2 min so that the hot product contacts the undersurface of the cover.
(v) Return to the upright position and leave to cool.

Method B: Filling before heat processing

(i) Wash, and sanitize cans, bottles, covers and caps.
(ii) Prepare the product according to formulation.
(iii) Pour the product (hot or cold) into the cans or bottles, leaving about a 2 cm headspace.
(iv) Clean the rim of the can or bottle and loosely place the cover or cap on the container.
(v) Place the loosely capped, filled cans or bottles into a kettle or pan and fill with water until it reaches the level of the product in the container.
(vi) Bring the water to a boil. When the temperature of the product reaches 85–90°C, continue heating for 10–15 min to pasteurize the product and exhaust the headspace.
(vii) Remove the containers from the water-bath and seal immediately.
(viii) Leave the closed cans or bottles to cool.

12.3.1 Ready-to-Serve (RTS) Beverages (non-alcoholic)

Ready-to-serve fruit beverages may be pulpy or they may be clarified. The processing steps in the manufacture of canned and bottled beverages are shown in Figure 9.

(a) Select fully mature, ripe fruits of good colour and flavour.
(b) Wash the fruits thoroughly in clean water and sanitize using a chlorine dip (50 ppm).
(c) Prepare an extract of the fruit as described in Section 8.3.1 (c).
(d) Blend the juice or pulp with water, sugar, citric acid and stabilizer according to a predetermined formulation. Gently heat the mixture to a temperature of 85–90°C while blending. If a preservative is to be used, add this ingredient during the final stages of preparation just prior to canning or bottling the product.
(e) Continue processing to preserve the beverage using either of the methods of section 12.3 (b).

12.3.2 Fruit in Syrup or in Brine

Ripe dunks, West Indian cherries, tamarinds and guavas may be canned in a syrup. Green plums and dunks and tamarinds maybe canned in a brine.

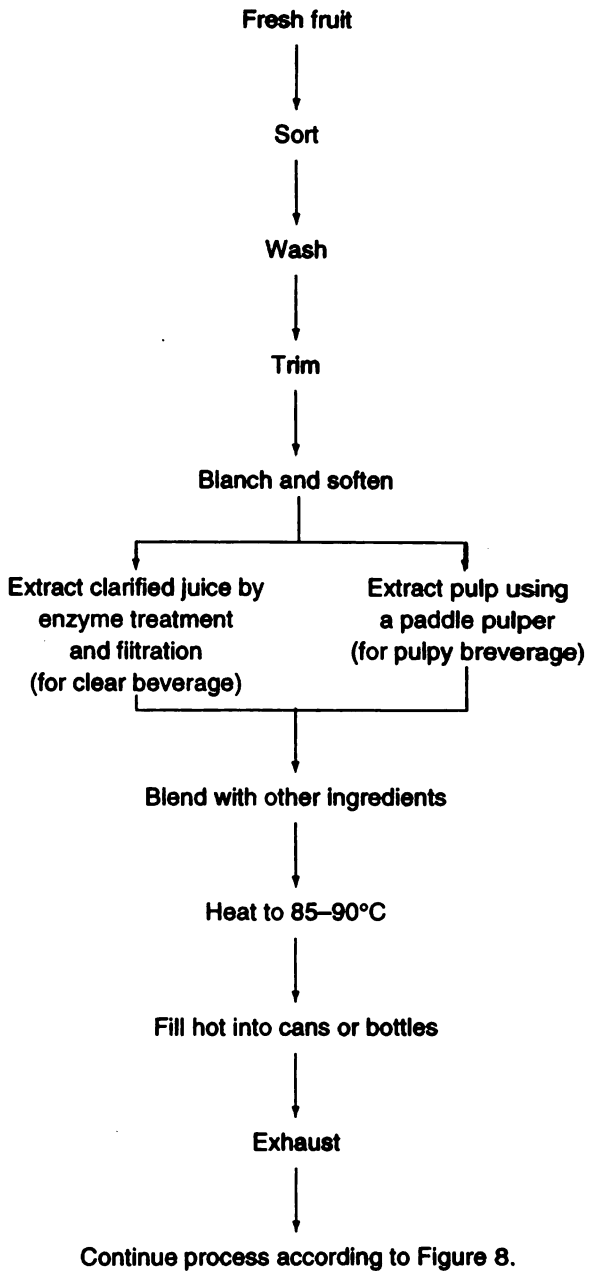

Figure 9: Processing steps in the manufacture of canned and bottled breverage products

The processing steps in the manufacture of canned/bottled syruped and brined fruit are shown in Figure 10.

(a) Select fully mature, ripe, firm fruits for placing in syrup. For brining, plums and dunks should be fully mature and green, tamarinds must be ripe. Reject fruit with blemishes and bruises.
(b) Wash the fruit thoroughly in clean water.
(c) Prepare the fruit for canning/bottling.

Tamarind: Remove the pod shell. Seeds may be left intact or may be removed.

Plum and West Indian cherry: Leave whole.

Dunks: Seeds may be removed, using a simple pitting tool.

Guava: Peel the guavas by dipping into a boiling lye solution (2.5% sodium hydroxide) followed by rubbing and rinsing in water. Cut the peeled fruit in half and scoop out the seeds.

(d) Pack the prepared fruits neatly and optimally into cans or jars.
(e) Prepare the syrup or brine of required strength. Acidify to pH 3–3.5 using citric acid. Heat the syrup or the brine to 85–90°C.
(f) Complete filling the cans or jars with the hot, acidified syrup or brine.
(g) Continue process according to Method B of Section 12.3 (b).

12.3.3 Fruit Sauces

Tamarind is a traditional ingredient in Worcestershire sauce. It also imparts a unique taste to other sauces such as barbecue sauces.

The processing steps for the manufacture of sauces are shown in Figure 11.

(a) Select fully ripe fruit.
(b) Wash the fruit thoroughly.

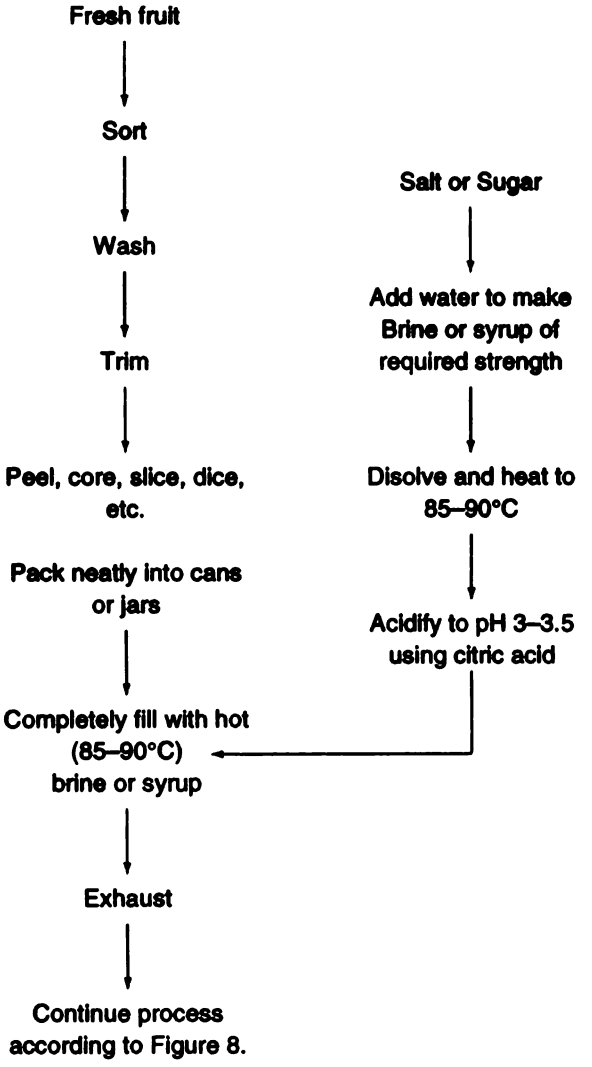

Figure 10: Processing steps in the manufacture of canned and bottled syruped/brined fruit

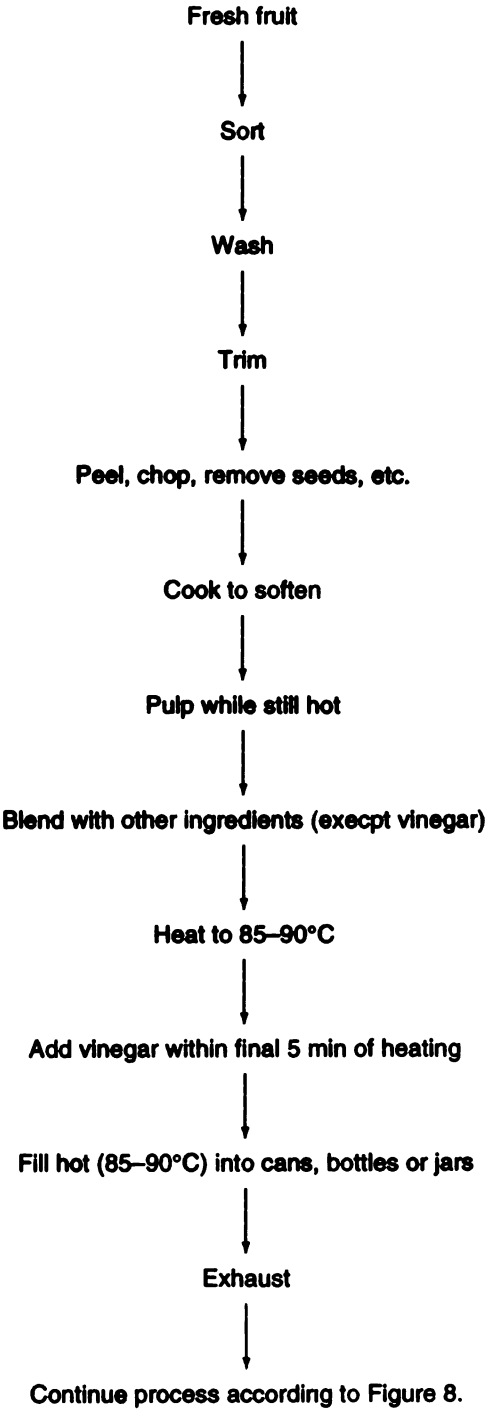

Figure 11: Processing steps in the manufacture of canned and bottled sauces

(c) Prepare a pulp from the fruit following the directions of Section 8.3.1 (c).
(d) Combine the pulp with other ingredients such as salt, sugar, herbs and spices. Heat the mixture to 85–90 °C.
(e) Add vinegar within the final 5 min of heating.
(f) Continue processing according to Method A in Section 12.3 (b), ensuring that the temperature of the product during filling and closing does not fall below 85°C.

13. Storage Methods

Given their seasonal nature, West Indian cherry, plum, dunks, guava and tamarind can be prepared into semi-processed product and stored for further processing into finished products during off-season periods. Storage also allows for export trade of these highly perishable fruits. Techniques such as drying, heat processing, freezing and salting may be used for medium to long-term storage of these fruits.

Table 6 summarizes the applicability/appropriateness of the various storage techniques to various forms of the fruit.

The storage technique of choice will depend on the form of the fruit and the intended use of the fruit. For example, freezing is not recommended for fruits to be candied or canned as whole fruit. The direct and operating costs of the technique and the availability of alternative energy supplies are also important factors to consider.

14. Conclusions

The West Indian cherry, tamarind, guava, dunks and plum are currently of minor processing significance, the major reason being the lack/unavailability of a raw material base. Other major constraints to the processing of these fruits are:

— Difficulty of harvesting and handling. This is especially critical for the softer fruits such as West Indian cherry, dunks and plum.
— High perishability of the fruits, particularly the West Indian cherry, guava, dunks and plum.

It is noteworthy that there is no lack of knowledge on processing techniques for the various fruits and their products.

Once these constraints are addressed, the commercial processing potential of these 'minor' fruits can be more intensively explored within the Caribbean region.

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Table 6: Storage techniques for minor fruits

Fruit/Form	Storage techniques			
	Freezing	Drying	Heat processing	Salting
Tamarind: shelled		✔		10%
Tamarind: pulp or juice	✔		✔	
West Indian cherry: pulp, juice or whole	✔			
West Indian cherry: pulp or juice			✔	
Green plums: whole				20-25%
Green dunks: whole				20-25%
Guava: whole	✔			
Guava: pulp or juice	✔		✔	

POSSIBILITIES FOR PROCESSING GOLDEN APPLE

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Abstract
Golden apple availability is seasonal therefore processing of the excess in the on-season results in an extension of its availability, adds value to the product, and utilizes the rejected fruits of the export market. Procedures are outlined for the manufacture of jams, a golden apple sauce, a dry fruit product, chutney, kuchela, pickles, and an alcoholic and non-alcoholic beverage. It is concluded that in addition to the highly appreciated taste of the ripe golden apple fruit, the fruit also gives cooked or processed flavours with a high consumer acceptance.

Résumé
La production de prune de cythère est saisonnière; la transformation des excédents en pleine saison permet d'étendre sa période de disponibilité, ajoute de la valeur au produit, et permet d'utiliser les écarts du marché d'exportation. Les procédés utilisés pour la fabrication de confitures, une sauce piquante, un produit séché, du chutney, de la kuchela, des fruits au vinaigre, et des boissons alcoholiques et non alcoholiques sont décrits. La transformation apporte d'autres arômes et saveurs, différents de ceux du fruit frais bien mûr, qui sont bien acceptés par les consommateurs.

Resumen
La producción de jobo de la India es estacional; por eso el procesamiento del exceso en periodo de plena producción permite extender su disponibilidad, agrega valor al producto, y permite utilisar el rechazó de frutas de exportación. Se indican los procedimientos para la fabricación de mermelada, una salsa piquante, un producto seco, chutney, kuchela, encurtidos, y bebidas alcoholicas y no-alcoholicas. Además del muy apreciado sabor de la fruta fresca, el procesamiento añade otros aromas y sabores que tienen una alta aceptación de parte de los consumidores.

Introduction

The processing of golden apple has good prospects:

- As the fresh fruit market seems to be saturated, it is a good way to extend it.
- It is a way to increase the value added to the product for small islands.
- It is a way to utilize the rejected fruits of the export trade.

Traditionally, few islands use the golden apple as a processed product, they mainly consume it fresh. Products available include:

- Jams in St Kitts, Nevis, Grenada, Trinidad and Tobago
- Juices in St Lucia and Martinique
- Chutney, kuchela and pickle in Trinidad

However, any fruit product can be made with this crop. The IICA project aimed at developing the processing of some of these products to encourage the industry and demonstrate the potential of this fruit. Experiments were conducted on developing a small cottage industry with the Produce Chemist's Labatory in Grenada and the Caribbean Industrial Research Institute (CARIRI) in Trinidad. Consumer evaluation was carried out in various supermarkets in Grenada.

Several products were made and evaluated; these are discussed in this paper.

Jam

Half-ripe fruits were used as they are richer in pectins. After these experiments, complementary information was found on the level of pectin required.

Passing the fruit through a food chopper before pulping ensures a proper removal of all the seed and fibres without the need for manual de-stoning.

Citric acid was used to inhibit the development of micro-organisms and put the pectins in solution as well as invert the sugar.

Pectins should be added at the end of the cooking as heat destroys them and they should be mixed with sugar to ensure a proper dispersion.

The jam is dark red with a delicious fruity flavour. The cooked flavour of golden apple is delicious, and jellies cheese and leather should also be very good products.

The taste was very much appreciated. Consumers prefer smooth products and will eat it frequently.

Golden Apple Sauce

The same pulping technique as for jam was used and then sugar and spices were added.

This gave an excellent product which could be used

as a replacement for apple sauce in pastries, pie fillings or hot dishes.

Consumers were amazed by the product; everybody liked it and consumption should be very high.

However, nobody knows about it and a lot of promotion would be needed on the use of the product, or on its name.

This was the most appreciated product made from golden apple.

Dry Fruits

It is important to peel the fruits well so as to remove the fibres located between the skin and pulp.

Proper cutting of the fruit is important to ensure an attractive presentation of the product and facilitate the movement of water and sugar during the process.

Boiling is used to tenderize the fruit, facilitate the absorption of sugar and avoid fermentation of the product by destroying the enzymes.

The time of boiling seems to react with the Maillard reaction of caramelization and create an appreciated flavour.

The final product was reddish and sticky with a characteristic flavour.

The flavour was well liked as well as the colour. However, the product has no smell due to the drying technique used and also consumers complained about the fibres. This emphasises the importance of peeling.

The dried fruits had a very good acceptance from the consumers with a high buying intention and frequent consumption.

Chutney

Storage in brine is interesting since it allows the fruit to be stored out of season.

The longer it is cooked the darker it gets. Fruit pieces can be added after cooking them separately.

The product was unknown before in Grenada but it was well accepted. However, there were a few people who did not like it because they said it was too acidic.

The fibres tend to bother tourists but Grenadians are used to them; they are considered as part of the fruit.

Good intentions for buying were expressed.

In Trinidad, a different type of chutney is made which is more of an Indian type.

Kuchela

Drying is used to change the colour of the fruits and preserve them.

The maceration is important for penetration of the oil and spices into the product.

White vinegar and potassium sorbate were used as a preservative as no mustard oil was available.

The product was unknown in Grenada but people were favourably surprised.

Pickles

Cutting was done to facilitate migration of water, sugar or salt and for a special presentation of the product.

The fruits can also be stored in the brine solution which needs a total soaking without any air contact.

The spices are optional.

The product was well accepted but there was a problem with texture. The fruits were too hard, therefore complementary trials should be done using hot syrup or boiling the product.

The fibres are bothersome to consumers and should be removed.

In Trinidad another kind of pickle is made. It is a red preserve which is a mixture of pepper and vinegar and corresponds to a special West Indian taste.

Beverages

Different techniques were tried. Two methods of obtaining the juice have to be further developed.

Alcoholic Beverages

Alcoholic products derived from golden apple are very good with excellent flavours. Several traditional wines can be found in various islands. CRITT has developed a technique to make a sparkling beverage.

Conclusion

Golden apple is a fresh fruit which is delicious when fully ripe and it also gives well appreciated cooked flavours.

Consumers liked the products a lot and some of them were being asked for at the supermarkets after the sampling.

However, the fruit is unknown in the tourist market and even its name is difficult to find throughout the Caribbean. Thus a lot promotion needs to be done.

A lot of fruit is available in Grenada and some processors have expressed interest in the products. I hope that a process is going to be developed soon.

(A presentation of various golden apple products is on display).

PROPAGATION OF MINORFRUIT CROPS IN THE CARIBBEAN REGION

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Abstract
In the Caribbean region, the minor fruit crops such as tamarind, cashew, West Indian cherry and plums, among others, are not grown commercially. The preservation, improvement and spread of these fruit species involves propagation. Propagation by seed has been and remains the primary method of multiplication of minor tropical fruit plants, however, plants may then vary from the mother tree and may show undesirable juvenile characteristics. Fruit crops propagated by vegetative means are genetically identical to the parent plant and are true to type. The paper lists all the minor fruit crops of the region and identifies the corresponding propagation methods (seeds, grafting, cutting, layering or tissue culture) used. For successful propagation, the ideal nursery facilities and conditions, media for rooting cuttings and potting mixtures are described. The factors to consider in choosing a propagation method such as plant species, market demand and available resources are discussed.

Résumé
Dans la région antillaise, les fruits mineurs tels que tamarin, anacarde, cerise des Antilles et prunes mombin entre autres ne sont pas cultivés commercialement. La conservation, amélioration et dissémination de ces espèces passe par leur multiplication. La propagation par semis a été et reste la méthode la plus employée, cependant la descendance peut varier par rapport à la plante-mère et posséder des caractères juvéniles indésirables comme une entrée en fructification tardive, une grande taille des arbres, une croissance végétative excessive et même la présence d'épines comme chez la prune du gouverneur. Les espèces propagées végétativement sont génétiquement identiques et conformes à la plante-mère. L'exposé énumère toutes les espèces mineures de fruits de la région et essaie d'identifier leurs méthodes respectives de propagation (semis, greffe, bouture, marcotte ou culture de tissus). Les conditions idéales de pépinière ainsi que les différents substrats pour enracinement et rempotage sont décrits. Les facteurs à considérer lors du choix d'une méthode de propagation — espèce fruitière, marché, ressources disponibles — sont discutés.

Resumen
En el Caribe, frutas ménores tales como tamarindo, marañon, acerola y ciruelas entre otras no son cultivadas comercialmente. La preservación, el mejoramiento y la difusión de estas especies pasa por su propagación. La multiplicación por semilla ha estado y sigue siendo el método primario de multiplicación de estas frutas, sin embargo las plantas pueden ser diferentes de la planta madre y presentar características juveniles indeseables. Esto no occure con la multiplicación vegetativa. El artículo lista todas las frutas ménores de la región e identifica sus métodos de propagación (semillas, injerto, estaca, acodo o cultivo de tejido). Se describen también las condiciones ideales en el vivero para una propagación exitosa. Los factores a considerar cuando se escoge un método de propagación se discuten.

Introduction

In the Caribbean region, the minor fruit crops such as tamarind, cashew, West Indian cherry, chilli plum, Jamaica plum and governor plum are not grown commercially, and are not well known in some of the islands. They are normally found as scattered trees in backyards. These fruit species are termed minor fruits when compared to major fruits such as citrus, mango and banana, that are widely distributed, well known and often used. Some of these minor fruits, however, may have the potential to be developed into a major fruit. The preservation, improvement and spread of these fruit species involves propagation.

1. Propagation Methods

There are two basic ways of propagating fruit plants:

- Reproduction by seeds which is sexual propagation.
- Reproduction by the use of a vegetative plant part which is called asexual propagation.

Propagation by seed has been the primary method of plant multiplication and remains the principal way of raising some of the minor tropical fruit plants. Since this is a sexual method involving both male and female plants, individual plants produced in this manner may show variation from the parent mother plant. Plants produced from seed usually show some undesirable juvenile characteristics such as; a long time before fruiting, large tree size, excessive vegetative growth and tree vigour and some (e.g. governor plum) may even develop thorns. Plants propagated by vegetative means, on the other hand, being genetically identical to the parent plant, produce plants similar to the mother plant and are therefore true to type. There are three main methods of propagating plants vegetatively:

- Divisions: a part of the stem is induced to grow roots and shoots before separation from the

parent plant. The techniques of stooling, layering and air-layering belong to this group.
— Cuttings: comparatively small pieces of a plant are set under conditions where they can develop into plants with roots and shoots. Cuttings can be taken from any part of the plant — root, shoot or leaf.
— Grafting: grafting is a technique of joining a cutting (which is usually a piece of stem) of one plant to the rooted stem of another. The plants to be joined together must be closely related, belonging to the same species, genus and sometimes the same family. The piece of stem to be grafted comes from the desired plant that is to be multiplied. It is very important in selecting scions for propagation that the parent tree has the following characteristics:
  - Typical of the desired cultivar to be propagated
  - Free from disease
  - Producing a high yield of good quality fruit

The scion should also be at the appropriate stage of maturity. Generally, it should be taken from the last mature flush when the buds are about to burst.

1.1 Tissue Culture

This is the most modern method of vegetative propagation where plantlets are induced to develop from undifferentiated tissue using plant growth regulators in artificial aseptic growing media under controlled environmental conditions. Tissue culture permits rapid multiplication of large numbers of plantlets once the protocol for multiplication has been established. Generally, the minor fruit crops are not propagated by tissue culture.

Table I shows the different methods of propagation by which most of the minor fruits are propagated. It also gives the scientific and common names of the minor fruits discussed in this paper.

2. Nurseries

Successful plant propagation requires certain facilities. These would be provided in a fruit nursery or plant propagation unit which is a place where plants are propagated and nurtured for subsequent field establishment. The main components are:
— A structure with ample light such as a greenhouse with bins for rooting cuttings and beds for germinating seeds.
— A second structure in which young tender plants can be moved for hardening preparatory to planting in the field. In the region, Saran sheds are mostly used for this purpose.

2.1 Media for Rooting Cuttings

There are several media and mixtures of different media that are widely used in propagation, not only for germinating seeds and rooting cuttings, but for growing plants in bags or containers. The medium should have the following major properties:
— It must be sufficiently firm and dense to hold or anchor the cuttings or seeds in place during rooting or germination.
— It must be sufficiently retentive of moisture so that watering does not have to be too frequent.
— It must be sufficiently porous so that excess water drains away permitting adequate aeration.
— It must be relatively free from weed seeds, nematodes and various disease-inducing bacteria and fungi.

Some local materials from Trinidad used for as rooting media are:
— Fibre bast, a by-product from the coconut copra industry
— Rice hull, a by-product from rice milling
— Sand (sharp sand or washed sea sand)
— A mixture of sand and fibre

Imported rooting media are peat, perlite sphagnum moss and Pro-Mix.

2.2 Potting Mixtures

In propagation procedures, young seedlings or rooted cuttings are sometimes planted directly in the field, but frequently they are potted in some type of container, such as clay pots, or polythene bags and hardened before field establishment. Soil alone is generally unsatisfactory for these young plants. To provide potting mixtures of better texture, the addition of sand and organic matter is usually practised.

An ideal potting mixture should have the following properties:
— An open structure which allows good aeration and holds sufficient moisture for plant growth yet permits excess water to drain away.
— Supplies adequate mineral nutrients to the plants during all stages of growth.
— Relatively free of all harmful organisms and toxic materials.
— Light weight.

Various mixtures are used for different situations at the St Augustine Nurseries, e.g.:
— For potting rooted cuttings and young seedlings of ornamentals and fruits:
  1 or 2 parts sand
  1 part loam soil
  1 part peatmoss (or manure)

— For vegetables, herbs and spices from seed:
  1 part sand
  2 parts loam soil
  1 part well-rotted manure

— For fruit crops starting from seed to field readiness:
  2 parts topsoil
  1 part rotted pen manure
  1 part bagasse or fibre bast.

before planting is recommended to hasten germination.

It is observed that sowing the seeds with the stalk end facing downwards 5–7 cm deep gives faster germination by up to 1 week. Germination normally takes about 2–3 weeks and the plants are suitable for planting in another 2–3 months. At this time plants are about 45–50 cm tall. All cultural practices, particularly weed control, must be carried out during the period of seedling growth and development.

3.1.3 Tamarind

The tamarind seeds are extracted from the fruit by removing the sack-like shell and washing off the pulp. Seeds are sown in seed-beds or bins or trays. It is recommended to soak the seeds for 24 hours in water before sowing to hasten germination which normally takes place in 3–4 weeks.

Seedlings are transplanted when they have about two pairs of true leaves which occurs about 2 weeks after germination. Tamarind develops a very strong tap root quickly. Plants are ready for field planting in 8–10 months. At this time they are about 75 cm tall.

3.1.4 Dunks

Mature and ripe fruits are collected, the pulp removed and the seeds left in the sun to dry for about 4–6 weeks. Another measure adopted to hasten germination is to sandpaper the stone (seed coat) of the fresh seeds before sowing in bags. Untreated seeds germinate in about 2 months and treated seeds in 2 weeks. Plants are suitable for field planting in a further 8–10 months. At this stage they are about 60–75 cm tall.

3.1.5 Soursop

Seeds are obtained from ripe fruits, washed and soaked for 24 hours in water before sowing. The seeds germinate in 6–8 weeks. Seedlings are transplanted into bags with a soil mix when they have 3–4 true leaves at about 2–3 weeks after germination. Plants become suitable for field planting in 6–8 months. At this stage they are 60–75 cm tall.

The time required to propagate some minor fruit crops by seed is presented in Table 4.

3.2 Propagation by Cuttings

In the region most of the following plants are propagated by cuttings: West Indian cherry, guava, governor plum, soursop, Jamaica plum and chilli plum.

Mother plants should be true-to-type, disease-free, high-yielding and well managed. There are four basic types of cuttings:

Table 4: Time required to propagate some minor fruit crops by seed from sowing to field readiness

Plant type	Average time required for propagation
Pomme cythere	6–8
Soursop	6–8
Guava	6–8
Tamarind	6–10
Sapodilla	6–10
Dunks	6–8
Cashew	2–3

— Stem cuttings
— Leaf cuttings
— Leaf-bud cuttings
— Root-cuttings

Of these stem cuttings are mainly employed in the generation of fruit crop species.

There are four types of stem cuttings:

Hardwood: used for chilli plum and Jamaica plum
Semi-hardwood: used for West Indian cherry, guava, governor plum, soursop and pommerac
Softwood: not used to multiply fruit plants
Harbaceous: not used to multiply fruit plants

3.2.1 Hardwood Cuttings

This type of cutting requires no special treatment or infrastructure to induce rooting. Hardwood cuttings are used to propagate deciduous woody plants, e.g. chilli plum and Jamaica plum.

Wood from the previous season's growth or older is used. The cuttings should have ample food stored to foster the development of roots and shoots until the new plant becomes self-sustaining. Cuttings between 60 and 80 cm long and of a diameter of 3–6 cm should be cut from desired high-yielding, disease-free trees. A basal cut is made just below a node and a top cut 1.5– 2.5 cm above a node. These cuttings are then placed directly in bags containing soil mix and kept in a cool area for the roots and shoots to develop. Adequate watering is needed. Plants are ready for planting in 4–6 months.

3.2.2 Semi-hardwood Cuttings

This type of cutting is most commonly used to propagate evergreen fruit plants. Semi-hardwood cuttings consist of a new flush of growth and the wood is partially matured. It may be terminal or sub-terminal. Cuttings are 20–30 cm in length and the leaves are retained. If the leaves are very large they must be trimmed to reduce total leaf area and consequent water loss by transpiration. It also allows closer spacing in the rooting bin and therefore more

efficient use of the bin. Guava, West Indian cherry, governor plum, soursop and pommerac can be propagated by this method.

Cuttings of the above plants are taken early in the morning, immediately placed in a moistened cloth and transported to the propagating unit. Upon reaching the propagating unit, they are placed in bathpans and immersed in water. This is to ensure that moisture loss does not occur. For cuttings with broader leaves such as the pommerac, soursop and guava, about 50% of the leaf area is removed by snipping it off halfway across the leaves. Basal leaves for about 4–6 cm are removed completely. A final cut is then made just below a node and the cuttings are dipped into a rooting hormone solution (500–1000 ppm IBA in 50% alcohol) for 5 seconds, then inserted about 3–4 cm deep in the rooting medium of a propagating bin. A high relative humidity (more than 70%) and cool temperature should be maintained.

Direct sunlight should be avoided. Regular watering twice per day for 2 weeks is critical. A misting system is ideal. Removing dead leaves and spraying fungicides such as Banrot help in getting a higher percentage of cuttings rooted.

West Indian cherry and governor plum are treated in a similar way but their leaves are not trimmed because they are small.

The development of roots can be checked by moving a hand through the media under a single cutting and lifting to observe root development. When there is a cluster of roots about 5 cm long at the base, the cuttings are potted into bags containing soil mix. Cuttings take about 3–4 weeks to develop adequate roots. They are then placed in a hardening bin. This is a bin with a well-drained concrete floor, without any medium but covered with plastic frames holding white shade-cloth. Here the potted cuttings are hardened by gradually exposing to full sunlight by raising the covers a little more every week for about 4 weeks. The plants are then removed and placed under Saran sheds or under a tree for further hardening and development before planting. Table 5 indicates the time period from setting of the cuttings to field readiness.

Table 5: Time required to propagate some minor fruit crops by cuttings from setting of the cuttings to field readiness

Plant type	Average time required for propagation (months)
West Indian cherry	2–4
Guava	4–6
Governor plum	2–4
Soursop	4–6
Pommerac	4–6
Chilli plum	4–6
Jamaica plum	4–6

4. Propagation by Grafting

Some of the main reasons for grafting minor fruits are:

- To perpetuate true-to-type plants
- To obtain benefits of certain rootstocks
- To control tree size
- To obtain benefits of a tap root system
- To obtain earlier bearing

There are many grafting techniques depending upon the cut made and the position along the rootstock the bud or graft is placed. The most common for woody fruit types are the terminal wedge graft and the side graft.

4.1 Sapodilla

Seeds are collected from ripe fruits, extracted and sown in bags containing soil mix. It has been observed that more seeds are obtained from round fruits than pear-shaped fruits. The seeds germinate within 2 months and stock plants are suitable for grafting in 8 months.

Scion material is selected from the last flush with a terminal bud that is about to burst. The best scions are those with the apical meristems still green. Red-tinged apical meristems should be avoided, as they tend to remain dormant for a long time after grafting.

The method used is the side graft which is as follows:

A shallow downward and inward cut from 4–6 cm long is made in a smooth area about 15 cm high on the stock plant. At the base of this cut, a second short inward and downward cut is made, intersecting the first cut so as to remove the bark and to form a lip. The scion is prepared with a long cut along one side and a very short one at the base of the scion on the opposite side to match the size and shape of the cut on the rootstock. The scion is inserted into the cut and adjustments are made if necessary to ensure that the cambium of both stock and scion meet. The graft is then tightly taped. The tip of the scion remains untaped.

After 45 days the tape is removed and 15 days later the stock is cut back about 2 cm above the graft. At this time the bud should have a first flush of leaves. After the first flush has hardened, the remaining stock above the graft union is removed. The plant should be ready for field establishment in a further 2–3 months.

4.2 Balata

The balata is a close relative of the sapodilla and is a fruit that is highly appreciated in Trinidad and Tobago. However, when grown from seed the tree

is very large. Seedling trees take about 8–10 years to come into bearing. By grafting on sapodilla rootstock, it has been possible to produce plants that bear fruit in 2–4 years when the plants are approximately 1.5 m high. Such dwarfed plants are ideal for backyard plantings and have potential for commercial plantations. The balata is grafted onto 12- month-old sapodilla rootstocks using the same method as for sapodilla grafting. For balata the scion used is the last mature flush unlike sapodilla where the scion is somewhat younger. Plants become suitable for planting 3 months later.

4.3 Dunks

Some work has been done in Trinidad on the grafting of dunks using a similar side graft method described for sapodilla. However, with dunks, the scion is selected from the middle portion of a flush of growth where the wood has matured, i.e. the scion is sub-terminal.

The scion would have about four lateral buds and the procedure is the same as for sapodilla except that the entire scion is taped. The stock plants should be about 6 months old (about 45 cm in height) when grafting takes place and the plants would be suitable for planting 3–4 months later. An 80% success rate have been achieved at the St Augustine Nurseries, Trinidad.

4.4 Soursop

Soursop has been grafted using a modified patch budding method at CARDI's St Lucia unit as reported in IICA's *Tropical Fruits Newsletter* No. 4, September 1992. The rootstock used was soursop and the scion was 1-year-old regrowth of 'staghorn' trees. Grafting was done at a height of 8 cm above the middle of the rootstock. A 95% success rate was achieved. Grafting of soursop has not been done in Trinidad.

The time periods required from grafting to field readiness for sapodilla, balata, dunks and soursop are presented in Table 6.

4.5 Pommerac and Other Fruits

The technique employed for pommerac is identical to that of balata using the hardened last mature flush as scion. A terminal or wedge graft has been successfully used to graft mangosteen, pomme cythere, chilli plum and Jamaica plum. Carambola, bilimbi and to a lesser extent, chenette and rambutan have been grafted using the method described for dunks.

Table 6: Time period required to propagate some minor fruit crops by grafting from sowing of rootstock seeds to field readiness

Fruit	Age of rootstock at grafting (mths)	Time to field readiness (mths)
Sapodilla	6–8	12–15
Dunks	6–8	10–12
Balata	10–12	14–15
Soursop	6–8	10–12

5. Air-layering (Marcotting)

Air-layering is the procedure by which rooting is initiated along the stem of a plant by the removal of the bark and scraping the underlying cambium thereby impeding the flow of photosynthates from the leaves to the roots. This causes an accumulation of photosynthates at the upper point of the wound. The provision of a moistened media such as moss or fibre bast allows for root development. In difficult-to-root plants such as rambutan, a rooting hormone is applied at the wounded surface to hasten and increase the development of roots.

A plastic wrap is usually used to maintain the moisture in the rooting medium. Rooting normally occurs in 3–6 weeks. A new plant is generated by snipping of the rooted stem from the parent plant. It is then potted and hardened before field establishment.

Air-layering is relatively unimportant in fruit crop propagation in the region. However, it has been successfully used to propagate cashew, pois doux and rambutan in Trinidad.

6. Conclusion

At the St Augustine Nurseries in Trinidad, some research work has been initiated on the grafting of some of the more rare and exotic fruits. Thus far, limited success has been achieved with penny piece, chennette and rambutan. Greater success has been achieved grafting mangosteen on mangosteen rootstocks; grafting mangosteen on mangosteen-related rootstocks has been less successful. Further work is continuing.

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REVIEW ON FRUIT PROCESSING IN SURINAME

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Abstract
Fruit processing in Suriname began in the 1960s with the establishment of a canned juice factory — Tropica Fruits Industries N.V., a state subsidary, processing only oranges and grapefruits. Subsequent activities were minimal until the mid 1980s when government and private sector initiatives resulted in more than 15 processing units of which five are large-scale. It is estimated that 1,500 tonnes of locally harvested fruits are processed annually which is far from filling the existing processing capacity. Constraints to fruit processing in Suriname include the backyard system of production, poor post-harvest handling at the farm level, the prevailing socio-economic conditions which makes it difficult to obtain inputs, the use of outdated machinery by the larger processors while the smaller processors rely heavily on manual labour. A foundation comprising government and private sector interests was set up to assist farmers in establishing fruit orchards.

Résumé
La transformation des fruits au Suriname a commencé dans les années 60 avec l'établissement d'une usine de jus — Tropica Fruit Industries N.V. -, une entreprise d'état, traitant seulement oranges et pamplemousses. Les subséquentes activités restèrent minimes jusqu'à la moitié des années 80 quand des initiatives du gouvernement et du secteur privé aboutirent à la mise en place de plus de 15 unités de transformation, dont 5 à grande échelle. Il est estimé qu'environ 1.500 tonnes de fruits récoltés localement sont transformés chaque année, essentiellement en confitures et jus simples, ce qui est loin de correspondre à la capacité installée. Les principales contraintes pour la transformation des fruits au Suriname incluent le système de production de jardins, la manipulation des fruits après la récolte, les conditions socio-économiques difficiles, l'emploi d'équipements démodés et la forte composante en main d'oeuvre. Une fondation comprenant le gouvernement et des intérêts du secteur privé a été créée pour aider les agriculteurs à établir des vergers.

Resumen
El procesamiento de frutas en Suriname empezó en los años sesenta con el establecimiento de una fábrica de jugo en lata — Tropica Fruits Industries N.V. - una empresa estatal, para naranjas y toronjas. Subsecuentes actividades fueron mínimas hasta medianos del ochenta cuando el gobierno e iniciativas del sector privado resultaron en la instalación de más de 15 unidades de procesamiento, de las cuales 5 a gran escala. Se estima que 1,500 toneladas de frutas locales se procesan anualmente, principalmente en jugos y mermeladas, lo que esta lejos de llenar la capacidad instalada. Factores limitantes incluyen el sistema de cultivo de traspatio, la manipulación inadecuada de la cosecha, las condiciones económicas difíciles, el uso de maquinaria obsoleta y el fuerte componente de mano de obra. Se ha creado una fundación conjunta entre el gobierno e intereses del sector privado para asistir a los granjeros en establecer huertos.

Introduction

It was not until the beginning of the 1960s that the fruit processing industry started with the founding of a canned juice factory. This factory, Tropica Fruits Industries N.V., is a state subsidiary. At that time, only oranges and grapefruits were the targeted fruit crops for processing due to the abundant cultivation of citrus in flourishing plantations and therefore a huge surplus remained from the exported fresh products.

Subsequently, research efforts at the agricultural experiment station of the ministry of agriculture (department of pomology and agro-technology) proved that other crops like West Indian cherry, passion fruit and papaya were promising raw material for processing into juices and jams. Due to the socio-economic situation, since the country became independent in 1975, and the negative attitude of the consumers to local fruit produce, the fruit subsector was gradually abandoned and did not receive the necessary attention for further development by the government or the private sector.

In the mid 1980s both the government and the private sector, as a major potential source for the generation of foreign currency for Suriname, took action towards the diversification of fruit crop production, particularly of those species that were previously only recognized as backyard fruit crops, including soursop, plums, West Indian cherry, guava, pomerac and tamarind.

As a result of this, there are currently at least five large fruit processing agencies established among the more than 15 processing units which exist in Suriname, namely Bleyco Fruit N.V., Suriname Bottling Company (CIC), Interfood, Three Stars and Tropica N.V.

Production Aspects

The total annual amount of the local harvested fruits that is processed in Suriname is estimated at 1,500

tonnes. In particular, processing is concentrated on juices, pulp (single strength) and jams. In addition, there is also processing into pickles (mango, papaya, West Indian cherry and carambola), puree (mango and banana), candied, and dried fruits. Despite the growing interest in the production phase of fruit crop cultivation, the processing industry cannot operate at full capacity, since the supply of raw material, which is insufficient, has a serious negative impact on the processing continuity.

The survey on fruit production and processing in Suriname that was conducted in 1991, revealed that the supply of raw material for the existing processing units to operate at full capacity, would need an area under cultivation of approximately 6,000 ha of the different fruit crop species.

Problems and Constraints Affecting the Fruit Processing Industry in Suriname

Problems in Fruit Cultivation

The majority of farmers are involved in fruit crop cultivation as a side-line activity within their mixed farming systems. Subsequently, there are only a few farms (agencies such as SLO, SLOC and Tropica) with minor fruit crop orchards (soursop, pomerac, West Indian cherry). This results in a poor flow of fruits to the processors, thus affecting the continuity, consistency and enlargement of the export volume potential of fruit produce.

On the other hand, the availability of (and if any, the access to) inputs are very limited due to the current socio-economic situation and the unstable exchange rate that is negatively affecting the development of the fruit subsector in Suriname. Among these problems, the efforts that are being put towards the establishment of a so-called fruit inter-institutional committee (to be chaired by the ministry of agriculture) in which all actors involved in the fruit subsector would be represented is, due to the irritating governmental bureaucracy, still in a prenatal phase. Therefore, a national coordinating entity is still non-existent in Suriname.

To overcome these problems and constraints, a private initiative was undertaken with the founding of SOFS (Foundation for the Development of Fruit Production in Suriname), a foundation comprising both producers and processors. The major objectives of this foundation are: to assist the farmers in establishing fruit orchards; to supply them with planting material; leasing machinery from the foundation; allocation and distribution of agro-inputs, so as to ensure that both producers and processors can cultivate and process respectively. This activity should result in the assessment of supply prices and sales arrangements between the farmer and processor. Thus, this is a sort of contract system with shared risks for both parties with fixed prices seasonally. This approach can be determined to be promising, since the plan is recognized by an NGO in the Netherlands (CEBEMO) and the Inter-American Development Bank (IDB), with the support of machinery know-how and inputs. The IDB is currently preparing a plan with the SOFS board for the allocation of funds to provide farmers with small loans in the start-up of their operations so they can become full-time fruit farmers.

Problems in Fruit Processing

The majority of fruit processing in Suriname is considered as a home/cottage industry and the processing is mainly manual, from washing to packaging, whereas the five larger units have less manual activities and use more advanced machinery for processing and in the packing systems, Among these, only one unit (Bleyco Fruit N.V.) could be considered the sole fruit processing factory in Suriname specialized in juices and sub-products. Subsequently, this agency has recently installed a computerized processing factory that meets production standards to produce internationally marketable, aseptic fruit products from Suriname, available for the domestic, regional and extra-regional markets.

One of he main problems in the fruit processing industry in Suriname, is the use of outdated machinery combined with the lack of spare parts. Also the unavailability of appropriate machines to remove seeds from certain fruits such as gooseberry, pomerac and the Malayan apple is hampering the development of the fruit processing industry with respect to product diversification. Another problem is the harvest and post-harvest handling system in the farmer's field, resulting in the supply of severely damaged fruits due to the improper handling operation system and the equipment utilized during harvest and transportation (crates, baskets, sacks, etc.). Also the purchase of processing inputs like sugar, preservatives, additives (pectin), flavourings, spare parts and packaging material are considered also as major constraints since these attributes can only be purchased with foreign currency. In addition, the necessary qualified and skilled technical personnel is lacking or non-existent in Suriname.

Challenge, Safeguard and Extending of Fruit Processing in Suriname

The non-existence of pure fruit orchard stands in Suriname results in a large demand and insufficient supply of raw material for the fruit processing industry. Processors must try to refrain from exporting pulp to foreign markets so as to process all the available raw material into final products and consequently obtain the added value.

One major consequence for obtaining the added

value, is that processors should have equipment utilizing high technology to bridge the gap between the status quo (by delivering the pulp) and the desired status (the final product). With modern, first class technology, the fruit processors should be able to penetrate into the international market successfully, particularly with the exotic fruit products made from the minor fruit crops. This should lead to a better competitive position for the processor to gain a reasonable market share.

Earning the needed and foreign currency will enable both the farmer and the processor to come to international prices for fruits in Suriname, resulting in the expansion of both the area under cultivation and the processing capacity of fruits. Since the domestic market will be over-saturated due to this approach it will be obligatory in achieving this goal that the processors/exporters should find reliable export markets for the supply of the intended volume of agricultural products from Suriname.

POST-HARVEST TECHNOLOGY OF GOLDEN APPLE

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ENSIA-SIARC

Abstract
The golden apple is a major non-traditional crop for some Caribbean islands such as St Vincent and Grenada. The sparse scientific information on this fruit and the resulting lack of appropriate post-harvest handling recommendations is a potentially serious impediment to the expansion of a viable golden apple industry based on exports. Post-harvest studies were conducted on the green golden apple. Golden apple fruit is climacteric and very sensitive to storage temperature. At 8°C the fruits underwent chilling injury, stayed green and hard, shrivelled and were not marketable. The critical storage temperature is 13°C. Green fruits were stored for 25 days at 13°C but ripening occurs after 15 days. A polyethylene film reduced ripening and chilling injury.

Résumé
La prune de cythère est une espèce fruitière non-traditionelle importante pour certaines îles de la Caraïbe, en particulier Grenade et St Vincent. Peu d'informations scientifiques concernent ce fruit et le manque de recommendations sur la manutention post-récolte qui en résulte constitue un sérieux handicap au développement de la filière en vue de l'exportation. Des études de post-récolte ont été mises en place pour le fruit vert. Elles ont montré que le fruit est climactérique et très sensible à la température de conservation. A 8°C les fruits subissent des dommages dûs au froid; ils demeurent verts et durs, se flétrissent et ne sont plus commercialisables. La température critique pour la conservation est de 13°C. Des fruits verts conservés pendant 25 jours à 13°C voient la maturation démarrer au bout de 15 jours. Le fait d'envelopper les fruits dans un film de polyéthilène permet de ralentir la maturation et de réduire les dégats dûs au froid.

Resumen
El jobo de la India es una fruta no-tradicional importante para unas islas del Caribe, tales como San Vincente y Grenada. La escasa información científica sobre esta fruta y por ende la falta de recomendaciones apropiadas para la manipulación de pos-cosecha constituye un impedimento serio para la expansión de la industria en base a la exportación. Estudios de pos-cosecha se condujeron con la fruta verde. Los resultados muestran que la fruta es climactérica y muy sensible a temperatura de almacenamiento. A 8°C las frutas sufrieron daños debido al frío, quedaron verdes y duras, se arrugaron y no fueron comerciables. La temperatura crítica de almacenamiento es 13°C. Se pudieron guardar frutas verdes por 25 días a 13°C pero comenzaron a madurar después de 15 días. Películas de polietileno permiten retrasar la maduración y reducir los daños causados por el frío.

INTRODUCTION

Golden apple is now a major non-traditional crop for some islands such as St Vincent and Grenada. Therefore there is a need for knowledge of the fruit handling and behaviour after harvest as expressed by the exporters of this commodity. But very little scientific research has been carried out on this fruit and this was one of the reasons why IICA started a programme of research on this fruit. The post-harvest study was conducted partially in Grenada with the collaboration of the exporters for practical considerations. Some results of the scientific aspects of the research, which were conducted in collaboration with Dr Clement Sankat at the UWI in Trinidad, are presented in this paper.

1. Respiration

1.1 Generalities

Fruits can be classified according to two profiles of respiration (see Figure 1).

— non-climacteric fruits which begin to decay directly after harvest

— Climacteric fruits which undergo an increase in respiration during their post-harvest life parallel to a phase of maturation and improvement in eating quality

One of the experiments conducted was to determine the type of respiration of the fruit to have a general idea of its post-harvest behaviour.

1.2 Materials and methods

Fully mature fruits were harvested, sorted, washed in 1% sodium hypochlorite and rubbed clean. The fruits were placed in a glass sealed jar and allowed to respire for half an hour. A measure of the CO_2 released into the jar's atmosphere was taken with a CO_2 analyzer.

This measurement represented the respiration rate and was taken every day during the ripening of the fruits.

1.3 Results

The results are shown in Figure 2.

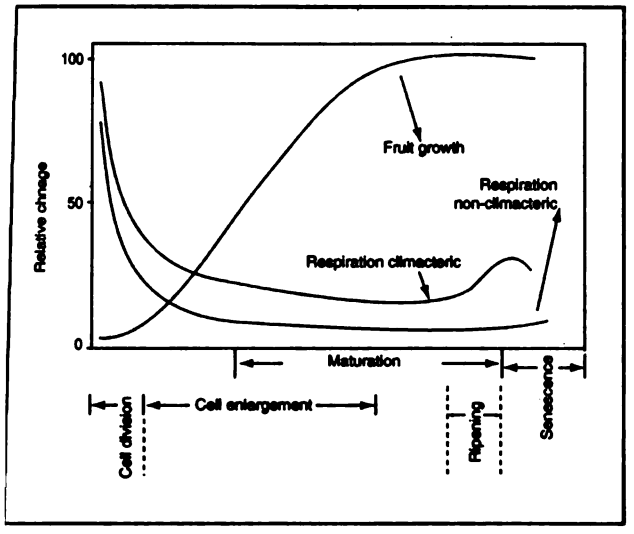

Figure 1: Types of fruit respiration

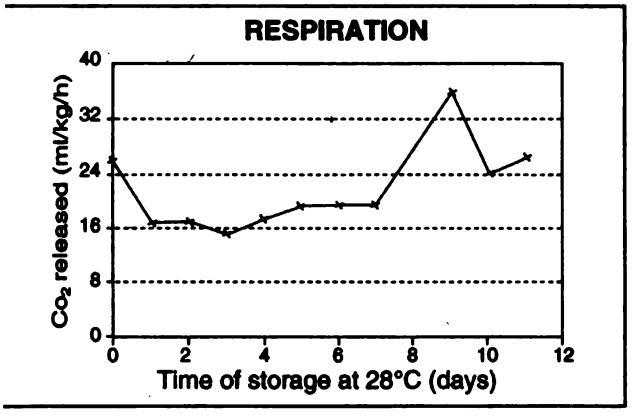

Figure 2: Respiration of golden apple during ripening at ambient temperature

The fruits ripened at different rates, showing that the sample was not fully homogeneous with respect to ripeness. However, the rise in the respiration indicated that golden apple is probably a climacteric fruit.

It is remarkable that the pre-climacteric phase lasted such a long time and the fruit can be classified as a late peak respiration type, with a maximum respiration when the fruits are fully ripe or overripe.

Therefore it would seem that the fruit has a short shelf-life with quick deterioration of its nutritional value when it ripens, but the fruit could probably be stored for longer during the pre-climacteric period.

2. Storage of green golden apple

A direct need of the exporters was to know at what temperature they should store the fruits and how long they could keep them. Therefore an experiment was conducted on the storage of green mature fruits.

2.1 Material and methods

Fully mature fruits were harvested, selected for homogeneous size and cleanliness, washed in sodium hypochlorite and rubbed clean.

They were packed in a closed box and subjected to two treatments:

- Unpackaged, i.e. wrapped in tissue paper
- Packaged, i.e. wrapped in low density polyethlene film.

Fruits were stored at 28 (ambient), 18, 13 and 8°C at approximately 95% humidity. Every 5 days, a sample of three fruits was removed and various parameters studied. The data collected were analyzed by variance analysis.

2.2 Results

2.2.1 Shrivelling

No shrivelling occurred at 28, 18 or 13°C but it did happen at 8°C. This is one of the major signs of chilling injury due to the collapse of the chilled cells beneath the surface of the fruit. The shrivelling finally resulted in pitting. This would imply that the temperature limit for chilling injury is between 8 and 13°C.

Polyethylene film reduced and delayed the shrivelling as the modified atmosphere created by the packaging reduced the extent of chilling injury (Figure 3).

2.2.2 Weight loss

The fruits continually lost weight no matter what the temperature at which they were stored (Figure 4).

It is remarkable that even with a loss of 12% no shrivelling occurred as a 5% loss could cause a lot of damage to many commodities.

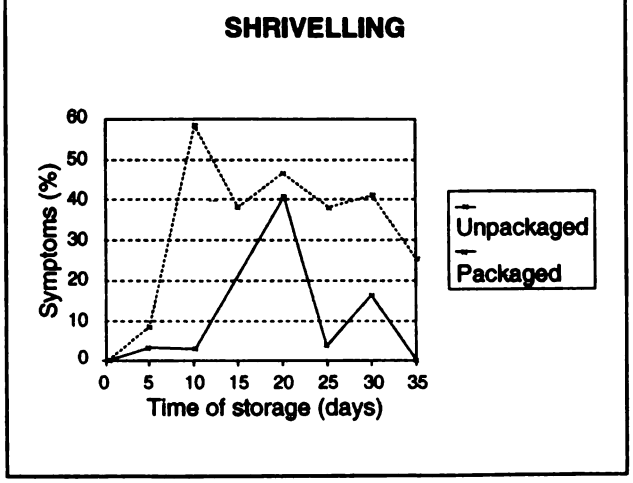

Figure 3: Shrivelling of green golden apple fruits stored at 8°C

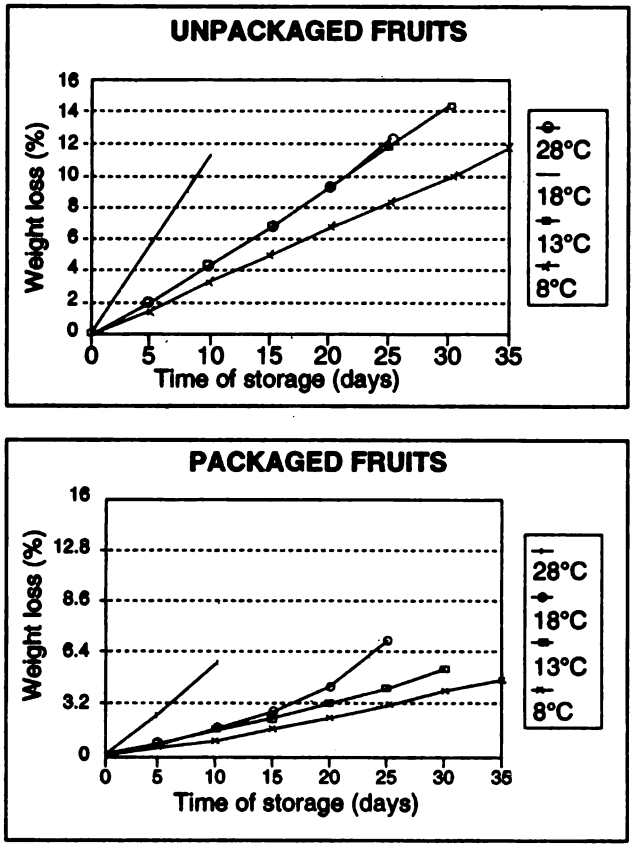

Figure 4: Weight loss undergone by green golden apple fruits during storage

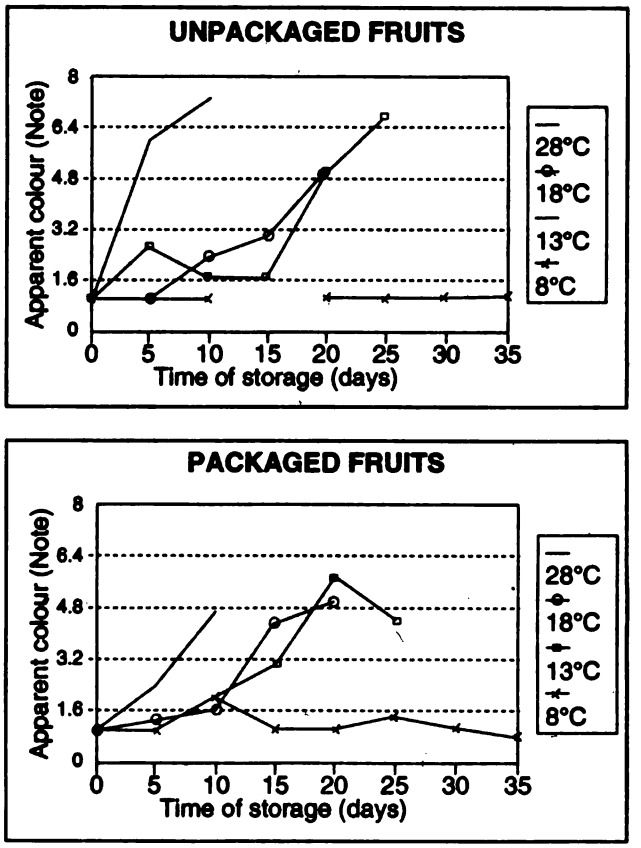

Figure 5: Changes in the skin colour of green golden apple fruits during storage

The weight loss decreased with increases in temperature. This was due to the fact that when the temperature decreases the air contains less moisture and the water vapour inside the fruit is reduced, therefore the fruit tends to lose less water. Thus this effect is more due to transpiration than respiration.

Packaging reduced the water loss due to the barrier it creates against water loss.

A similar situation was observed for volume loss.

2.2.3 Colour

In refrigerated storage, the development of the colour was reduced which is a sign of a delay in the maturation of the fruit (Figure 5). However, the final colour attained was still marketable and attractive. At 8°C, the colour stayed green which is another symptom of chilling injury. Polyethylene film reduced the colour and did not allow fruits to ripen properly. Similar results were observed for the pulp of the fruits.

The chlorophyll content of the fruit, followed a regular decrease except at 8°C which is logical (Figure 6). However, the carotenoid content of the fruit also showed this decrease (Figure 7). Therefore the appearance of the yellow colour must be mainly due

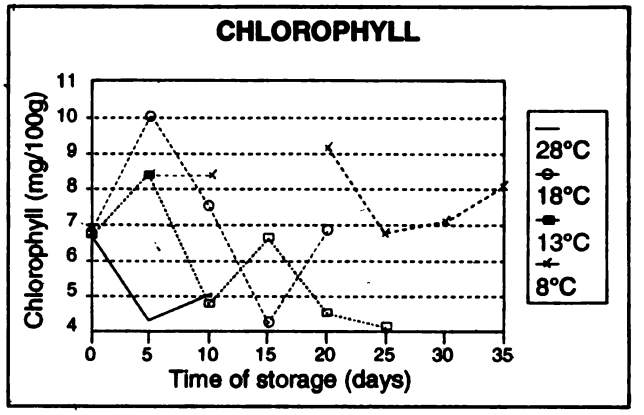

Figure 6: Changes in the chlorophyll content of the skin of green golden apple fruits during storage

to the degradation of the green pigments revealing the yellow pigments already existing initially. However, in the pulp carotenoids are synthesized.

2.2.4 Firmness

Firmness decreased during the ripening as a breakdown of insoluble pectin into soluble pectin occurred (Figure 8). The softening was reduced under refrigeration which is another sign of the delay in ripening under refrigerated conditions. At 8°C,

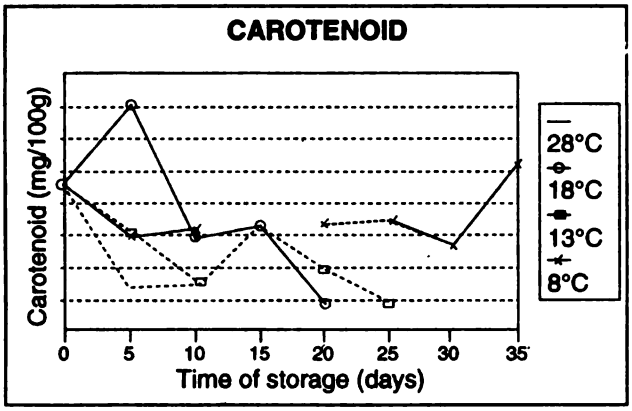

Figure 7: Changes in the skin caroteniods of green golden apple fruits during storage

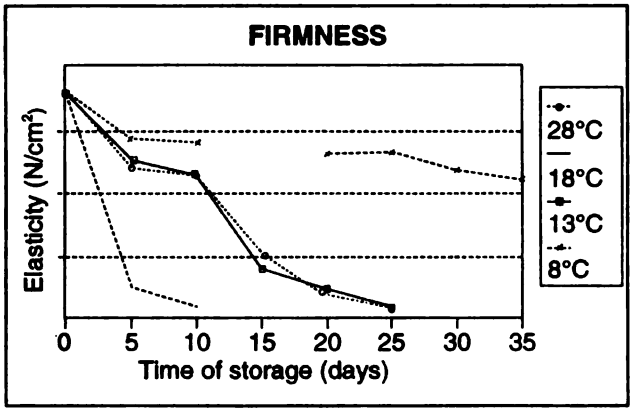

Figure 8: Changes in firmness of unpacked green golden apple fruits during storage

the fruits lost their elasticity and became very hard, but degradation was inhibited.

2.2.5 Fruit ripening

Ripening after refrigerated storage was also studied. A general degradation of the edible and marketable qualities of the fruit was observed. However, it was slight and the fruits were still edible.

Chill-injured fruits did not ripen further; they stayed hard, became brown and acidic with increased phenols and spoilt with an alcoholic smell.

3. Conclusions

The storage of the fruits was affected by fungal growth which reduced its shelf-life. Therefore, serious investigations must be carried out on the fungi responsible in order to find ways to store the fruits properly.

Golden apple is a fruit very sensitive to storage temperature. At 8°C the fruits underwent chilling injury and stayed green and hard, became shrivelled and unmarketable. Therefore fruits should be stored at a higher temperature; the critical temperature is between 8 and 13°C.

When stored above the critical temperature, ripening of the fruit was slowed down but never stopped; the fruits finally ripen under refrigeration. Fruits were stored for 25 days at 13°C, but after 15 days they could not be considered as green anymore.

The fruits ripened properly after such a storage even if the quality was slightly reduced. Complementary studies are needed to find out more precisely the optimum storage temperature.

Polyethylene film reduced ripening and chilling injury. More investigations should be done on this type of packaging as it seems promising and could avoid chilling injury. It could, therefore, become a means of extending the storage life of the green fruits.

POST HARVEST STORAGE OF BREADFRUIT

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Abstract
Developing breadfruit reach full size some 13–21 weeks after the female inflorescence is first detectable on the tree. Only fruit 15–19 weeks old proved acceptable to a taste panel and such fruit were characterized by surface latex and flattened fruit segments without a central spur. The respiratory climacteric of harvested breadfruit parallels the softening of the fruit and peaks at 200 ml CO_2/kg per h. Peak ethylene production is lower (1.5 µl C_2H_4/kg per h) than would be anticipated from such high respiratory rates and fruit became more C_2H_4-sensitive with increasing maturity. Attempts at modified atmosphere storage using a wide range of coatings and plastic films showed that films, but not coatings maintained green skin colour and fruit quality. Breadfruit sealed in medium thickness (about 40 µm) high or low-density polyethylene films could be stored at 13°C successfully for 2 weeks and were still of acceptable eating quality.

Résumé
Le fruit de l'arbre à pain atteint sa taille normale de 13 à 21 semaines après apparition de l'inflorescence femelle sur l'arbre. Seuls des fruit de 15 à 19 semaines ont été classés comme acceptables par un panel de dégustateurs; de tels fruit montrent la présence de latex en surface, les alvéoles sont aplaties et ne présentent plus de pointe en leur centre. Le type de respiration climactérique du fruit récolté peut être mis en parallèle avec fils ramolissement; il culmine à 200 ml de CO_2/kg/heure. La production maximum d'éthylène est inférieure (1,5 litre C_2H_4/kg/heure) à ce que l'on pourrait attendre de taux de respiration si élevés, et le fruit devient de plus en plus sensible à l'éthylène au fur et à mesure que la maturité s'avance. Des essais de conservation en atmosphère modifiée, en utilisant une large gamme de produits de surfaçage et de films plastiques montrent que seuls les films permettent de maintenir la couleur verte du fruit et ses qualités. Des fruits enveloppés dans des films en polyétilène de moyenne (~ 40m) ou basse densité ont pu être stockés à 13°C pendant 2 semaines et maintenir des qualités organoleptiques acceptables.

Resumen
La fruta de pan alcanza su tamaño normal de 13 a 21 semanas después de la aparición de la inflorescencía femenina en el árbol. Solamente frutas de 15 a 19 semanas de edad fueron clasificadas como aceptables por un grupo de catadores. Este tipo de frutas se caracteriza por la presencia de latex en su superficie y alveolas aplanadas sin punta en su centro. El tipo de respiración climactérica de la fruta cosechada se desarrolla paralelamente al ablandamiento de la misma; culmina a 200 ml de CO_2/kg/hora. La producción máxima de etileno es inferior (1.5 litro C_2H_4/kg/hora) a lo que se podría esperar con tasas de respiración tan elevadas, y la fruta se vuelve más y más sensible al etileno a medida que la maduración avanza. Ensayos de conservación en atmósfera modificada, utlizando una amplia gama de productos de envoltura y de películas plásticas demostraron que unicamente estas últimas permiten conservar el aspecto verde y las cualidades organolépticas de la fruta. Frutas envueltas en peliculas de polietileno de mediana (~ 40 µm) ó baja densidad pudieron ser almacenadas a 13oC durante 2 semanas y mantener cualidades organolépticas acceptables.

INTRODUCTION

Breadfruit, *Artocarpus altilis* (Park.) Fosb., is a common backyard tree in the Caribbean. Several cultivars are recognized in this region (Andrews 1991) and over a hundred are known in the Pacific (Ragone 1989). In Barbados, a single 'white flesh' cultivar predominates which, following exchange of herbarium material with the National Tropical Botanical Garden, Hawaii, has been recognized as synonymous with the Tahiti cv. Rare (D Ragone, personal communication, 1993).

The importance of breadfruit as an export crop for the ethnic market in North America and Europe is growing steadily (Andrews 1991) but this trade is hampered by the fruit's extreme perishability. In this study, we discuss maturity indices and work we have carried out aimed at improving post-harvest storage.

MATERIALS AND METHODS

Developing fruit were identified on mature breadfruit trees by fingering the terminal leaf sheath, confirming the presence of female inflorescences/fruit at a size of 1–2 cm in diameter and tagging these branches. Diameters of developing fruit were measured and batches of six fruit harvested fortnightly for dry and fresh weight determination. Starch levels were obtained by isolating alcohol-insoluble solids (AIS) from fresh fruit pulp and measuring the generation of reducing groups following amyloglucosidase treatment (Denison et al. 1990).

Carefully harvested mature fruit (with surface latex and fully expanded surface polygons) were placed in 25-l plastic bell-jars at room temperature (25–30°C)

and ventilated with humidified air (1.5 l/min), the exit flow entering a 225-MK3 infra-red gas analyser via a WA-161 multi-channel switching unit (ADC Ltd, Hoddesdon, UK). Linkage to a microcomputer allowed half-hourly data logging. Ethylene production was monitored twice daily in the same fruit by temporarily reducing the flow-rate to 0.18 l/min and injecting a 1-ml air sample from the exit air stream into a Photovac gas chromatograph (Photovac Inc., Ontario, Canada). Both instruments were calibrated with appropriate certified standards (Matheson Gas Products, NJ, USA). Fruit were assessed visually for the percentage area showing skin discolouration. Fruit softening was gauged by finger pressure (1 = fully firm; 2 = spongy; 3 = soft).

Replicates of eight fruit were brush-coated with several commercial coatings: Semperfresh F (Semperfresh Biotechnology Ltd, Reading, UK), Nutri-Save (NovaChem, Halifax, Canada), Sta-Fresh MP (FMC Corp., Lakeland, FL, USA) and a 'homemade' chitosan coating (Ghaouth et al. 1990). Fruit were also heat-sealed in a range of films: high-density polyethylene (HDPE) and low-density polyethylene (LDPE) (Superior Plastics, Barbados), Clysar LLP & EHC (DuPont, Willmington, DE, USA) and Sealed Fresh 1.5 MIL (Sealed Fresh Inc., Englewoood, CO, USA). Fruit were either stored at ambient temperature or in large incubators at 13°C and monitored for firmness, skin discolouration, softening and fungal contamination.

RESULTS AND DISCUSSION

One cannot address post-harvest biology without looking at maturity. Choosing the correct stage of development of a fruit is critical to good shelf-life. Fruit growth in breadfruit represents a single sigmoidal curve with equatorial and polar diameters reaching a maximum some 14 weeks after the globular female inflorescence is first detectable (Figure 1A). Contrasting with this early, rapid size generation, dry weight and fresh weight increases lag somewhat and appear to be double sigmoidal curves (Figure 1B). Only after the rapid size increase of the first 10 weeks is complete, does the fruit begin to dramatically increase its dry weight, starch representing some 60% of this dry weight. Fruit development, then, is in two phases, the first is concerned with size generation, the second with bulking up or laying down of reserves.

In characterizing maturity, we looked at a number of parameters including colour and fruit density, but found surface features to be the key. Mature fruit should have: some surface latex; relatively flattened polygons; no prominent spur at the centre of these polygons. Taste tests were carried out on fruit 13–21 weeks of age. Only those during the 6-week age

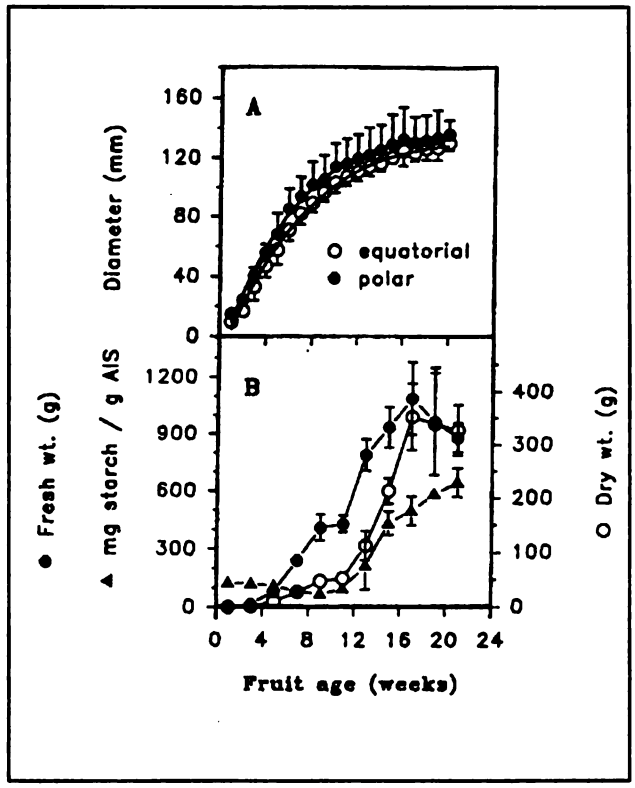

Figure 1: Changes in (A) size and (B) fresh weight, dry weight and starch in developing breadfruit. (Mean of six fruits ± SD)

period of 15 to 19 weeks were acceptable and only these fruit ages satisfied all three maturity criteria outlined above.

Fruit ripening is evidenced by a dramatic, rapid softening of the fruit and once this has begun the fruit is no longer fit for consumption. At ambient temperatures of 25–30°C, breadfruit, even at optimal maturity, begins to soften 2–4 days after harvest. Breadfruit is a climacteric fruit with one of the highest known respiratory rates (Biale and Barcus 1970) and the peak of CO2 production coincides with softening and peak C_2H_4 production (Figure 2).

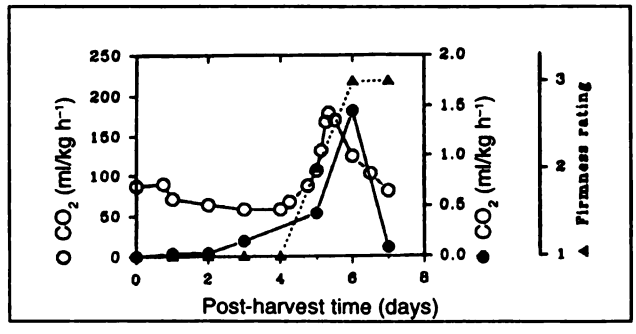

Figure 2: Post-harvest respiratory behaviour of a typical mature breadfruit at ambient temperature (25–30°C). Firmness ratings: 1 = firm; 2 = spongy; 3 = soft.

Despite these high respiratory rates its peak C_2H_4 production of 1.5 µl/kg per h is relatively low. When fruit were exposed to 6 h of C_2H_4 at 5, 50 or 500 ppm, fruit harvested at the early mature stage showed no response to applied C_2H_4 while those harvested at late maturity ripened precociously compared to the control untreated fruit and those exposed to 5 ppm C_2H_4 (data not shown). As shown previously (Thompson et al. 1974; Maharaj and Sankat 1990), we confirmed that refrigeration retards the onset of ripening considerably, 12°C being the minimum acceptable temperature if chilling injury is to be avoided. Fruit stored at this temperature show a delay in the climacteric by about 1 week compared to fruit at ambient temperature.

While refrigeration at 13°C clearly delays the onset of ripening, the skin of fruit stored in this manner soon turns an unsightly brown colour. Attempts to control this with anti-oxidants and polyphenol oxidase inhibitors, like ascorbic acid and diethyl-dithiocarbamate, were unsuccessful. One traditional short-term storage method for breadfruit in the Caribbean is to keep them submerged in water. In fact, when this is carried out at 13°C such fruit retain their fresh green skin without discolouration for 2–3 weeks. Skin browning therefore seems to be a water loss problem and so attempts were made to reduce water loss from fruit using coatings and film wrapping.

A range of fruit coatings were assessed for their role in enhancing storage life at 13°C. Of these, Nutrisave, Semperfresh F and chitosan delayed softening while Sta-Fresh MP did not delay softening but did reduce skin browning and water loss (data not shown). The skin browning generally still occurred and internally these coated fruit were often discoloured with soft areas and off-odours especially after 2 weeks storage (Figure 3).

In contrast, film wrapping of fruit delayed ripening and skin browning both at ambient temperature and at 13°C. Despite preliminary results showing storage for up to 2 weeks at ambient in some plastic films, consistently good results were only obtained with film wrapping in conjunction with refrigerated storage at 13°C (Figure 4). Most films retarded skin discolouration and delayed softening as the sample data for low density polyethylene films show (Figure 5). When such film-wrapped fruit were cooked and given to a taste panel it was apparent that these films were not equally effective at maintaining fruit quality (data not shown). After 1 week at 13°C, fruit in most films were acceptable. After 2 weeks, only the medium thickness (about

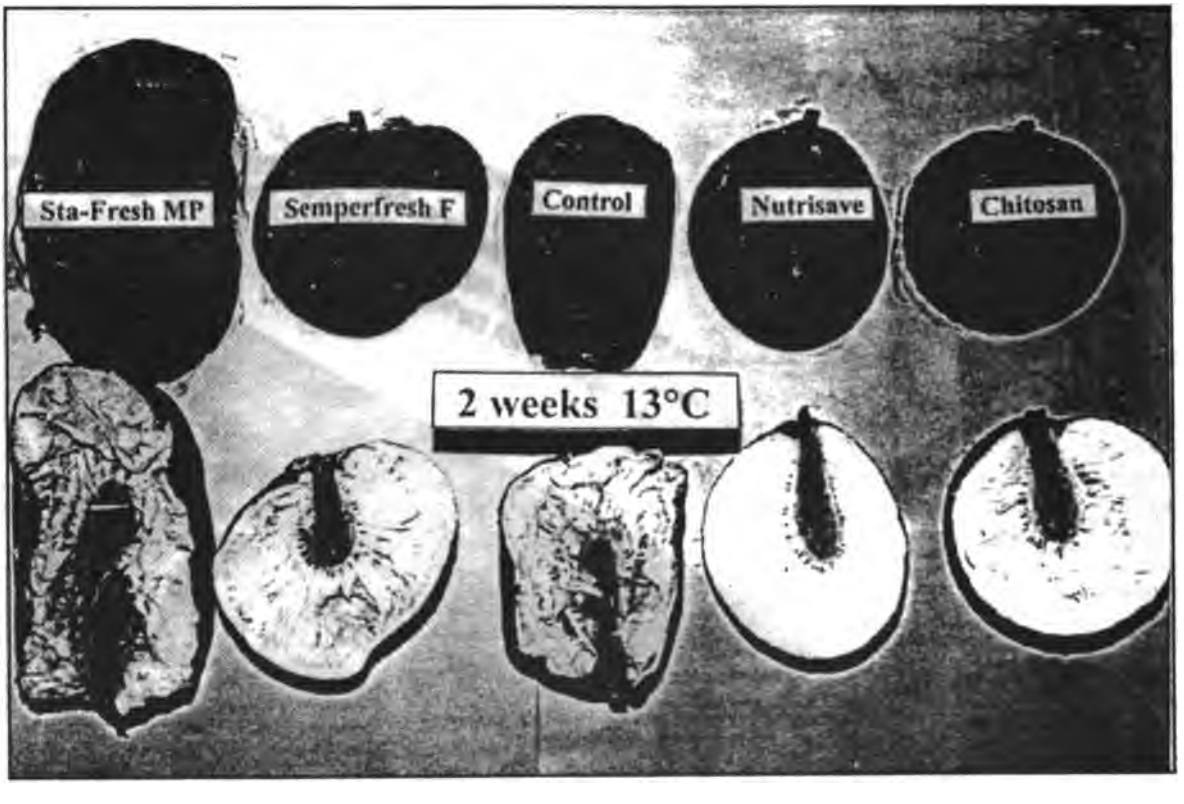

Figure 3: External and internal appearance of breadfruit coated with one of four different fruit coatings or left uncoated (control) and stored for 2 weeks at 13°C.

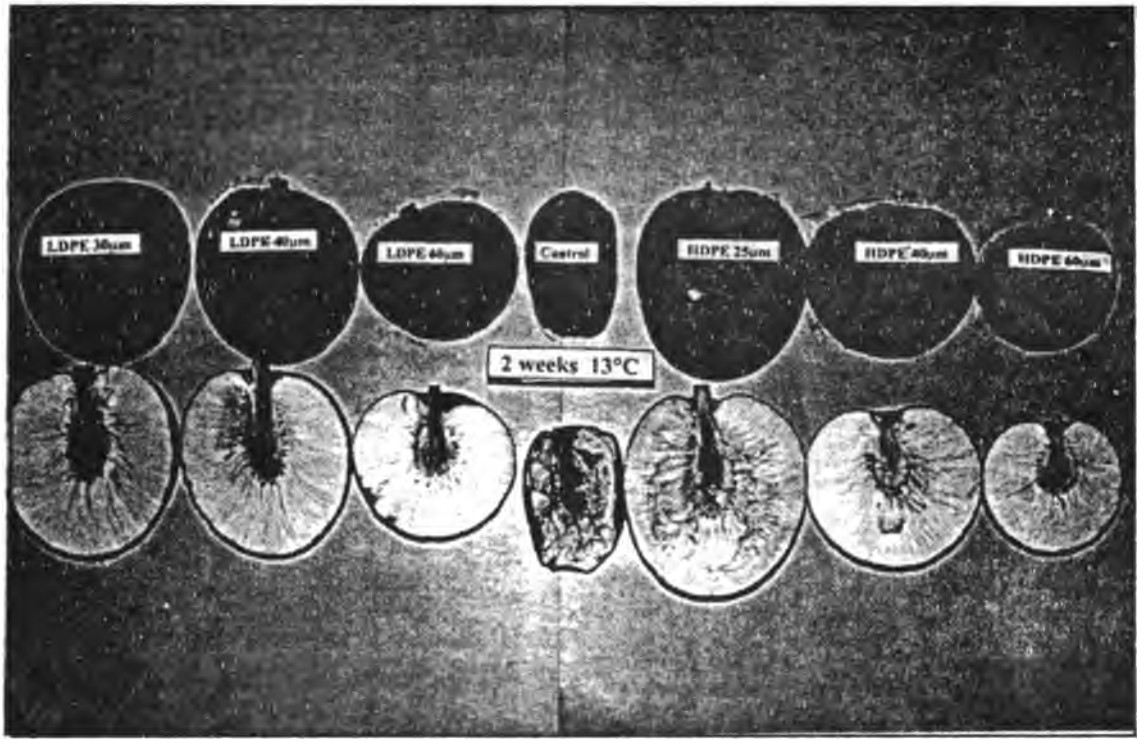

Figure 4: External and internal appearance of breadfruit sealed in a low-density polyethylene (LDPE) or high-density polyethylene (HDPE) film or left unbagged (control) and stored for 2 weeks at 13°C.

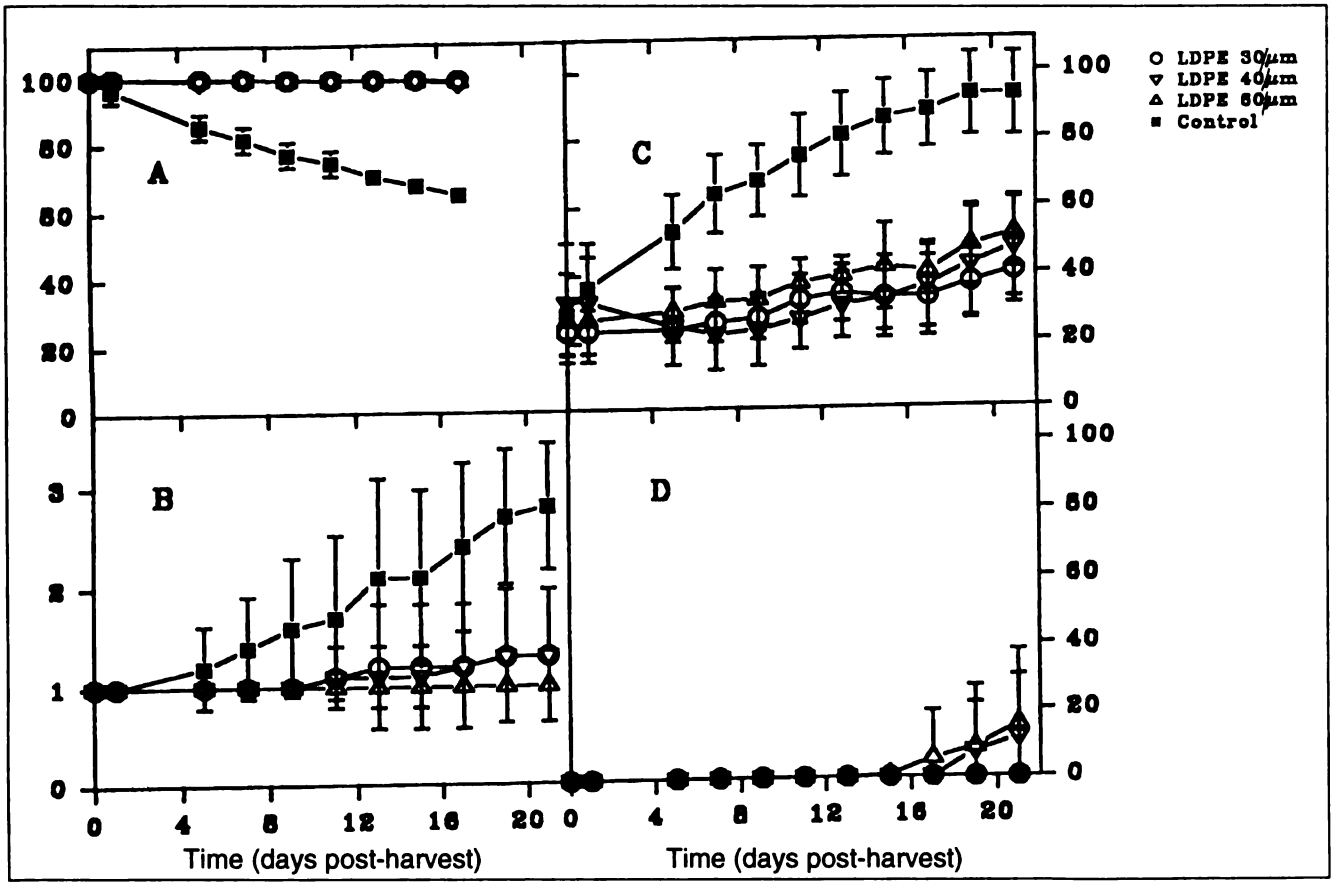

Figure 5: Changes in weight (A), softening (B), skin discolouration (C) and fungal contamination (D) in breadfruit sealed in low-density polyethylene film (LDPE) or left unbagged and stored at 13°C.

40 µm) high- or low-density polyethylene films yielded edible fruit. After 3 weeks, none of the treatments were acceptable, with off-flavours and odours, discoloured flesh, sweetness and textural problems being common.

The challenge remains to improve on these post-harvest handling procedures so far developed to permit sea freight of this bulky commodity.

Acknowledgements

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QUALITY CONTROL AND RESEARCH/DEVELOPMENT AT ROYAL S.A.

ODILE FRANCOIS AND HAUGRIN MARCELIN

Abstract
Royal S.A. which was established in 1934, manufactures 16 flavours of jams and jellies and 13 flavours of juices and nectars. Its annual production is 500 tonnes of jams and 2 million litres of juice. The structure and physical facilities at the Royal S.A. research and development laboratory is outlined. The factory is putting into place a system of quality assurance in production and installations based on the ISO (International Standards Organization) standard 9002. Various measurements are outlined for raw materials, intermediate products and final products. The parameters which are measured are different according to the level of control, but several parameters are usually used to rapidly detect failures. Some of the parameters which are regularly measured and control the whole process are: weight, brix, pH, acidity, colour, dried extract, percentage of pulp, soluble sugars, acids, ethanol and vitamin C. Research and development programmes are aimed at extending the product range and creating new products. Current research and development programmes include selection and characterization of different varieties of guava for processing, enzymatic processing of guava pulp with variable consistency, characterization of guava flavour, and determining the ideal harvesting point for processing of pineapple, among others.

Résumé
Royal S.A. s'est établi en 1934: il fabrique 16 types de confitures et gelées et 13 types de jus et nectars. Sa production annuelle est de 500 tonnes de confitures et 2 million de litres de jus. L'infrastructure et les moyens physiques de Royal S.A., en particulier les laboratoires de recherche/ développement sont présentés. L'usine développe un système de contrôle de la qualité pour la production et pour les installations, basé sur la norme ISO 9002 (Organisation Internationale de Normalization). Diverses mesures se font au niveau des produits frais, des produits intermédiaires et des produits finaux. Les paramètres qui sont mesurés sont différents selon le niveau de contrôle, mais plusieurs d'entre eux sont habituellement employés pour détecter rapidement certains problèmes. Parmi les paramètres qui sont régulièrement mesurés lors du processus complet sont: poids, brix, pH, acidité, couleur, extrait sec, pourcentage de pulpe, sucres solubles, acides, ethanol et vitamine C. Des programmes de recherche/ développement visent à étendre la gamme des produits et à créer des nouveaux produits; ceci inclut la sélection et la caractérisation de variétés de goyaves, la caractérisation des arômes de goyave, le traitement enzymatique de la pulpe de goyave et la détermination du moment idéal de récolte de l'ananas pour transformation.

Resumen
ROYAL S.A. se estableció en 1934; fabrica 16 clases de mermeladas y jaleas y 13 clases de jugos y néctares. Su producción anual es de 500 toneladas de jalea y 2 millónes de litros de jugo. La infraestructura y los medios físicos de ROYAL S.A., en particular los laboratorios de investigación/desarrollo, se presentan. La fábrica esta implementando un sistema de control de calidad para la producción y las instalaciones, basado en la norma ISO 9002 (Organización Internacional de Normalization). Diversas medidas se hacen a nivel de la materia cruda, de los productos intermedios y de los productos finales. Los parametros que se miden difieren según el nivel de control pero se usan varios de ellos para detectar rápidamente posibles problemas. Algunos de los parámetros y controles que se miden regularmente en el proceso entero son: peso, brix, pH, acidez, color, extracto seco, porcentaje de pulpa, azúcares solubles, ácidos, etanol y vitamina C. Programas de investigación/desarrollo tienden a expander el rango de productos y crea productos nuevos; esto comprende la selección y caracterización de variedades de guayabas para procesamiento, el procesamiento enzimático de la pulpa de guayaba, la caracterización de los aromas de guayaba y la determinación del momento ideal para cosecha de piña para procesamiento, entre otros.

Introduction

Royal S.A. was established in 1934. It manufactures juices, jams and jellies made from tropical fruits. The factory makes 16 flavours of jams and jellies and 13 flavours of juices and nectars. Table 1 shows the products marketed for 1993/1994.

The annual production is 500 tonnes of jam and 2 million litres of juice.

For this production, we use local pulp (470 tonnes a year; 40% of the total used), and imported pulp (750 tonnes a year; 60% of the total).

The local pulp is manufactured from fresh fruit at Royal (Table 2).

The factory makes 65% of its sales in Martinique, 18% in Guadeloupe, 11% in French Guyana and 6% in France.

Table 1: Products marketed in 1993/94

Jams, jellies	% of total sales	Juices, nectars	% of total sales
Guava	45	Guava	39
Banana	20	Orange	15
Pineapple	11	Passion fruit	15
Mammy apple	7	Pineapple	10
Coconut	4	Guava/pineapple	5
Guava/pineapple	4	Tamarind	5
Lime	2	Tropical	5
Tamarind	2	Mango	2
Passion fruit	1	Grapefruit	1
Sweet potato	1	Mammy apple	1
Ginger	1	Golden apple	0.5
Mango	1	Soursop	0.3
Star fruit	0.9	Papaya	0.2
Soursop	0.3		
Golden apple	0.2		
Sorrel	0.1		

Table 2: Pulp manufactured from fresh fruit

Fruits	Tonnes processed in 1992/93
Guava	940
Pineapple	838
Banana	98
Mammy apple	44
Star fruit	14
Tamarind	10
Lime	4
Sweet potato	3
Ginger	0.7

The Laboratory for Quality Control and Research/Development

The laboratory was established in January 1993, on the factory site. The staff is composed of the head (doctor of biochemistry), a laboratory senior technician (agricultural food diploma), and laboratory assistant (recruited from among people already working in the factory and formed on site).

To make this structure operational, an investment of about 1 million francs has been made.

The main equipment includes:

Refractometer
pH meters
Balances
Drying and ashing oven
Water distiller
Water demineralizer
Texture analyser
Rotary and capillary viscometers
Optical microscope
Colour analyser
Rotary evaporator
Centrifuge
Spectrophotometer
Sifting machine

With this laboratory equipment, we can not only make routine and simple analyses but also more specific ones which are generally done in outside laboratories.

The Quality System

The aims:

Quality is defined as being an answer to the consumer's requirements. A product or a service of quality is the one that satisfies the consumer. Royal's concept of quality is defined and built up with this object.

Today, the factory aims at putting into place a system of quality assurance in production and installations, based on the ISO (International Standards Organization) standard 9002.

First of all, the quality policy is defined by the head who puts in place the financial and human means for its realization.

The next step consists of giving appropriate responsibilities to all those involved in this system, from the director up to the workers. So, the first and crucial step is sensitizing the staff by giving information about quality.

Actually, in the quality approach it is necessary to write, to act, to control, to prove and to demonstrate. Royal's aim is the certification of a product's conformity which is a very good way for the consumer to recognize quality.

Levels of control:

Raw materials consist of local fruits and pulp, imported pulps and concentrates, and packing materials.

Intermediate products consist of juices in manufacturing or packaging rooms, jams and jellies in cooking material, and packaging in filling.

Final products — samples of juices and jams are taken as they will be offered to the consumer.

Measuring instruments — these are frequently standardized.

Frequency of the controls — the parameters measured vary according to the level of control considered necessary. It is important to note that the frequency of the controls has to be adjusted according to the final products.

Nature of the controls — the parameters which are measured are different according to the level of

control desired. It is important to put in place several controls for the same parameter, at different levels in the manufacturing process. In this way, manufacturing accidents or any failures are detected more quickly.

The overall controls are:

Weight
Brix
pH
Acidity
Colour
Dried extract
Percentage of pulp
Soluble sugars and acids
Ethanol
Vitamin C
Formol index
Ash
Texture
Viscosity
Sensory analysis

Control validation — all the controls are registered on checking forms and the information is used to decide if the final product is suitable for marketing.
Research/Development Programmes

General aims:

Product conformity — improvement of the actual products to conform to the consumer's demand and to the law.

Innovation — extension of the product sales and creation of new sales. This work is done in close collaboration with the marketing service which analyzes the market and can define the supporting products. Research and development tells what technology can do and formulates the products.

Production:

- To know new materials and help in their choice.
- Definition of manufacturing processes at the pilot level.
- Technical assistance.

Technological vigilance and interface with the outside:

- To be aware of what takes place in factories that are in the same field.
- Put in place research programmes for the medium and long term with external research organizations.

Research programmes in progress at Royal:

Local fruit and pulp standardization — we put in place physico-chemical and organoleptic standards of quality for all raw materials manufactured in the factory and used for the production of secondary transformations.

Guava:

- Selection and characterization of different varieties of guava for processing.
- Processing of guava pulp with variable consistency by enzymatic methods
- Characterization of guava flavour.

Pineapple:

- Definition of the ideal harvesting point for the processing

Future work

Standardization of the local pulp:

- Royal has begun a study on this subject. However, this programme lies beyond the firm's capacity because almost all the tropical fruits are concerned.
- Pulp standardization is very subjective and for a lot of fruits there is no legislation for lack of data. Nevertheless, these fruits have started to be known and exported to temperate countries, indirectly by their processed products (juices, jams, etc.).
- This kind of study implies a real mobilization and cooperation of local farmers and processors in collaboration with public research organizations. We also wish for cooperation with the other Caribbean countries because they produce and process the same fruits and have probably the same problems we have.

PRODUCTION OF THE ANNONAS WITH PARTICULAR REFERENCE TO SOURSOP

LENNOX ANDREWS
CARONI (1975) LIMITED, TRINIDAD AND TOBAGO

Abstract
The family Annonaceae contains about 130 genera, *Annona* and *Rollina* are the genera with many desirable species of commercial interest; some of them occurring in the Caribbean. There is great variability, even within species, in fruit quality characteristics which is expressed in grittiness, fibre content, flesh colour, skin texture and skin colour; (green, yellow, pink and purple). Flowering in these two genera is discussed; it is pointed out that hand-pollination can result in 90% fruit set in some species. The ideal site for soursop provides full sunshine, wind shelter, an annual rainfall of about 1,500–2,000 mm, and well-drained soil with a pH of 5.5–6.5. A yield of 6.3 t/ha removes the equivalent of 19 kg N, 8 kg P_2O_5, 19 kg K_2O, 6 kg Ca and 0.9 kg Mg. Micronutrient (Zn, Fe, Bo, Mg, Mn) application is recommended under high pH conditions. An ongoing fertilizer trial (NPK at 2 levels) on cv. Burris in Grenada showed no fertilizer effect after 18 months. Critical moisture requirement periods are at transplanting, flowering, and fruit development. Topping at about 1 m in order to stimulate branching and widening of the crotch angle is thought to be helpful since fruiting is greater on branches at right angles to the main stem. Defoliation, pruning and growth regulators (GA) result in varying levels of success of fruiting manipulation. Trees established from seedlings begin bearing within 3 years and achieve full bearing by the seventh year. Yields vary from 6 to 10 t/ha with year-round bearing, peaking in March/April and August/September. The major pests are the annona fruit borer, a moth *(Cerconata annonella)* and a wasp *Brephatelloides* sp., the annona seed borer. The most common disease problem is anthracnose *(Colletotrichum gloeosporioides)* which causes black rot and mummification of fruits, flower fall, twig die back and may also causes damping off in the nursery.

Résumé
La famille des Annonacées contient environ 130 genres, dont *Annona* et *Rollinia* qui renferment de nombreuses espèces d'intérêt commercial dont plusieurs se rencontrent dans la Caraïbe. Il existe une grande variabilité au sein des espèces elles-mêmes en ce qui concerne la qualité des fruits, laquelle peut être exprimée en termes de pulpe plus ou moins graveleuse, contenu de fibres, couleur de la chair, texture et couleur de l'épiderme (vert, jaune, rose et violet). La floraison au sein de ces deux genres est discutée et il est indiqué que la pollination manuelle peut augmenter la nouaison jusqu'à 90% pour certaines espèces. Les conditions idéales pour le corossol sont: beaucoup de soleil, une protection contre le vent, une pluviométrie annuelle d'environ 1500–2000mm, des sols drainant bien avec un pH de 5.5–6.5. Un rendement de 6.3t/ha exporte l'équivalent de 19 kg de N, 8 kg de P2O5, 19 kg de K2O, 6 kg de Ca et 0.9 kg de Mg. L'application d'éléments lourds (Zn, Fe, Bo, Mg, Mn) est recommandée pour des conditions de pH élevées. Un essai engrais (NPK à 2 niveaux) sur le cultivar "Burris" à Grenade n'a montré aucun effet après 18 mois. Les périodes critiques quant aux exigences en humidité sont au moment de la transplantation, à la floraison et au développement de fruit. Des pincements à environ 1m pour stimuler l'émission de rameaux secondaires et un élargissement de l'angle avec le tronc sont sensés être efficaces, étant donné que les fruits sont plus nombreux sur des branches qui font un angle droit avec la tige principale. La défoliation, la taille et l'usage de régulateurs de croissance (GA) permettent de mieux contrôler le développement du fruit. Les arbres de semis commencent à produire au bout de 3 ans et atteignent un plein rapport vers la septième année. Les rendements varient de 6 à 10t/ha avec une production toute l'année, culminant en mars/avril et août/septembre. Les principaux parasites sont le charançon des annones (*Cerconata annonella*) et une guêpe (*Bephratelloides sp*). La maladie la plus commune est l'anthracnose (*Colletotrichum gleosporioides*) qui cause la pourriture noire et la momification des fruits, la chute de fleurs, la mortalité des brindilles et peut aussi causer des fontes de semis en pépinière.

Resumen
La familia de las Anonaceas contiene aproximadamente 130 géneros, Annona y Rollina siendo los que contienen muchas especies de interés comercial; las que ocurren en el Caribe se listan. Existe una gran variabilidad hasta dentro de una misma especie en cuanto a características de calidad de la fruta que se expresan en granulosidad, contenido de fibras, color de la pulpa, textura y color de la cáscara: verde, amarilla, rosada y púrpura. La floración en estos dos géneros se discute; se señala que, en algunas especies, la polinización manual puede aumentar en 90% el cuajo de frutas. El sitio ideal para guanábana consiste en mucho sol, buena protección contra el viento, una pluviosidad anual de aproximadamente 1500–2000 mm, y tierras bien drenadas de pH entre 5,5 y 6,5. Rendimientos de 6.3t/ha exportan el equivalente de 19kg N, 8kg P2O5, 19kg K2O, 6kg Ca y 0.9kg Mg. Elementos pesados (Zn, Fe, Bo, Mg, Mn) se recomiendan en condiciones de pH alto. Un ensayo de fertilizantes (NPK a 2 niveles) con el cv 'Burris' en Grenada no ha mostrado ningún efecto en 18 meses de experimento. Los períodos críticos en cuanto a requisitos de humedad son al trasplante, a la floración, y al desarrollo de la fruta. Se cree que la poda del tallo principal a aproximadamente 1m para estimular la ramificación y el ángulo de apertura es útil puesto que la fructificación es mayor en ramas que tienen un ángulo abierto con el tallo principal; técnicas de desfoliación, poda y el empleo de reguladores del crecimiento (GA) incrementan los resultados. Arboles

nacidos de semilla empiezan a producir a los 3 años y alcanzan su plena producción en el séptimo año. Los rendimientos varían de 6 a 10t/ha con producción todo el año; los picos se dan en marzo/abril y agosto/septiembre. Las mayores plagas son los perforadores de la fruta, una polilla (Cerconata annonella) y una avispa Bephratelloides sp. La enfermedad más común es la antracnosis (Colletotrichum gleosporioides) que causa una putrefacción negra y la momificación de frutas, caida de flores, secamiento de ramitas y también muerte de plantitas en vivero.

Classification and Origin

The family Annonaceae contains about 130 genera, the ones of commercial interest being *Annona* and *Rollinia*. The genus *Annona* contains about 120 species many of which are considered desirable but are yet to be domesticated. The atemoyas (*A. cherimola* x *A. squamosa* hybrids) have also achieved considerable commercial importance.

The annonas are native to tropical America, the soursop being the most tropical. Ilama (*A. diversifolia*) is from Mexico whereas the cherimoya (*A. cherimola*) came from the highlands of Peru and Ecuador. Some of the annonas found in the Caribbean are listed in Table 1.

There is great variability in fruit quality characteristics even within species. This variability is expressed in grittiness, fibre content, flesh colour, skin texture and skin colour (green, yellow, pink, purple).

Table 1: Annonas in the Caribbean

Common name	Botanical name	Cultivars	Elevation cultivated
Soursop, guanabana	*A. muricata*	Burris	<1000 m
Sugar apple	*A. squamosa*		"
Custard apple*	*A. reticulata*		"
Soncoya, monkey apple	*A. pururea*		"
Mountain soursop	*A. montana*		"
Cachiman*	*A. mucosa*		"
Pond apple	*A. glabra*		"
Atemoya	*A. cherimola* x *A. squamosa*	African Pride	
Biriba	*R. deliciosa*		
Ilama	*A. diversifolia*		
Cherimoya	*A. cherimola*		1200–2000 m

*The name 'custard apple's refers to atemoya in Australia and to sugar apple in India. The name 'cachiman' refers to custard apple in St Lucia, to sugar apple in Dominica and *A. mucosa* in Trinidad.

Flowering and Fruit Set

Flowering:
Soursop flowers are borne singly on the trunk , branches or shoots. Atemoya and sugar apple produce clusters of two to three flowers. Annonas are bisexual , the female stage being mature and receptive before pollen is available on the same flower. Flowering occurs throughout the year with peak periods once or twice per year. Development of a small bud (2 mm diameter) to anthesis may take as long as 2 months.

Pollination occurs by beetles of the Nitidulae family in atemoya and sugar apple. Lopsided fruit may be due to inadequate pollination. Natural fruit set is reported to be 0–3.6 % in sugar apple in Guadaloupe and 6–12% in soursop in Barbados.

Hand-pollination :
An increased set of greater than 90% is possible by hand-pollination of sugar apple, atemoya and soursop. The technique involves the following steps:

- Mature flowers are harvested and placed in a paper bag.
- The bag is emptied on the following the day and the pollen separated from abscissed petals and other floral parts.
- A soft brush is used to apply pollen to the stigma of flowers that are sufficiently mature on the tree (see Figure 1 for maturity stages).

Hand-pollination results in heavier and better shaped fruit. Intercultivar pollination has resulted in even heavier fruit in sugar apple (Cogez and Lyannaz 1993) but poor fruit quality resulted from some interspecific crosses (Mahdeem 1989).

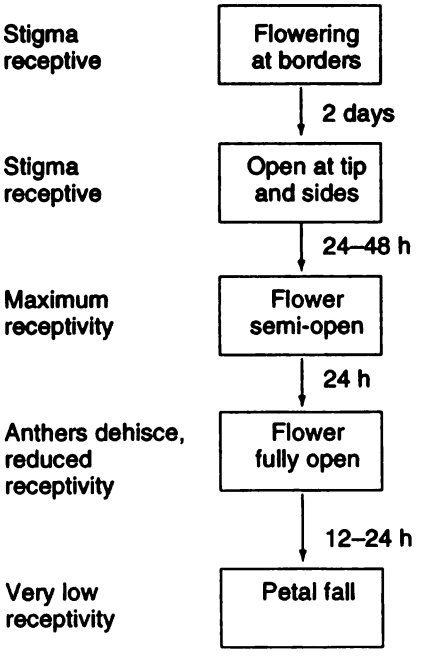

Figure1: Floral stages of soursop (after Escobar et al. *1986)*

Fruit Development (soursop):
After fruit set, fruit development is characterized by a quiesient period of 9–15 weeks followed by continued growth in a double sigmoid fashion. Maturity is achieved in an additional 15–21 weeks (Worrel and Carrington 1992). The fruit is a large fleshy syncarp that may have as many as 200 seeds.

Culture

Site Selection:
Soursop requires full sunshine, wind shelter and an annual rainfall of about 1,500–2,000 mm. Good growth can occur on a wide range of soils, the most critical factor being drainage since waterlogging cannot be tolerated. Optimum pH is 5.5–6.5. Annonas are generally shallow-rooted although soursop roots may extend to 1 m deep in unimpeded soils.

Establishment:
Spacing varies with soil fertility and moisture availability. The following spacings have been used:

Puerto Rico	5.5 m x 5.5 m
Costa Rica	8 m x 8 m
Dominican Republic	6 m x 6 m or 7 m x 7 m

Intercropping may be done with short-cycle species such as beans, cassava or plantain. A planting hole size of 60 cm x 60 cm x 45 cm is recommended with the plant established at the same level as the medium in the propagating bag. It is also advantageous to place the topsoil at the bottom of the hole at planting.

Nutrition:
It has been determined that 1,000 kg of fresh fruit contains the following:

N	2,966 g
P	535 g
K	2,527 g
Ca	988 g
Mg	153 g

At a yielding potential of 6.3 t/ha this removes the equivalent of 19 kg N, 8 kg P_2O_5, 9 kg K_2O, 6 kg Ca, and 0.9 kg Mg (Avilan et al. 1981). In contrast the recommendations of some countries are as follows for bearing trees (> 3 years):

Jamaica	10-10-10; 120-240 g/tree/yr
Hawaii	10-10-10; 7.3 kg/tree/yr
Dominican Republic	15-15-10; 900–1200 g/tree/quarter
Venezuela	15-15-15; 900–1200 g/tree/quarter

Nitrogen and phosphorus are thought to be the more important nutrients during the early development years. High P is used at the transplant stage — TSP in Hawaii , 12-24-12 in the Dominican Republic — and is drastically reduced in the fifth year in Puerto Rico. Micronutrient (Zn, Fe, Bo, Mg, Mn) application is recommended under high pH conditions. An ongoing fertilizer trial (NPK at two levels) on cv. Burris in Grenada has shown no fertilizer effect after 18 months (Anon. 1992).

Weed Control:
Weed control is done manually, mechanically or chemically and the effect may be enhanced by the use of an organic mulch. The following chemicals have given adequate results:

paraquat 1.2 l/ha	) avoid contact with
glyphosate 1% solution	) the plant
diuron 6 0 kg/ha	)
simazine 2 l/ha	) apply under moist
oxyflouren 2 l/ha	) conditions

Irrigation:
Most annonas are sensitive to excess soil moisture except for the pond apple. Under dry conditions they benefit from mulching since the root system tends to be shallow. Water availability is most critical at transplanting and during flowering and fruit growth in order to ensure good fruit set and fruit size.

Soursop fruits developed under dry conditions are small and have poor taste. However a short drought is thought to cause increased and uniform bearing.

Pruning and Training:
Plants should be topped early at about 1 m height in order to stimulate branching. This creates a bushy shape that will facilitate harvesting. Widening of the crotch angles is thought to be helpful since fruiting is greater on branches at right angles to the main stem. It is also necessary to routinely remove dead and diseased wood.

Manipulation of Fruiting:
Defoliation: Ethrel (1,500 ppm) and manual defoliation of soursop increased lateral shoot growth and flowering but decreased yield. However, potassium iodide (1.5%) gave partial defoliation and increased yield (Cruz-Castillo and Cedenon-Maldonado 1989).

Pruning: Flowering is closely associated with vegetative flushing in atemoya. Tipping of shoots and removal of six to seven leaves increases flowering. Preliminary work with sugar apple suggests that a similar response can be expected with the same treatment.

Growth regulators: Sugar apple treated with GA (50 ppm) at flowering gave increased fruit set, increased fruit size and weight, and fruits had fewer seeds.

Harvesting and Yields:
Seedling soursop trees begin bearing within 3 years and achieve full bearing by the seventh year. A few fruits are borne throughout the year but the main

crop(s) are in March/April and August/September. Fruits are generally 15–30 cm in length , 10–20 cm in diameter and 1–2 kg in weight , although weights of up to 10 kg have been recorded. Trees carry 12–35 fruits at the main crop. Fruit may be harvested when there is a lightening of colour and widening of spine spacing (six to seven spines per 12 cm). Yields vary generally from 6–10 t/ha although the estimate for a seedling crop in Hawaii was 18 t/ha for 6–year-old trees (Nakasone 1972). In Grenada 5-year-old trees from rooted cuttings of cv. Burris produced 52 fruits/tree/year at a mean weight of 72 kg/tree (17 t/ha at 238 trees/ha). Twenty-eight per cent of this production was considered unfit for extra-regional export due to unacceptable size and uniformity or to skin defects.

Pests and Diseases

The major pests are the annona fruit borer, a moth (*Cerconata annonella*) and a wasp, *Brephatelloides* sp., the annona seed borer. The wasp lays eggs in the young fruit and larvae develop in the seeds and exit the fruit at maturity. The moth eggs are laid on the fruit surface and larvae penetrate the flesh and cause damage by feeding. Larval feeding also causes flower and fruit fall. Weekly sprays of Lebaycid and Atellic are recommended for control of the moth. Malathion or Diazinon sprays are recommended for control of wasps (Bonilla 1991) but the timing for *B. maculicollis* may be different to that of *B. cubensis*. Rogor, Sevin and Ambush were found to be phytotoxic (Mc Comie 1987).

Control by insecticides is not always complete and the use of a protective envelope e.g. polythene or fibreglass mesh bags is a good alternative and efficacy is enhanced by the use of a chloropyriphos dust (Pena et al. 1990). Other minor pests are mealybugs on fruit and other sucking insects on leaves, e.g. aphids, stink bugs. The most common disease problem is anthracnose (*Colletotrichum gloeosporioides*) which causes black rot and mumification of fruits, flower fall, twig die back and may also cause damping off in the nursery. Sprays of Benlate, Cupravit or Dithane are helpful.

Propagation

Seed stored at 15–20°C in plastic or paper bags give > 70% germination after 390 days. (Lopes et al. 1982). Soil mixtures of 1:1 with sand, bagasse or sawdust give good germination. Germination usually takes 2–3 weeks but may take as long as 8 weeks. Shield and patch budding give excellent take on soursop but are less successful on *A. montana* or *A. reticulata*. (Eglesias and Sanchez 1985). The best stocks are considered to be soursop or mountain soursop, the latter resulting in more vigorous scion growth but may delay time to bearing. Propagation by cuttings is reported to be easy (Morton 1966) but attempts without a misting system have yielded poor results.

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PRODUCTION PROCESSING AND MARKETING OF WEST INDIAN CHERRY IN SURINAME

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Abstract
West Indian cherry is currently being produced in Suriname on an area of approximately 33 ha comprising five projects. Physical soil conditions (heavy clays) and water management are the main cultivation problems experienced. Average production is 6.8 t/ha. The availability of fertilizers, pesticides and water resources for irrigation are some factors limiting the expansion of West Indian cherry. The production cost of 1 kg fruits was calculated at US$0.11 but fluctuates with the price of inputs. Bearing is practically year-round with a peak period from November to February. Propagation of the most cultivated variety (clone 1/8) which was selected from *Malpighia glabra L.* is by cuttings, however, the percentage success is low and as a result the demand for plants exceeds supply. Plantations are established in a square or triangular plant pattern with a density ranging from 328 to 571 trees/ha depending on spacing. Bruised fruits and fruits containing fruit fly larvae are the main causes of fruit rejection. The main products of West Indian cherry are extracts (pulp), juices and jams which are distributed on the local market.

Résumé
La cerise des Antilles couvre actuellement environ 33 ha au Suriname au sein de 5 projets différents. Les conditions physiques du sol (argiles lourdes) et la gestion de l'eau sont les principaux problèmes rencontrés. La production moyenne atteint 6,8 tonnes par ha. Le manque d'engrais, de pesticides et d'irrigation sont les principaux facteurs limitant l'expansion de cette culture. Le coût de production de 1 kg de fruits a été calculé à US $0,11 mais fluctue en fonction du coût des intrants. La production a lieu pratiquement toute l'année avec cependant un maximum de novembre à février. La propagation de la variété plus cultivée (clone 1/8) se fait par boutures, mais le pourcentage de réussite est faible; en conséquence la demande excède l'offre. Les plantations sont établies selon un dispositif de base carré ou triangulaire avec des densités variant de 328 à 571 plantes/ ha. Les fruits abimés et ceux affectés par des larves de mouche des fruits constituent les principales causes de rebut. Les principaux produits transformés sont de la pulpe, des jus et des confitures qui sont tous distribués sur le marché local.

Resumen
Acerolas se producen corrientemente en Suriname en una área de aproximadamente 33 ha compuesta de 5 proyectos. Las condiciones físicas de suelo (arcillas pesadas) y el manejo del agua son los problemas principales de este cultivo. La producción promedia es de 6.8 toneladas por ha. La no-disponibilidad de fertilizantes, pesticidas y sistemas de irrigación son otros factores que limitan su expansión. El costo de producción por 1kg de frutas se calculó en US$0.11 pero el mismo fluctúa de acuerdo al precio de los insumos. La producción tiene lugar prácticamente todo el año con picos de noviembre a febrero. La propagación de la variedad más cultivada (clón 1/8) se hace por estacas, sin embargo el porcentaje de éxito es bajo lo que resulta en una demanda superior a la oferta. Las plantaciones se establecen en un diseño cuadrado o triangular con una densidad variable de 328 a 571 plantas/ha dependiendo de las distancias. Frutas magulladas y frutas con larvas de moscas de la fruta son las causas principales de rechazamiento. Los principales productos procesados de acerola son extractos (pulpa), jugos y mermeladas que se distribuyen en el mercado local.

1. Generalities

Traditionally, fruit production in Suriname concentrated only on citrus and banana, and it was not until the late 1970s, that the government of Suriname initiated activities towards the diversification of fruit crops. Since then, emphasis has been put on the commercial production of fruit crop species which previously were only recognized as backyard fruit crops. These crops comprise West Indian cherry, mango, avocado, passion fruit, soursop and carambola as the major promising fruit crops for the local and export markets. Both private enterprises as well as governmental agencies have started several projects on fruit production.

Of these crops, West Indian cherry has received considerable attention in all of the production phases from pre-production to marketing. West Indian cherry projects that are currently being implemented in the country are presented in Table 1.

1.1 Major Ecological Problems Related to West Indian Cherry Production

Since agricultural activities in Suriname are executed mainly on the coastal area, which for a major part consists of clay soils, the chemical and physical composition of these soils is one of the major problems. In addition, proper water management is also considered as a main cultivation problem.

Table 1: West Indian cherry projects currently being implemented in Suriname

Agency	Area (ha)	Age (yr)
Boma	12.0	16
Jarikaba	1.9	12
SLO	2.5	5
SLOC	9.0	3
Tropica	8.0	3
Total	33.4	

1.2 Production

Excluding the 18.6 ha that is scattered in mixed farming systems with plots less than 1 ha, the commercial area of West Indian cherry under cultivation is estimated at 33.4 ha with an average production of 6.8 t/ha. Although several private growers have expansion intentions, there are some limiting factors hindering the realization of expansion, particularly the availability of agro-chemicals (fertilizers and pesticides) and proper water resources for irrigation purposes. The acquisition of agrochemicals is currently very expensive due to the uncertain economic situation and the unstable exchange rate of the US dollar in the country and this has had a negative impact on the industry.

1.3 Production Costs and Returns

Since prices for inputs are fluctuating constantly, it is difficult to calculate an exact figure for the production costs and return for West Indian cherry. Notwithstanding this difficulty, a review of the costs can be presented (Table 2).

Total cost for the non-bearing period (1st and 2nd years) is US$2400; distributed over 8 years this is US$300/yr. Annual cost for the production period is US$425.

Table 2: Costs and returns for the cultivation of 1 ha of West Indian cherry

Activity	Costs (US$)*
Land clearing and preparation	150
Inputs (e.g. planting material, fertilizers, pesticides and equipment)	2,000
Labour costs (plot establishment)	25
Subtotal	2,175
Maintenance costs (1st – 2nd year; non-bearing period)	225
Production period from Year 3	
Annual costs (fixed)	225
(labour)	200

*US$1.00 = 55 sf

At a total production rate of 6.8 t/ha the production cost of 1 kg fresh West Indian cherry is calculated at US$0.11.

Current farmgate price for West Indian cherry is US$0.18/kg. Profit for 1 kg of West Indian cherry is US$0.07/ha; US$476 net return.

1.4 Seasonality

For West Indian cherry, the main bearing period is practically all year round with peak periods from November to February. This pattern of bearing is related to the occurrence of the minor rainy seasons.

The main market for fresh West Indian cherry is the local market, particularly the processing industry. It is also recognized by the processors that the demand for West Indian cherry as raw material is very high, but the supply cannot be met from current production.

2. Pre-production

The most common cultivated variety of West Indian cherry in Suriname is a Surinamese selected clone (clone 1/8) from *Malpighia glabra L.* which is native to Suriname. The importance of this variety is that it is well adapted to the country's agro-ecological conditions and that it is officially used as propagation mother material. The characteristics of this variety include a pH demand of 5.5–7.0; when the pH is lower than 5.5 liming is necessary (shells). It can be grown on both light and heavy soils and the planting times are at the beginning of the rainy seasons, i.e. May/June and December/January.

In Suriname, West Indian cherry is normally propagated by cuttings. Problems that are related to propagation are common to all fruit crops that are vegetatively propagated in Suriname, particularly input provision and the technology used in propagation. The percentage of success of propagation by cuttings is currently still low but it is anticipated that in the near future, as a result of a training course on propagation methodologies and nursery management held in Suriname recently, propagation of planting material will be more successful.

The demand for planting material is very high, but the supply is still not enough. The deficit of the demand is a result of the poor conditions of the nurseries and the lack of skilled plant propagators, in addition to the lack of sufficient propagation inputs and inadequate nursery management practices. The distribution of planting material encounters problems because of the location of the nurseries and the poor availability of transportation from the nurseries to the farms.

Table 3: Planting distances and patterns for West Indian cherry used by various agencies

Agency	Between rows (m)	In row (m)	Plant pattern	No. of trees/ha
Boma	5	3.5	Square	571
Jarikaba	6	4	Square	328
S L O	4	4.5	Triangular	520
S L O C	5	5	Triangular	400
Tropica	6	6	Square	368

3. Production System

The planting patterns and planting distances used in the production of West Indian cherry in Suriname in bed systems are presented in Table 3.

3.1 Cultural practices

Cultural practices (crop husbandry) for West Indian cherry production are shown in Table 4.

The average yield per tree is estimated at 14.4 kg.

Table 4: Cultural practices for West Indian cherry production in Suriname

Activity	Non-bearing trees	Bearing trees
Fertilization	Four times/year (NPK and super-phosphate).	Four times/year (NPK and triple superphospate).
Weed control	All year round with knapsack sprayer and manual.	All year round with knapsack sprayer and manual.
Irrigation	In dry season with water pump	In dry season with water pump
Spray programme	None	Occasionally against mites, aphids and scale insects, but without a fixed spray programme.
Pruning	Once a year	Once a year

4. Harvesting

West Indian cherry is harvested by hand; the fruits are picked from the trees and placed into baskets. The maturity index used to harvest is the change of colour from orange to red. The main problem encountered in harvesting is that within the harvested bunches there are also immature fruits. Some agencies used the method of shaking the trunk of the tree resulting in the fall of the mature cherries but employing this method flowers and green fruits also fall which results in a decrease of yield at the next harvest.

5. Post-harvest Handling

Fruits are transported from the field to the processing plant by motorized transport in wooden crates or baskets.

At the processing plant, the fruits are washed and crushed in a blender after which the pulp is pasteurized. After pasteurization, the pulp is packed in plastic containers and subsequently stored in a freezing unit.

Bruising of the fruits is the main cause of rejection. Also the infection of the fruits with larvae of fruit flies is of great importance, but to a lesser extent.

6. Processing

The main products of West Indian cherry are extracts (pulp), juices and jams which are distributed on the local market. Brands are Coropina extract (SLO), Bleyco juice (Bleyco) and Tropica juice and jam (Tropica).

A shortage in the supply of raw material and the shortage of suitable containers and spare parts for the processing equipment are problems.

7. Marketing

The main market for processed West Indian cherry is the domestic market, but the demand is higher than the supply. Although the demand for pulp for export to the Caribbean and the western European markets is promising, nothing is being done so far to achieve a piece of these markets.

Since there is no national coordination within the West Indian cherry production system, information on prices and the level of competition is not available.

With regard to advertising, nothing is being done either.

THE PRODUCTION OF WEST INDIAN CHERRY

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Abstract
The West Indian cherry which belongs to the Malpighiaceae family is a native of the West Indies and tropical South America. Fully ripe fruits of the West Indian cherry have the highest vitamin C content of all fruits, ranging from 1,000 to 2,000 mg/100 g. Processed forms of the juice result in little loss in vitamin C, consequently, it is used to improve the ascorbic acid content of other juices. Best yields are obtained at temperatures ranging between 25 and 30°C with a rainfall of 1,000–1,500 mm/year (yields are reduced under very wet or dry conditions) on well-drained soils with a pH of 6–7. High soil calcium promotes high yields and high ascorbic acid content. Various cultivars are listed with a brief description of their characteristics. Commercial orchards are usually established from leafy, hardwood cuttings (12–30 cm long, 0.5–1 cm in diameter and dipped in 5,000 ppm IAB). Orchards should be established at the beginning of the rainy season using plants that are at least 6–12 months old at a spacing of 4.5 m × 4.5 m. Fertilizer recommendations are provided for various stages of crop growth. Pruning just after the main bearing season followed by fertilizer application is recommended. Drastic pruning to a height of 1 m can be employed to rejuvenate old orchards. Root-knot nematode *(Meloidogyne incognita* var. *acrita)* can be a major problem to West Indian cherry production. Other pests include scales, aphids, whiteflies and fruit flies.

Vegetatively propagated plants flower in 18 months attaining maximum production in 5 years. Average yields in the Caribbean range from 20 to 25 tonnes/ha/yr.

Résumé
La cerise des Antilles qui appartient à la famille des Malpighiaceae est originaire des Antilles et des régions tropicales d'Amérique du Sud. Les fruits mûrs se caractérisent par le plus haut taux de vitamines C de tous les fruits, soit 1 000 à 2 000 mg/ 100g. Après transformation, le jus obtenu garde une très forte proportion en vitamine C et il peut être utilisé pour améliorer le contenu en acide ascorbique d'autres jus. Les meilleurs rendements sont obtenus avec des températures de 25 à 30°C, des précipitations variant de 1 000 à 1 500 mm/an (sécheresse ou humidité excessive affectent les rendements), et un sol bien drainé de pH 6–7. Un sol très calcique favorise les hauts rendements et une haute teneur en acide ascorbique . Plusieurs cultivars sont présentés avec une brève description de leurs caractéristiques. Les vergers à vocation commerciale sont généralement établis à partir de boutures de bois dur et feuillu (de 12 à 30 cm de long, 0.5 à 1 cm de diamètre et immergé dans une solution de 5 000 ppm de AI(3)B). Les vergers devraient être établis au début de la saison des pluies en utilisant des plants âgés de 6 à 12 mois et avec une espacement de 4.5 m sur 4.5 m. Les recommandations en matière de fertilisants sont fournies pour différentes phases de croissance de la plante.Une taille juste après la principale saison de fructification suivie d'une application de fertilisants sont recommandées. Une taille sévère à hauteur d'un mètre peut être effectuée pour régénérer de vieux vergers. La nématode du noeud des racines (Meloidogyne incognita var. acrita) peut être un problème très important pour la production de cerise des Antilles.La plante est aussi susceptible aux pucerons, mouche blanche et mouche des fruits.

Multipliées végétativement, les plantes fleurissent au bout de 18 mois et atteignent une production maximale à 5 ans. Les rendements moyens dans les Caraïbes sont de l'ordre de 20 à 25 tonnes/ha/an.

Resumen
La cereza *Maipighia glabra* pertenece a la familia de las *Malpihgiaceae*, y es nativa del Caribe y la zona tropical de Sur America.La fruta completamente madura tiene un contenido de vitamina C entre 1000–2000 mg/100g, que es el mas alto de todas las frutas. La fruta procesada, pierde muy poca vitamina C, por lo que es usada para mejorar el contenido de ácido ascórbico de otros jugos. La mejor producción ocurre en areas con temperaturas entre 25–30°C y una precipitacion de 1000-1500 mm/año; suelos bien drenados y con pH de 6–7. La producción se reduce en suelos muy húmedos o muy secos. Suelos con alto contenido de calcio inducen una mayor producción y un mayor contenido de ácido ascórbico. Se mencionan varios cultivares y se describen brevemente. La propagación comercial se hace con estacas de madera dura con hojas, para ello se utilizan estacas de 12–30 cm de largo y 0.5–1 cm de diametro, que se sumergen en una solución de 5000 ppm de IBA. Los huertos se deben establecer al inicio de la estación lluviosa utilizando plantas de 6–12 meses de edad en una distancia de 4.5 × 4.5 m. Se provee con recomendaciones de fertilizantes para diferentes estados de crecimiento de las plantas. La poda seguida de una aplicación de fertilizante se recomienda despues de la cosecha principal. La poda drástica a 1 m se recomienda para rejuvenecer los huertos viejos. El nemátodo de las raices *Meloydogyne incognita* puede ser el principal problema, aun que otras plagas como escamas, áfidos, mosca blancas y mosca de la fruta pueden estar presentes. Plantas producidas vegetativamente, florean a los 18 meses alcanzando la maxima producción a los 5 años. El promedio de producción en el Caribe varia entre 20–25 t/ha/año.

Introduction

The West Indian cherry, which is also called Barbados cherry, acerola, cereza, cerise des Antilles and switie kersie, is a member of the family Malpighiaceae. It is native to the West Indies and tropical South America but it is now cultivated throughout the tropics and in subtropical areas such as Florida, USA, Australia and Israel.

Utilization

In 1945, at the School of Medicine, Puerto Rico, it was discovered that the West Indian cherry had the highest vitamin C content of all fruits. In fully ripe fruit, ascorbic acid content ranges from 1,000 to 2,000 mg/100 g and in partially ripe fruit, values as high as 4,500 mg/100 g can be obtained. Therefore, this fruit is recognized as the best natural source of vitamin C and one fruit can supply the vitamin C daily requirement of an adult. It is consumed fresh, but due to its poor keeping qualities, processed forms have been developed with very little loss of ascorbic acid content. These forms include: frozen fruit pieces; dehydrated cherry juice which is useful for enriching the nutritional content of other juices, as well as improving their flavour; fresh juice; frozen ice; purees; baby food; flavouring syrups; ice-cream; preserves. The fresh fruit is added to fruit salads to improve colour and flavour as well as to prevent discolouration in other fruits, such as bananas. The pasteurized canned juices do not keep well, are unattractive and rapidly lose their nutritional value.

Production

Following on the discovery of the nutritional value of the West Indian cherry, large plantations were established in Puerto Rico (200 ha) and Hawaii (837 ha) for the Nutritive Products Company. Smaller plantings were also undertaken elsewhere, for example in Guyana where the production of a syrup called 'Serola' was developed by the Guyana Pharmaceutical Corporation. Most of these earlier ventures have declined because of the availability of the cheaper, synthetic ascorbic acid. However, during the 1980s, there was an upsurge of interest with new commercial plantings in Puerto Rico, Barbados and Suriname, mainly for the processing market.

Botany

The plant is either a large, bushy shrub or a small tree which can attain heights up to 8 m. The branches are erect to spreading and form a dense canopy. The evergreen leaves are hairless, glossy and dark green when mature and are generally small, 2–7 cm long and 9.5–40 mm wide. The flowers are borne in inflorescences which are sessile or have short peduncles, and are pink with five fringed petals. The fruit is a thin-skinned, three-lobed drupe, globose, up to 2.5 cm in diameter and weighing 2–10 g. It ripens to a bright red colour and the pulp is orange coloured, very juicy, acid to sub-acid in flavour. The three small seeds bear wings which give them a triangular shape.

Environmental Requirements

This fruit crop performs well at temperatures between 25 and 30°C, but at lower temperatures the growth rate decreases. Young trees are destroyed by frost. Optimal rainfall receipt is 1,000–1,500 mm/year, well distributed over the year; the crop will tolerate wetter or drier conditions but fruiting is reduced. West Indian cherry tolerates a wide range of soils but prefers well-drained soils with pH 6–7. A high soil calcium promotes high yields and high ascorbic acid content. Therefore, acid clay soils should be limed.

Cultivars

Selections from seedling populations have led to the development of superior clonal varieties, the first of which was 'B-17' - a tart type. This is surpassed in vitamin C content and yield by 'A-21', 'B-6', 'B-7', 'B-15' and 'Florida Sweet'. The 'Florida Sweet' is a sub-acid type which is well suited to the fresh fruit market. Cultivar B-15 is superior to all the others, with yields of 90 kg fruit/tree and a vitamin C content of over 2%. Other desirable selection qualities include large fruit, high juice content, thick skin and firm flesh to reduce bruising, desirable flavour, erect open trees and easy propagation from cuttings. The tart varieties are favoured for processing. In terms of habit, it has been found from work conducted in Hawaii that the sour types generally have the more desirable tree form and are better suited to orchard culture. The trees have a single trunk, or are easily trained to this form, with a compact well-branched, densely foliaged, low-growing canopy. Such cultivars include F Haley, Red-Jumbo and Maunawili.

Propagation

Most plants occuring in the wild or in backyards are from seeds. Commercial production is usually based on plants grown from leafy, hardwood cuttings (12–30 cm long, 0.5–1 cm in diameter and dipped in 5,000 ppm IBA). Air layers may also be used. Side, wedge and cleft grafting as well as chip budding are also very successful but rarely used techniques possibly because scion material is not limiting and the production of large plants takes longer by these methods than the use of cuttings.

Crop Management

Land Preparation and Planting

After the land is cleared, the soil pH should be determined and, if low, liming is necessary to obtain a pH value of 6.5–7.0 in the upper 15 cm of soil. Then holes 60 cm in diameter and 40 cm deep are

prepared and the backfill mixed with manure. The backfill is re-placed in the holes and formed into a small mound, so that the plants are slightly raised when planted. On flat land where the soil is heavy or compact, ploughing and rotavation may be necessary and banks or cambered beds formed.

Planting should take place at the beginning of the rainy season. The plants should be at least 6–12 months old.

The recommended spacing is 4.5 m x 4.5 m which gives a plant population of 500/ha. Hedgerows with a spacing of 6.5 m x 3 m can be made, but ultimately the choice will depend not only on plant size at maturity but also on soil depth, topography and fertility.

Fertilizer Application

At planting up to 0.25 kg of triple superphosphate is applied to the planting hole or a complete NPK fertilizer such as 10-10-15 or 10-10-8 may be added to the hole, covered with 5 cm of soil and then the plant is put into the hole. Subsequent fertilizer recommendations are based on age; those for Puerto Rico are presented in Table 1.

Table 1: Fertilizer recommendations for West Indian cherry in Puerto Rico

Fertilizer	Quantity (kg)	Age	Frequency	Total (kg)
Triple superphosphate	0.25	At planting	1	0.25
10-10-5	0.25	1st yr: 6 wks, 4, 8 and 12 mth	3–4	0.75–1.0
10-10-5	0.25	2nd yr: 15–18 mth, 21–24 mth	3–4	0.75–1.0
12-6-10 or 15-5-10	1.0	2nd and 3rd yr: in autumn	1	1.0
10-5-20 or 12-6-16	1.0	in spring	1	1.0
As above	1.5	4th yr; autumn	1	1.5
	1.5	in spring	1	1.5

From the fifth year onwards, the same fertilizer analyses can be used but 0.25–0.5 kg is added each year up to 7 years, then this rate can be maintained thereafter. Foliar applications of NPK (20-20-20) every 30 days also increase growth of young trees. On limestone soils, supplemental applications of copper, zinc and manganese may be necessary to avoid deficiencies from occurring.

Irrigation

Irrigation is essential for maximum growth and development of large fruits, especially in the dry season. Generally, in the Caribbean the crop is not irrigated and yields may fluctuate throughout the year.

Pruning

Plants with a tendency for thick, dense growth should be thinned to improve yields and fruit quality. Erect growers should be headed back to induce lateral branching and also promote yields. The pruning exercise should also include removal of weak, dry or injured branches. The main benefits are better aeration and light penetration, reduced disease incidence, more effective chemical application, more flowering, fruiting and improved fruit quality. Pruning should be carried out just after the main bearing season, and the crop fertilized to promote healthy regrowth. Drastic pruning, to a height of 1 m above soil level is used to rejuvenate old unproductive trees.

Pest and Disease Control

One of the biggest problems which can constrain commercial production is the susceptibility of West Indian cherry to the root knot nematode *(Meloidogyne incognita* var. *acrita)* which is especially a problem in sandy, acid soil. Control measures include planting on heavier soil, fumigation, irrigation and mulching. Grafting on to *M. tuberosa* rootstock confers resistance but the trees are unproductive, so that development of *M. punicifolia x M. tuberosa* hybrids may be more useful. Other pests include scales, bugs, caterpillars, aphids whiteflies and fruit flies, all of which can be controlled by application of Malathion, Dipel or Safer.

In high humidity areas, a leaf spot fungus can occur but is easily controlled by copper fungicides.

Bearing Yield and Harvesting

West Indian cherry seedling plants begin flowering at about 2 to 3 yr, but those that are vegetatively propagated may flower in 18 months. Subsequently, the trees flower throughout the year, but peak production is in May and November in the Caribbean. Trees achieve maximum production levels by 5 yr. The period between flowering and fruit maturity is 28–30 days.

Average yields in the Caribbean range from 20 to 25 t/ha/yr but with 'B-15' yields of more than 50 t/ha/yr have been obtained.

The fruits are ready for harvesting when they turn pink or red and should not be allowed to ripen fully on the tree because they deteriorate rapidly and cannot be transported. Fruit is harvested by hand every 2–3 days. Manual harvesting is difficult and time-consuming due to the prickly nature of the tree. However, harvesting can be made easier by pruning

the centre of the trees and by using protective clothing. Mechanical harvesting is not feasible at present due to the different stages of fruit maturity on the tree at any one time.

Exposure of harvested fruits to direct sunlight for more than 4 hr could cause significant losses in vitamin C.

Storage

West Indian cherries lose moisture rapidly and are very prone to infection. They are susceptible to chilling injury and should be stored at temperatures above 12–15°C. Fruits for processing can be stored for 6–8 wk at 0°C for 1 wk and 85–90% RH.

Fruits treated with a surface application of Talprolong (1.5% solution for 10 s) followed by storage at 10°C for 1 wk were of acceptable quality. Best results were obtained with fruits stored in polyethlyene bags.

Packaging

Fruits can be jumble-packed in moisture-resistant containers which may range from polyethylene bags to fibreboard cartons.

Fresh fruits have to be air-freighted and consumed very quickly after harvest. The trend is towards the utilization of frozen cherries in health food markets in the USA and Japan.

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REGIONAL FRUIT NETWORK

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Abstract
The need for the setting up of a regional (Caribbean) fruit network is discussed. It would promote and support regional cooperation in research, development and transfer of technology for selected fruit crops. The objective is to improve the economic viability and sustainability of the Caribbean's fruit industry. The expected institutions, activities, and crops to be promoted by such a network are listed. A proposed plan of action is also included.

Résumé
Le besoin de mettre en place un réseau fruitier régional (Caraïbes) est discuté; ceci permettrait de promouvoir et d'appuyer la coopération régionale dans les domaines de la recherche, développement et transfert de technologie. L'objectif est d'améliorer la viabilité économique et la durabilité des filières fruits dans les Antilles. La liste des institutions à impliquer, les activités à développer, et les espèces qui seraient promûes au travers d'un tel réseau sont énumérées. Un plan d'action est également proposé .

Resumen
Se discute la necesidad de instalar una red regional (Caribe) de frutas tropicales para promover y apoyar la cooperación regional en investigación, desarrollo y transferencia de tecnología en este campo. El objetivo es mejorar la viabilidad económica y la durabilidad de la industria de las frutas en el Caribe. Las listas de instituciones a involucrar, actividades a desarrollar, y especies de frutas que serán promovidas a través de tal red se detallan. Se incluye también una propuesta de plan de acción.

Background

Apparently, the idea of a regional fruit network (RFN) was first mooted in December 1991, at the Second Regional Workshop on Tropical Fruit Crops. This was followed by Rafael Marte's survey showing satisfactory interest by regional institutions. Results of the survey were presented at the regional meeting on Fruit Diversification in April 1993. A three-member committee was appointed. Rafael Marte presented a proposal for Lomé funding; the results are unknown to date.

A committee meeting was held in March 1994. Progress has been slow but the need for the RFN to take over from and expand the activities of the current IICA project is as valid now as it was in December 1991.

As such, I would like to again discuss the idea with you, receive your comments and obtain your agreement as to a process of moving the idea forward.

1. Aim

The aim is to promote and support regional cooperation in technology research, development and transfer of selected fruit crops with a view to improving quality and yield of fresh fruit and their efficient marketing and processing so as to improve the economic viability and sustainability of the fruit industry.

2. Network Participation

2.1 Countries

Initially: all CARICOM countries, Suriname, the French islands, Haiti and the Dominican Republic.

Subsequently: Puerto Rico, Cuba and the Dutch islands will be included.

2.2 Institutions

All national, regional and hemispheric institutions and individuals, of either the private or public sector (within the countries listed) that are actively involved in the promotion, maintenance and development of the fruit industry.

3. Crops to be Included

Obviously, there must be some prioritization of the fruit crops to be initially included. This prioritization will be established by the members of the network. However, using the results of the meeting on Fruit Diversification as a base, the following criteria, now suggest themselves:

- Economic potential based both on production and productive capacity and availability and accessibility of markets
- Level of interest by producers and consumers and allied concerns, including national governments
- Level of on-going research
- Existence of apparently solvable problems/ constraints to economic development.

Based on the above criteria and supported by the Fruit Diversification workshop, the following crops are initially suggested:

- Citrus
- Mango
- Banana
- Pineapple
- Passion fruit
- Avocado
- Breadfruit
- Plantain
- Carambola

4. Activities

The activities could initially be:

- Accessing and dissemination of selected information and documentation relative to production, processing and marketing
- Identification of problems and challenges of common interest and the means of their resolution
- Dissemination of information on successful practices including the exchange/introduction of germplasm
- Facilitating and coordinating of training and research activities within and without the network
- Pursuit of the technical and economic excellence of the regional fruit industry through the organization of an annual regional meeting
- Provision of a resource relative to the promotion of the industry
- Establishment and promotion of standards of fresh and processed products relative to the end-use
- Acting as a liaison with appropriate national and regional administrative and legal institutions.
- Establishment of sources of funding and means to obtain them

5. How Do We Go Forward

5.1 Steering Committee

As stated earlier, a committee has already been formed with representatives from:
UWI - Laura Roberts-Nkrumah
CIRAD -FLHOR, Guadeloupe - Jean Lyannaz
IICA - Rafael Marte, and now Gérard Barbeau

I propose that this committee be expanded to include representatives from CARDI, TROPRO/OECS/ ADCU, CARIRI and one other from the non-OECS territories.

I have already held discussions with CARDI and have their support and will do likewise with ADCU and CARIRI.

5.2 Secretariat

A secretariat (full-time) requires funding. This is not directly available. However, I believe that at least IICA, CARDI and ADCU may be persuaded to contribute in various forms to support the initial operative (not full-time) of this secretariat. Indeed, as a start, I understand that IICA and CARDI appear to be willing to house the secretariat.

The steering committee will oversee the launching of the network and report back to this body on its progress through *Focus* and the *Tropical Fruits Newsletter*.

COMPETITIVE POTENTIAL OF SELECTED CARIBBEAN TROPICAL FRUITS IN THE US AND REGIONAL MARKETS

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Abstract
For many Caribean countries, the desire to reduce their dependence on traditional exports has led to the acceleration of agricultural diversification initiatives. A critical element to ensuring success of these initiatives is the *a priori* determination of those commodities that have potential to be economically viable. Due to the data-poor environment, *ex ante* assessment of competitiveness is a difficult task. Mindful of the difficulties, the authors utilize the domestic resource costs (DRC) measure to assess the competitive potential of "specialty" tropical fruits, specifically West Indian cherry, cashew, golden apple, guava and soursop in the US and Regional markets. The DRC provides a direct comparison of the economic value created through production of a given crop and that which otherwise be obtained if resources were devoted to an alternative activity. Since these commodities may be utilized in both fresh and processed form, conclusions regarding potential competitiveness are made for each of these market segments.

The analysis indicates that the US, which is the world_s largest and most sophisticated country market for fresh horticultural products, has grown rapidly. However, with the notable exception of Grenada and St. Vincent, the potential for Caribbean producers to compete in this market appears limited unless the industry is restructured and modernized. While there appears to be little potential for Caribbean producers to compete in external markets for tropical concentrates and juices, the competitive outlook for jams, jellies and other preparations is more promising. The potential for expanded intra-regional trade appears to exist for certain crops such as golden apple, guava and soursop, particulary in the tourism sector. However this will necessitate improvements in intra-regional transportation infrastructre if the volumes, quality and reliability of supply required by the market are to become attainable.

Résumé
Pour de nombreux pays de la Caraïbe, le désir de réduire leur dépendance vis-à-vis des exportations agricoles traditionnelles les a conduit à accélérer les initiatives de diversification agricole. La détermination *a priori* des productions pouvant être économiquement viables est un élément d'analyse important pour assurer le succès de ces initiatives. Etant donné la faiblesse des données disponibles, l_estimation *ex ante* de la compétitivité est une tâche difficile. Conscient de ces difficultés, les auteurs utilisent la mesure du " domestic resource cost (DRC) " pour estimer le potentiel compétitif des fruits tropicaux mineurs, notamment la cerise des Antilles, la noix de cajou, la pomme cythère, la goyave et le corrosol, sur les marchés américains et régionaux. Le DRC fournit une comparaison directe de la valeur économique créée pour la production d'une culture donnée et celle qui pourrait être obtenue si les ressources étaient consacrées à une activité alternative. Les productions étudiées pouvant être utilisées en produits frais ou transformés, les conclusions en matière de potentiel de compétitivité sont détaillées pour chacun de ces segments de marché.

L'analyse indique que les USA, qui représente le marché de produits horticoles frais le plus large et le plus sophistiqué du monde, a connu une croissance rapide. Toutefois, àl'exception notable de Grenade et de St. Vincent, le potentiel pour les producteurs de la Caraïbe d'être compétitif sur ce marché apparaît limité, à moins d'une modernisation et restructuration du secteur. Alors que les producteurs caraïbeéens apparaissent avoir un très faible potentiel de compétitivité sur le marché extérieur des jus et concentrés, les perspectives de compétitivité pour les confitures et gelées sont plus prometteuses. Le potentiel pour augmenter les échanges intra-régionaux semble exister pour certaines cultures telles que la pommecythère, la goyave et le corrosol, particulièrement dans le secteur du tourisme. Toutefois, cela nécessitera une amélioration des infrastructures intra-régionales afin que les critères de volumes, qualité et fiabilité demandés par le marché puissent être possibles.

Resumen
Para la mayoria de los paises del Caribe, la necesidad de reducir la dependencia de los productos tradicionales de exportación, los ha llevado a acelerar las iniciativas por una diversificación de la agricultura. Un elemento crítico para asegurar el éxito de esas iniciativas, es determinar previamente aquellos productos potencialmente viables desde un punto de vista económico. Debido a la pobre información disponible para evaluar la competitividad de un producto, ésta evaluación se hace dificil. Concientes de éstas dificultades, los autores utilizaron las fuentes domesticas de costos(DRC) para estimar la competividad potencial en los mercados regionales y en Estados Unidos, de algunos frutales tropicales "especiales", especificamente acerola, marañon, jobo de la India, guayaba y guanabana. El DRC provee una comparación directa del valor económico creado a traves de una cosecha dada y el que se obtendría por otro lado si los recursos se dedicaran a una actividad alternativa. Debido a que esas productos se puede utilizar como productos frescos o procesados, las conclusiones en cuanto al potencial de competitvidad, son hecha para esos dos segmentos del mercado. Los analisis indican que Estados Unidos, el mas grande y sofisticado merecado para productos frutícolas, ha crecido rapidamente. Sin embargo,

con la notable excepción de Grenada y St Vincet, el potencial para que los productores del Caribe puedan competir en ese mercado es limitado, al menos que la industria se reestructure y se modernice. Aun que parece que hay poco potencial para los productores del Caribe para competir en los mercados externos de concentrados y jugos tropicales, la competividad en mermeladas, gelatinas y otras preparaciones, es mas promisorio. Existen perspectivas para expandir el mercado intra-regional en cultivos como jobo de la India, guayaba y guanabana, particularmente en el sector del turismo. Sin embargo, ésto necesitará un mejoramiento en la infraestructura de trasportación intra-regional, si los volumenes, calidad y reguralidad en los suministros requeridos por el mercado son alcanzados.

Introduction

Agricultural diversification in the Caribbean gained impetus in the 1980s as many countries began to pursue policies aimed at reducing their dependence on traditional exports, such as banana, cocoa, and sugar. Critical to the success of agricultural diversification initiatives are numerous and costly factors, ranging from improved production and post-harvest handling practices to expanded marketing efforts. Given the budgetary constraints faced by countries in the region, *a priori* determination of those commodities that have the potential to be economically viable is a critical element to ensuring that diversification initiatives are directed in the most efficient manner and achieve their stated goals.

In a usually data-poor environment, *ex ante* assessment of competitiveness is a difficult task requiring consideration of many factors. Quite often, potential competitiveness is gauged merely by analysing production cost in relation to market price or by making cross-country cost comparisons. While such measures provide insight into the private profit potential of a given crop, they can mask other fundamental factors which underlie economic viability. Indeed, factors such as infrastructure and institutional characteristics that underlie market access also play a critical role in the ultimate success of agricultural diversification initiatives.

Mindful of the importance of these factors, this study utilizes an alternative approach for assessing the *ex ante* competitive potential of minor tropical fruit. First, the domestic resource costs (DRC) are computed in order to assess the foreign exchange earning/saving potential for each crop under investigation. This measure provides a direct comparison of the economic value created through production of a given crop and that which would otherwise be obtained should resources be devoted to an alternative activity. By using data which are adjusted to remove price distortions arising from policy measures such as tariffs, quotas and other border measures, the DRC reveals the underlying sources of competitiveness often concealed by traditional cost measures. Indeed, while a commodity may appear to be profitable on the basis of actual cost and market prices, and hence a gross earner of foreign exchange, when the market distortions reflected in these prices are disentangled, it is quite possible that a net loss of foreign exchange may result.

While the DRC provides insight into the potential foreign exchange earning/saving ability of a given crop, it is not sufficient by itself to determine the potential viability of a given crop. Additional analysis of the operational and institutional characteristics of regional and international markets must also be performed in order to determine the potential for successful entrance or product expansion by Caribbean producers. In this regard, assessments of existing infrastructure to support expanded intra-regional and international trade are critical.

The paper is organized as follows: Section 1 provides an overview of broad historical trends in the US market for fresh speciality commodities, in general, and tropical fruits and vegetables, in particular. In Section 2, basic trends and characteristics of world tropical fruit juice and pulp markets are summarized. Following these general sections are individual analyses of the competitive potential of each of the commodities under investigation. These analyses present the estimated DRC for each crop, analyse regional and international markets and provide an overall assessment of competitive potential. The final section of the paper presents the study's conclusions.

1. General Trends in the US Market for Speciality Commodities

The US is the world's largest and most sophisticated country market for fresh horticultural products. Beginning in the 1980s, and driven by an increase in the health consciousness of American consumers, consumption of fresh fruits and vegetables has increased substantially. While this increase in consumption has been broad based, the increase in the shipments in the product category defined as 'speciality commodities' or simply 'specialities' has been especially dramatic.

Specialities are generally characterized by low market volumes, relatively high values, and a perception of being unique or unusual to US consumers. In this class of commodities are speciality lettuces and greens, various herbs, oriental commodities (e.g. bean sprouts, bok choy, etc.) and tropical fruits and vegetables. Within the tropical fruits and vegetables category are such crops as breadfruit, pumpkin, chayote, dasheen, gingeroot, malanga, yam and yucca.

While the primary focus of this study is West Indian cherry, cashew, golden apple, guava and soursop, it is important to realize that the specific markets for these products are influenced by the market trends for specialities in general, and the tropical fruits and vegetables in particular. As evidenced by Figure 1, shipments of speciality commodities to the US market over the past 14 years have increased substantially, rising from about 160 million kg in 1979 to over 7.7 million kg in 1992. It is also apparent that the rate of increase in shipments rose considerably after 1984. Of special significance is the fact that the share of *imported* speciality commodities has accounted for the majority of this increase.

The contribution of tropical fruits and vegetables to the increase in shipments of speciality commodities is noteworthy. As shown in Figure 2, from 1980 to 1987 the market share of speciality crops attributable to tropical fruit and vegetables averaged around 2% per year. Since 1987, however, the market share of these commodities increased dramatically to a 1992 level of 20 %. The importance of the growth in tropical fruits and vegetable shipments takes on added significance when it is considered in light of the fact that US production of commodities in this product category is negligible.[1] Indeed, as shown by Figure 3, the share of US imported specialities attributable to tropical fruits and vegetables, which averaged between 7 and 9% over the 1980 to 1987 period, now accounts for well over 50%.

It is difficult to determine whether or not the increase in the demand for specialities will continue. There is however, some evidence to suggest that it will. First, the bulk of demand for these commodities has come from the food service industry; primarily upscale restaurants experimenting with nouvelle and other types of innovative cuisine. While this is serving to increase consumer awareness of these commodities, penetration to the more general consumer market remains low, with perhaps the exception of the state of California. However, a recent consumer survey published by the *Packer* indicated the existence of considerable consumer interest in these products. With a continued presence on restaurant menus and improved product availability, consumer interest and awareness should increase with a resulting commensurate increase in demand. Marketing efforts by innovative firms, such as Freida's Finest, to educate consumers on product use will further enhance consumer awareness. Given the current low levels of penetration of tropical fruits and vegetables in traditional consumer markets, the potential for expanded demand appears substantial.

Consequently, once this demand growth continues,

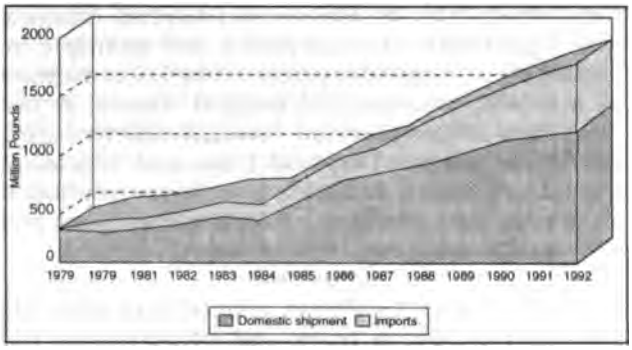


Figure 1: Domestic and import shipments of specialities to the US market

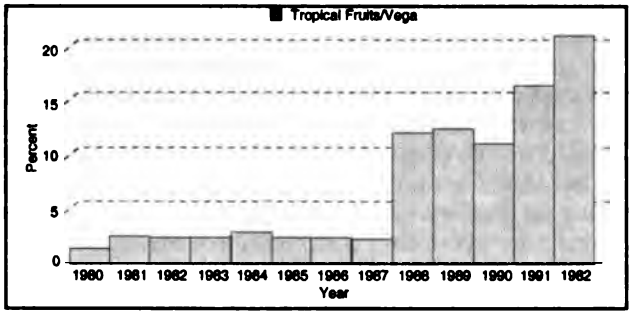


Figure 2: Market share of tropical fruits and vegetables

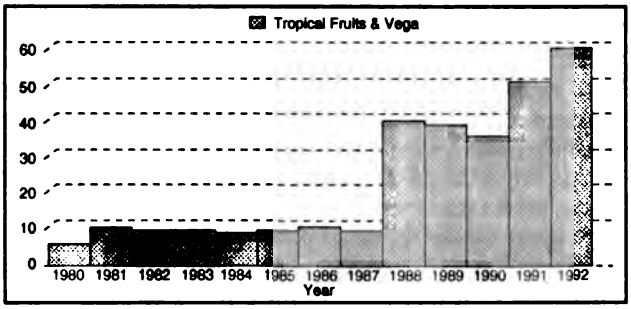


Figure 3: Tropical fruit and vegetable shares of US speciality imports

there appears to exist some potential for Caribbean countries to successfully penetrate the US market for certain tropical fruits and vegetables. This market is characterized by small volumes and high prices and, as such, it is amenable to the small-scale production that is typical of most Caribbean countries. Furthermore, the use of air shipment, perhaps the most adequate transportation system presently available to regional producers, can be justified on economic grounds given current market prices and likely export volumes.

It is important to realize, however, that while this potential for Caribbean countries to successfully enter US markets for tropical fruits and vegetables exists, competition for these markets from both domestic and other foreign suppliers is keen. This suggests that it is not sufficient to think merely in terms of selling these products, but rather they must be actively marketed. In this regard, Caribbean countries have an implicit advantage over potential

[1]It should be noted that the US does produce significant quantities of certain tropical fruits such as avocado. However avocado, like mango and papaya, are not considered to be speciality commodities due to the magnitude of consumption.

competitors such as Mexico and Central America. The Caribbean, as compared for example to Guatemala, is generally perceived by US consumers as a region comprised of tropical islands. Active marketing efforts directed towards differentiating Caribbean produced tropical fruits and vegetables should be pursued by building on this perception. If successful, such marketing efforts will enhance and help sustain the competitive position.

The potential of Caribbean countries to enter US markets for tropical fruits and vegetables is also significantly impacted by enterability restrictions. Gaining enterability status is a complex, lengthy, and often frustrating process. Even though the economic data may suggest competitive advantage and hence the potential for market entrance exists in theory, the capacity to achieve enterability status for the US for commodities not currently enjoying such status should not be presumed. In this regard, it should be noted that Grenada and St Vincent, which possess 'fruit fly free' status, enjoy a significant competitive advantage over other competing countries.

2. World Markets for Tropical Fruit Juices and Pulp

Data on markets for processed tropical fruit products are limited. However, a recent study by the United Nations International Trade Centre (ITC), provides a useful description and assessment of these markets. According to the ITC study, world imports of tropical juice products were valued at over $3.6 billion in 1988. As shown in Figure 4, orange juice represented the largest category with imports valued at about $2.3 billion. Imports of 'other juices', which include tropical fruit juices, were the second most significant with a value of $90 million.

According to the ITC, the major consuming markets are the industrial nations in Europe and North America. When considering all fruit juices, in which trade is dominated by citrus, the major consuming nations are the US, Germany, the Netherlands, UK and Canada. If attention is focused only on tropical products, the major importing nations are much the same with Germany, France, Switzerland, the Netherlands (for re-export), the UK and US representing the major consuming markets. It should

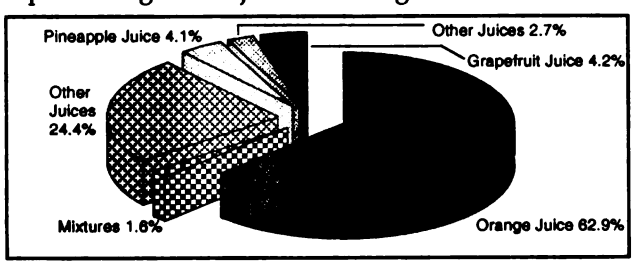


Figure 4: World distribution of tropical fruit juice and pulp imports

be noted, however, that the Commonwealth of Independent States (the former Soviet Union) appears to have the potential to develop into a significant market.

Tropical fruit and pulp, excluding citrus, are exported from numerous countries, most of which are classified as developing countries. Major exporting countries include Brazil, Mexico, and Argentina. One notable exception, however, is Israel which has recently developed a significant mixed fruit juice industry using tropical fruits such as passion fruit, guava and papaya.

The market outlook for tropical fruit juices and pulp is somewhat mixed. Many markets have experienced modest demand increases resulting from promotion activities by beverage industries. This activity has been partially spawned by the increase in travel to tropical destinations and the commensurate increase in consumer exposure to tropical products. The likelihood of substantial increases in demand is tempered, however, by a lack of consumer awareness and the fact that many tropical fruit juices offer tastes substantially different (e.g. cashew juice) from usual consumer preferences. This creates a significant marketing challenge to those seeking to expand markets for new tropical juice products.

West Indian Cherry

The West Indian cherry (*Malpighia glabra* L.) is a member of the Malpighiaceae family. Other common names for the fruit include Barbados or native cherry, acerola and semeruco. Though cherries may be consumed in their fresh state, they are primarily used in agroprocessing. Major commercial uses include preparations and purees as well as being used dried and frozen for juice, syrup, jams and jellies, baby foods and wine. The juice from the fruit is also used as an additive to other beverages to increase vitamin C content and improve flavour.[2]

The fruit is widely cultivated in the tropics and subtropical regions of Asia and Africa. Major producing countries include Australia, Israel and the Philippines. Major producing countries within Latin America and the Caribbean include Brazil, Guatemala, Jamaica, Guyana, Suriname and Venezuela. There are no large commercial plantings in this region with the exception of a 200-ha establishment in the Commonwealth of Puerto Rico. West Indian cherries are also grown on a limited scale in Florida and Hawaii. Estimated area in Florida is 10 ha. The fruiting season for cherries is dependent

[2]It should be mentioned that the largest market at present is Japan. THe Japanese have tried for several years to establish production in the Caribbean for their own market, without any success. They have now gone to Vietnam. (Personal communication of ITC staff members/EDC Workshop in Port of Spain, 1993.)

on climatic conditions. For example, in Latin American and the Caribbean peak production usually occurs in May, with smaller intermittent production continuing until December. However, Guyana and Suriname do exhibit different seasonal production patterns.

Domestic Resource Cost

Figure 5 presents the estimated DRCs for West Indian cherry production. Based on these estimates, cherry production does not compete favourably with other domestic activities in any of the four countries investigated. For cherry production to become competitive with other domestic activities, producers in Barbados must realize increases in yield of 17%, while yield increases of 13, 9 and 6% are required for producers in St Lucia, Grenada and St Vincent, respectively.

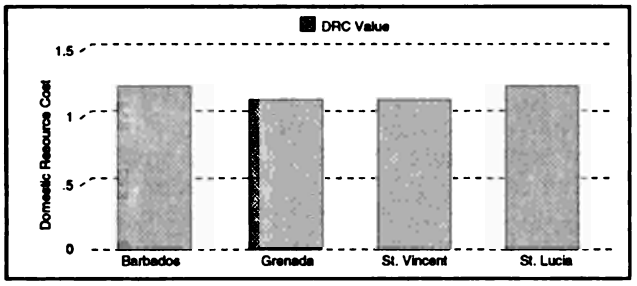


Figure 5: Domestic resource cost — West Indian cherry

Alternatively, it should be noted that a 10% increase in export prices would result in the estimated DRCs declining below the threshold value of one for all countries investigated. Under this scenario, the cost of US$1.00 in export earnings from cherry production would be only BDS$1.82 for producers in Barbados, EC$2.16, $2.35 and $2.08 for producers in St Lucia, Grenada and St Vincent respectively. Comparison of these values with current exchange rates indicates that given such increases West Indian cherry production would yield net foreign exchange earnings.

Competitive Assessment

Given the limited attention accorded research, development and extension efforts for West Indian cherries, substantial improvements in production efficiencies and yield may be possible. It is clear that significant improvements in present production systems are required if Caribbean countries are to potentially establish viable production.

However, though market data are limited, those that exist suggest several factors likely to inhibit the competitive potential of the fruit in regional or international markets. First, the fruit is highly perishable, with storage limited to about 3 days. This severely limits the potential of West Indian cherries as a fresh commodity in all but very localized markets. Secondly, the major use of the fruit has been in processing due to it its extremely high ascorbic acid content. However, the development of low-cost, synthetically produced sources of crystalline ascorbic acid represents an impediment to expanded, if not continued, use of the fruit in processing.

Cashew

The cashew, a native tree in tropical America, is found throughout the tropical regions of the world. Cashew *(Anacardium occidentale* L.*)* is a member of the Anacardiaceae family and is also known as marañon, cajuil and caju. Though the most valued product of the cashew tree is the cashew nut, a market also exits for the cashew apple, the swollen stalk to which the nut is attached.

Cashew Nut

Cashew nuts are generally used in fresh or dried form, but they are also processed for use in candies and baked goods. The oil from the cashew shells, CNSL (cashew nut shell liquid), has economic significance as a commercial waterproofing agent and preservative. Major producers of cashew nuts include Brazil, India, Mozambique, Tanzania, Indonesia and Kenya.

The Dominican Republic has established extensive commercial orchards and the appropriate agro-processing facilities to support a viable industry. Within the Caribbean, the economic potential of this high priced nut has stimulated intereSt Small-scale plantings have been established in Jamaica, and wild cashews are reported to exist in Guyana and Belize. Plantings of pure-stand plots of cashew trees have also been reported in Trinidad, Dominica, St Lucia and Montserrat.

Domestic Resource Cost

Cost data for cashew production that may be considered reliable were obtained only for Grenada. As shown in Figure 6, given the current

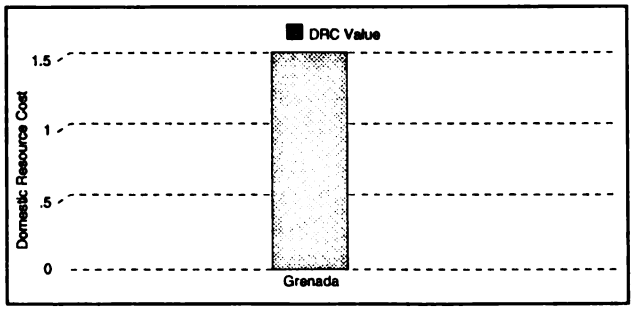


Figure 6: Domestic resource cost — cashew

level of technology, cost structure and prices, the DRC estimate of 1.55 indicates that cashew production does not compete favourably with other domestic production activities. The data reveal that presently cashew yields are low. Indeed, an increase in cashew yields of 30% is required for the DRC of this enterprise to reach the threshold value of one. This could come about both by the introduction of improved varieties and/or agronomic practices.

US Import Market

The US market for cashew nuts categorized as fresh or dried accounted for over 60% of the total value of US nut imports in 1992. As shown in Table 1, in that year, cashew nut imports totalled 61.0 million kg with a customs value of $259 million. Brazil and India were the leading exporters of cashew nuts to the US over the 1990 to 1992 period. Brazilian exports accounted for 42.5% of total world shipments of cashew to the US over this period, with US imports averaging 23.6 million kg with a customs value of $99.1 million. US imports from India over the 1990 to 1992 period averaged 22.6 million kg with a customs value of $108.5 million. The average share of the US market for India over this period was 22.6%. The dominance of Brazil and India is evident from the fact that the third leading source of cashew nuts, Mozambique, accounted for slightly over 5% of US imports over the 1990 to 1992 period.

US imports of prepared/preserved cashew nuts totalled 1.2 million kg in 1992 with a customs value of $4.7 million (Table 2). For these product forms, India and Brazil have also generally been the leading suppliers to the US market. However, shipments from both countries have declined over the 1990 to 1992 period. In contrast, Kenya and Mozambique have significantly increased shipments of prepared/preserved cashew nuts to the US market over this period. Kenyan exports of prepared/preserved cashew nuts to the US in 1992 totalled 738,100 kg, valued at $2.55 million. This represented 60.4% of total US imports. The US also imports cashew nut liquid. Over the 1990 to 1992 period imports of cashew nut liquid were reported from only two countries, Brazil and Indonesia. Total US imports of cashew nut liquid totalled 1.32 million kg with a customs value of $2.06 million in 1992. Imports from Brazil accounted for nearly 100% of all shipments over the 1990 to 1992 period.

Cashew Apple

In contrast to the nut, cashew apple, the swollen stalk to which the nut is attached, is highly perishable, spoilage beginning within one day at room temperature. While the cashew apple may be consumed fresh, it is also used in agroprocessing for juice, syrup, in the manufacture of wine, and in the preparation of stewed and candied preserves. Though Brazil and India are the largest producers of both cashew nuts and derivative products, neither country has devoted much attention to the marketing of cashew apples. As such, production of cashew for the export of the apple has become concentrated in Central America and the Dominican Republic.

Table 1: US imports of fresh cashew nuts by volume/value (1990–1992)

Country	1990			1991			1992		
	Volume (kg)	Value ($000)	$/kg	Volume (kg)	Value ($000)	$/kg	Volume (kg)	Value ($000)	$/kg
Total world	54,453,175	225731	4.15	49,449,217	243,882	4.93	61,068,220	258,640	4.23
Brazil	21,306,279	83,550	3.92	19,324,346	91466	3.73	30,193,384	122,101	4.04
India	23,686,676	105,961	4.47	21,047,387	111,128	5.28	23,169,270	108,651	4.69
Mozambique	3,102,490	10,329	3.33	2,690,307	10,992	4.08	3,290,339	10,787	3.28
Tanzania	959,973	35,521	3.70	1,013,805	4,638	4.57	932,983	3,327	3.56
The Netherlands	1,191,638	5,490	4.60	986,284	4,891	4.96	966,328	4,118	4.26
Kenya	275,020	856	3.11	1,047,703	1,695	4.48	559,072	1,849	3.31

Table 2: US imports of prepared/preserved cashew nuts (1990-1992)

Country	1990			1991			1992		
	Volume (kg)	Value ($000)	$/kg	Volume (kg)	Value ($000)	$/kg	Volume (kg)	Value ($000)	$/kg
Total world	910,813	4,130	4.50	743,525	3,727	5.01	1,220,859	4,703	3.85
India	486,420	2,247	4.62	439,638	2,475	5.63	35,2445	1,591	4.51
Brazil	254,041	1,131	4.45	83,937	465	5.54	32,228	129	4.00
Mozambique	15,876	70	4.41	45,541	216	4.74	63,504	257	4.05
Kenya	0	0	0	44,336	167	3.78	738,117	2,558	3.46
China	47,449	229	4.83	2,245	15	6.68	16,533	83	5.02

US Import Market

Imports of cashew apples (all in frozen form) into the United States have been reported since 1984. As shown in Table 3, total shipments of cashew apples into the US have exhibited a generally upward trend, increasing from 9,500 kg in 1984 to almost 32,000 kg in 1989. Guatemala and the Dominican Republic are the predominant suppliers to the US market. Shipments from the Dominican Republic enter south Florida ports, while primary ports of entry for Guatemala include Los Angeles, California and Houston, Texas.

Though imported in frozen form, US imports of cashew apples exhibit seasonality. As indicated in Figure 7, average monthly imports over the 1983 to 1989 period tend to peak in November and December. A secondary peak in imports is observed during March/April.

US import data also record imports of cashew apples as part of broader product groupings including both sapodilla and mameys. As shown in Table 4, total US imports of cashew apples/sapodilla have exhibited no clear trend over the 1990 to 1992 period. In 1992, US imports of this product aggregate totalled 510,100 kg with a customs value of $607,000. The major sources of US imports in this product category have varied over the 1990 to 1991 period. However, in 1992 the Dominican Republic was the leading supplier to the US market accounting for 67% of total US imports

As shown in Table 5, US imports of cashew apples/mameys amounted to 573,200 kg in 1992 with a customs value of $620,000. As with the cashew apple/sapodilla aggregate, the primary source countries of cashew apples/mameys for the US have varied. In 1992, the Dominican Republic was the

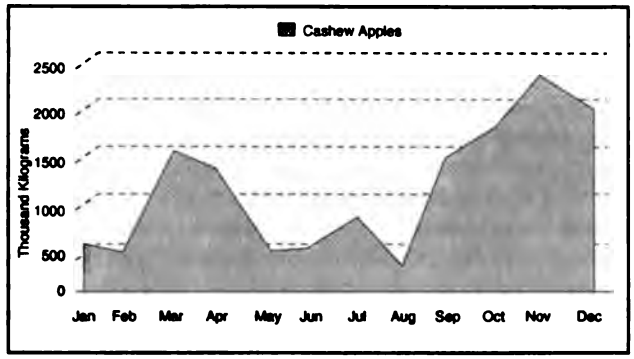


Figure 7: 1984–1989 average monthly US imports of frozen cashew apples

Table 3: US imports of cashew apples by selected countries 1984–1989

Country	1984		1985		1986		1987		1988		1989	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
Total world	9,543		7,389		16,150		5,855		8,249		31,732	
Dom. Republic	1,452	15.2	4,254	57.5	12,142	75.1	2,500	42.6	1,006	12.1	15,304	48.2
Guatemala	6,629	69.4	3,135	42.4	4,008	24.8	3,292	56.2	5,409	65.5	6,987	22.0

Table 4: US imports of cashew apples/sapodillas by volume/value, 1990–1992

Country	1990			1991			1992		
	Volume (kg)	Value ($000)	$/kg	Volume (kg)	Value ($000)	$/kg	Volume (kg)	Value ($000)	$/kg
Total world	495,148	558	1.13	401,980	419	1.04	510,140	607	1.19
Dom. Republic	110,310	147	1.33	47,460	59	1.24	341,918	409	1.2
Gualemala	248,233	241	0.97	88,915	82	0.92	0	0	0
Columbia	27,394	46	1.68	109,634	152	1.39	89,241	119	1.33
Venezuela	0	0	0	35,954	28	0.78	38,200	53	1.39

Table 5: US imports of cashew apples/mameys by volume/value, 1990–1992

Country	1990			1991			1992		
	Volume (kg)	Value ($000)	$/kg	Volume (kg)	Value ($000)	$/kg	Volume (kg)	Value ($000)	$/kg
Total world	858,082	915	1.07	937,927	926	0.99	573,250	620	1.08
Dom. Republic	571,529	599	1.05	775,867	727	0.94	402,160	421	1.05
Columbia	32,804	70	2.13	29,234	55	1.88	5,023	10	2.00
Peru	1,873	2	1.07	15,600	10	0.64	78,000	108	1.38
Venezuela	176,518	152	0.86	63,000	53	0.84	26,200	22	0.84

predominant supplier accounting for 70.1% of the total imports.

Competitive Assessment

The estimated DRC for cashew nut suggests that the crop does not compete favourably for domestic resources and, without significant increases in yield, will not generate net foreign exchange earnings. Furthermore, the potential of Caribbean producers (as represented by Grenada) of cashew nut and derivative products to establish a presence in the US market appears limited for several factors. First, the market is dominated by two major producers, Brazil and India, both of which have significant labor cost advantages over the Caribbean. Given the labour-intensive nature of the decortication process, it does not appear that Caribbean producers will be able to overcome the cost advantages held by Brazil, India or even Mozambique. Nevertheless, it should be noted that mechanical decortication is possible and this may present an opportunity for regional producers to compete on the basis of coSt A second factor limiting the competitive potential of the Caribbean is the low volume of production likely to emanate from the region. The substantial volumes that Brazil and India provide suggest access to the US market may pose a challenge for small Caribbean producers.

The prospect for cashew apples is similar. As illustrated by US import data, the Dominican Republic is already a significant supplier of frozen cashew apples to the US market. However, as demand for cashew apple in the US market is ethnic based, substantial consumption increases are unlikely in the absence of significant product promotion efforts. The inroads that the Dominican Republic and Guatemala have already established in the US market in combination with the slow demand growth convey a competitive advantage to these two countries which other Caribbean nations are likely to find difficult to overcome.

Golden Apple

A close relative of the mango, the golden apple (*Spondias cytherea* Sonn.) is a member of the Anacardiaceae family. Other common names for the fruit include ambarella, june plum, and pomme cythere. While the golden apple is primarily consumed in its fresh state, it also has potential for agroprocessing. Processed product forms include stewed or canned golden apples as well as use of the pulp in additives and bases for beverages, sherbets, relishes, jams and jellies.

Golden apple is widely cultivated throughout the world. Significant production occurs in Malaya, India, Ceylon, Vietnam and Thailand. In the western hemisphere, the fruit is cultivated throughout the Caribbean, and in Suriname and Venezuela. However, there is limited commercial production in these regions, with mixed cropping and 'backyard plantings' typifying most production schemes. Some minor plantings of golden apple have been reported in Hawaii and south Florida. However, there is no commercial production in the US.

Within the Caribbean, the harvest season generally runs from August through November with peak production in September and October. Primary markets for golden apple are ethnic, comprised of West Indians and Asians familiar with the product. Lack of consumer knowledge among non-ethnic groups, confusion created by the fruit name and differences with the traditional apple to which North American and European consumers are accustomed, create significant marketing challenges for expanding market demand in Europe and the US.

Domestic Resource Cost

The estimated DRCs presented in Figure 8 indicate that golden apple production appears to have potential in all of the countries investigated. While St Vincent has the lowest DRC estimate, 0.30, Dominica and Grenada also have favourable DRCs of 0.46 and 0.49, respectively.[3] It should be noted that despite the fact that St Vincent has a lower estimated DRC, typical yields in Grenada are 10% above those observed in St Vincent. This underscores the diverse nature of the factors (shadow prices, yields, technical production coefficients, etc.) which affect the net foreign exchange earning/saving ability of a crop. The estimated DRCs are particularly encouraging given the high harvest and post-harvest losses (about 30%) currently realized. Attention to this constraint as well as to propagation of plants which are shorter and more manageable could further enhance the economic viability of this crop.

Trade

Due to the extremely small volumes of golden apples

[3]Dominica was included for comparison purposes only, since golden apple is in general not a major crop in that country. The lower limit of yield levels based on the fifth year of production along with the technical coefficients from Grenada have been used in the analysis for Dominica.

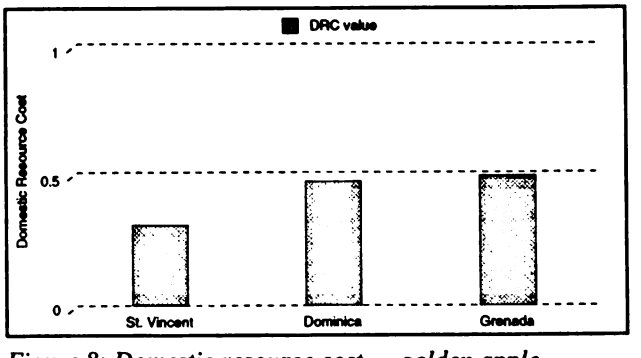


Figure 8: Domestic resource cost — golden apple

entering regional and extra-regional markets, trade data on Caribbean shipments of the fruit are limited. Besides some national statistical publications, which periodically report agricultural commodity exports, including the exports of golden apple, the only other known source appears to be a recently completed OECS/ADCU report on OECS exports. Table 6 shows that total exports of golden apples from the OECS declined over the 1988 to 1990 period. Over this period, Grenada was the principal OECS exporter of golden apples, accounting for more than 96% of total shipments. However, it should be noted that in 1990, exports from St Vincent declined substantially, while those from St Lucia increased. The principal destination for these shipments was Trinidad and Tobago, which in 1991, imported 29,620 kg and 91,605 kg from Grenada and St Vincent, respectively. However, St Vincent also shipped small quantities to Barbados and the UK. Shipments from St Kitts went to the US Virgin Islands, while St Lucia reported exports to Canada.

Additionally, a recent study by Antoine, reported exports of about 635,000 kg in 1991 to the UK and US. Additional unpublished trade data suggest that between 1988 and 1991 golden apple exports from Grenada exceeded those from St Vincent. Prior to 1989 however, the data indicate that St Vincent was the only country in the OECS with significant exports of this product.

Competitive Assessment

The estimated DRCs suggest that golden apple production has the potential to compete favourably for domestic resources and that both Grenada and St Vincent could potentially benefit from exports of this commodity. For Grenada, earning US$1.00 of foreign exchange requires the expenditure of only EC$1.32 considerably less than the exchange rate of $2.70. In the case of St Vincent earning US$1.00 of foreign exchange requires the expenditure of only EC$0.81.

The scant data that exist on golden apple suggest that, while some exports of golden apples to external markets are occurring, the potential for Caribbean producers to substantially expand exports to these markets may be limited. This conclusion stems from the fact that the product has low consumer awareness in external markets, plus the fact that production volumes likely to originate from the Caribbean may not be of sufficient magnitude and consistency to attract the interest of import brokers beyond present levels. However, there does appear to exist some potential to develop commercially viable production through expanded intra-regional trade especially as regards agroprocessing. As shown above, some intra-regional trade currently exists, and the potential for expanding this trade appears to exiSt However, for this to occur, improvements in post-harvest handling practices are needed to reduce the current high loss rates.

Guava

Guava (*Psidium guajava*) is a member of the Myrtaceae family. Other common names for the fruit include guayaba, guyava, and kuawa. Although guava may be consumed in fresh form, its predominant use is in agroprocessing. Major commercial uses of the fruit include processing into paste, jams and jellies, and as a flavouring additive in juice products.

Guavas are cultivated throughout the tropical and subtropical regions of the world. Major producing countries include Mexico, Brazil, India, New Zealand, the Dominican Republic, Cuba and Thailand. Guavas are also produced on a very limited scale in Florida and Hawaii. Brazil, India and Mexico have developed significant processing industries for guava.

Within the Caribbean, guava trees constitute one of the largest tropical fruit-tree populations. However, with the exception of the Dominican Republic and Puerto Rico, which have a few commercial plantings, most production originates from wild tree stands.

Domestic Resource Cost

As shown in Figure 9, the DRC estimates for guava production were greater than unity in all four of the countries investigated. In the case of Grenada and St Vincent however, the DRC estimates of 1.05 and 1.03, respectively, suggest guava production in both countries would require relatively modest efficiency improvements (even with the wild tree stands) in order to be competitive with domestic resources. The favourable DRC estimates for Grenada and St

Table 6: OECS exports of golden apples by selected countries 1988–1990 (kg)

Country	1988	%	1989	%	1990	%	Total	%
OECS	79,050		252,774		228,878		559,702	
Grenada	58,334	73.8	249,641	98.8	227,271	99.7	535,246	95.7
St Vincent	20,716	26.2	2,782	1.0	42	0.18	23,540	4.2
St Lucia	0	0	341	0.1	565	0.25	906	0.16
St Kitts	0	0	10	0.004	0	0	10	0.002

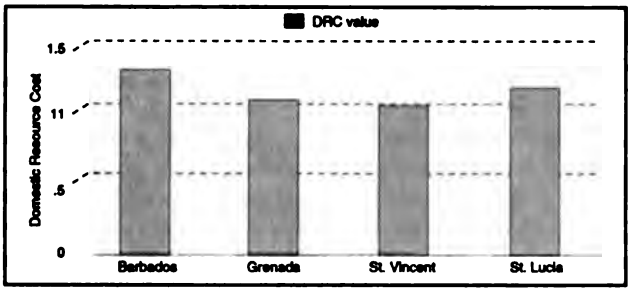


Figure 9: Domestic resource cost — guava

Vincent are explained in part by the lower structure of costs in these two countries than in either Barbados or St Lucia, where the level of technology employed in guava production remains quite low.

Using base yields ranging between 15,000 and 20,000 kg/ha, should marketable yields increase by approximately 10%, the estimated DRC would be less than the threshold value of one for all countries except Barbados. Even for Barbados, the DRC estimate declines significantly to just over one (1.03). This indicates that if the improved production and post-harvest technologies were to be successfully applied to guava, the crop would have the potential to generate net foreign exchange earnings.

The US Import Market and Intra-regional Trade

Due to the limited amount of fresh product trade, data specific to guava are limited to frozen product forms. Data on other processed product forms such as jams and other preparations are generally aggregated into broader product classifications. As shown in Table 7, US imports of frozen guava have been highly variable over the 1984 to 1989 period. Imports peaked in 1984 at about 240,000 kg, then declined dramatically in the following year. After some moderate increases in 1986 and 1987, imports again declined in 1988 before increasing to almost 110,000 kg in 1989.

This volatility is mirrored by the variation in major sources of supply to the US. In 1984, Mexico was the predominant source of US imports accounting for over 79% of the frozen guava imports. However, over the 1985 to 1988 period, Mexico's share of the US market averaged less than 2%. In contrast, the Dominican Republic, from which there were no reported shipments of frozen guava in 1984, accounted for about 44% of US imports in the following year. In 1986, once again no imports were reported from the Dominican Republic. However, in 1987 and 1988, the Dominican Republic was again the predominant supplier to the US market, accounting for 62% and 72% of US imports, respectively. In 1989, Mexico regained its position as the major supplier of frozen guava to the US market with an import share of 38%, while Brazil emerged as a significant competitor accounting for 37%. In contrast, the Dominican Republic accounted for less than 2% of total US imports.

As demonstrated in Figure 10, US imports have been highly seasonal. Average monthly imports over the 1983–89 period exhibited a peak during December and January, with a secondary peak in April. It appears this seasonal pattern is related to product availability, prices and inventory decisions of US processors.

Some additional data on guava exports from the OECS are reported in Table 8. Exports totalled 3,107 kg over the 1988 to 1990 period. Though St Lucia was the largest exporter over this period, volumes have been small, with neither Dominica, Antigua nor St Lucia exhibiting a consistent pattern of exportation.

Competitive Assessment

The estimated DRCs for guava production suggest that, with the current levels of technology, including

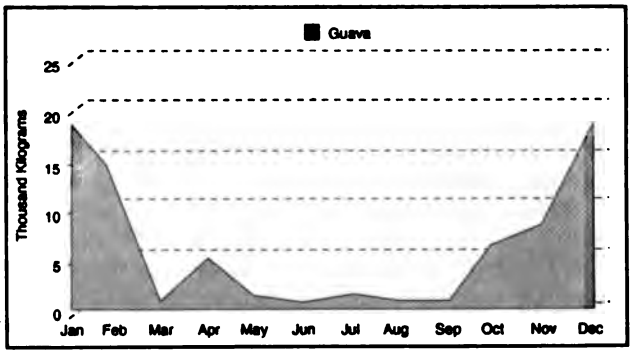


Figure 10: Seasonal US imports of frozen guava

Table 7: U.S. imports of guava from selected countries 1984–1989

Country	1984		1985		1986		1987		1988		1989	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
Total world	239,918		28,153		54,432		65,548		17,109		109,631	
Mexico	190,847	79.5	0	0	1,773	3.2	0	0	1,189	6.9	41,777	38.1
Dom. Republic	0	0	12,487	44.3	0	0	40,902	62.4	12,258	71.6	1,734	1.6
Brazil	4,950	2.1	0	0	0	0	19,431	29.6	0	0	40,040	36.5
Thailand	0	0	25	0.089	5,782	10.6	4,750	7.2	1,254	7.3	136	0.12
New Zealand	0	0	0	0	36,375	66.8	0	0	327	1.9	0	0
Colombia	0	0	20	0.071	334	0.61	368	0.56	250	1.5	0	0

Table 8: OECS exports of guava by selected countries, 1988–1990

	1988		1989		1990	
Country	kg	%	kg	%	kg	%
Total OECS	799		29		2,279	
St Lucia	0	0	0	0	1,622	71.2
Dominica	32	4.0	0	0	657	28.8
Antigua	767	96.0	0	0	0	0

general non-use of improved varieties, none of the countries investigated has the potential to generate net foreign exchange earnings. However, the estimated values are quite sensitive to variations in both yields and labour costs. In fact, with modest improvements in efficiency, it appears that guava production can compete favourably for domestic resources in both Grenada and St Vincent.

In spite of the relatively favourable DRC estimates, the competitive potential of the Caribbean in the US market appears limited. As witnessed by the data in Table 7, the variation in major supplying countries to the US market suggests a high degree of competition. Given the volumes of guava likely to originate from the Caribbean (other than the Dominican Republic and Cuba) in relation to those supplied by countries such as Mexico and Brazil, it appears that market access could represent a major impediment.

However, the Caribbean may have some potential to supply the US market with processed guava products, such as, jams and jellies. This, however would require the development of agroprocessing facilities and expanded intra-regional trade to ensure product volumes sufficient to capture attendant economies of scale.

It should also be noted that, even with increased intra-regional trade, the volumes of processed guava products from the CARICOM Caribbean, are still likely to be relatively small. As such, marketing efforts directed at developing strong product differentiation for 'Caribbean produced' jams or jellies are critical. An excellent example of this marketing approach, and one which has had some measure of success is that associated with Caribbean produced pepper sauces which are finding a market in the US Additionally, the industry in these countries will have to be modernized with the introduction of appropriate and improved technology.

Soursop

Soursop (*Annona muricata*) is a member of the Annonaceae family. Other common names for the fruit include guanábana, huanaba, zapote de viejas, cabeza de negro, or catoche. Though consumed in fresh form, soursop is widely used in agro-processing. Principal processing uses are for juice and as a flavouring in mixed fruit beverages and frozen dairy products.

Soursop is cultivated throughout the tropical world. In Latin American and the Caribbean, soursop is found in abundance in several countries including the Dominican Republic, Puerto Rico, Venezuela, the Bahamas, Colombia, and Brazil. In the US, the soursop has been grown to a limited extent in Florida and Hawaii. However, there is currently no commercial production.

Domestic Resource Cost

As illustrated in Figure 11, the estimated DRCs for both Grenada and St Vincent are less than one. In contrast, the estimated DRC for St Lucia of 1.56, suggests that given the present level of technology, structure of costs and prevailing prices, the resources employed in the production of this commodity may have more profitable alternatives elsewhere in the economy. However, it should be noted that while soursop production in St Lucia is not presently competitive with other domestic activities, the improvements in yield required to bring the DRC estimate below one is only about 10%.

US Import Market

Due to phytosanitary restrictions, US imports of soursop are limited to frozen product forms. Principal destinations for frozen soursop exports are New York, Miami, and Port Everglades, Florida. As shown in Figure 12, US imports of frozen soursop, though exhibiting some degree of variability, have increased over the 1983 to 1989 period. From 1983 to 1986, imports sharply increased from 47,200 kg to almost 290,000 kg. In 1987, imports declined sharply to 110,400 kg before rebounding to about 142,000 kg in 1989.

As illustrated in Table 9, the Dominican Republic is the dominant supplier of frozen soursop to the US market. Over the 1983 to 1989 period, the Dominican Republic accounted for more than 90% over total US

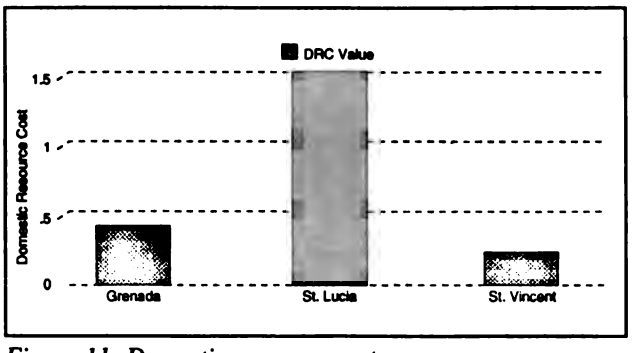


Figure 11: Domestic resource cost —soursop

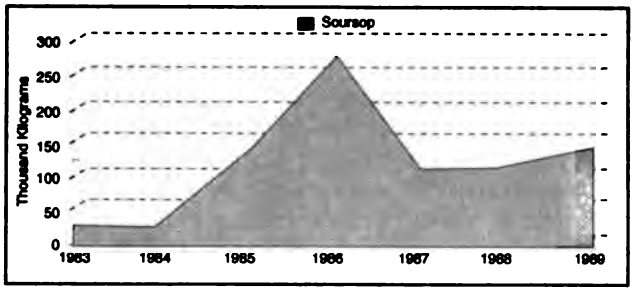


Figure 12: US imports of frozen spoursop

imports in every year except 1986, when it accounted for only 86%. However, though its share of the US market declined in that year, the volume of US imports from the Dominican Republic in 1986 was more than double any other year over the 1983–1989 period. The Dominican Republic also supplied the Puerto Rican market with shipments averaging 6,300 kg per year over the 1983 to 1989 period.

Though imported in frozen form, US imports of soursop exhibit several seasonal peaks. As indicated (Figure 13), peak imports of frozen soursop over the 1983 to 1989 generally occur over the February to March period. However, US imports exhibit secondary peaks in December and July.

There are limited data on exports of soursop (all product forms) from the OECS reported by Nurse. Between 1988 and 1991, total shipments from the OECS were 45,300 kg with a customs value of EC$55,747. St Lucia was the major exporting country accounting for 98% of total shipments. The primary export markets for St Lucia were Canada, the UK

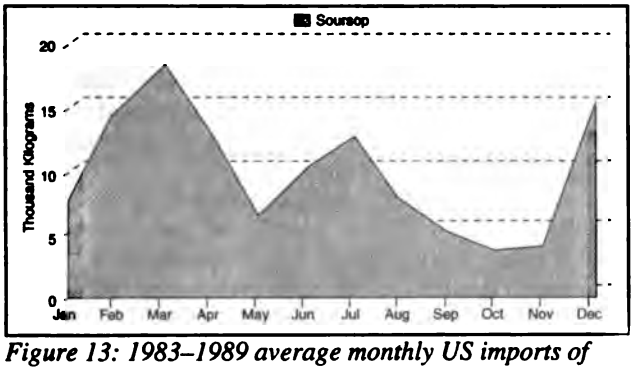


Figure 13: 1983–1989 average monthly US imports of frozen soursop

and US Some intra-regional exports of soursop were also reported from Dominica. In 1991, Trinidad and Tobago imported 167,370 kg of soursop from Grenada.

Competitive Assessment

Utilization of soursop in the US market is primarily as a flavouring agent in tropical juice drinks and frozen dairy products. Although the US imports of frozen soursop to support these uses have generally increased over the 1983 to 1989 period, it does not appear that substantial increases in US consumption of products using soursop are likely. As such, the competitive potential of other Caribbean nations in the US market must be judged on the basis of their ability to compete with the Dominican Republic which has historically been the predominant supplier of the US market.

Given the predominance of the Dominican Republic, which has consistently accounted for an average of almost 95% of US frozen soursop imports over the 1983 to 1989 period, the ability of other Caribbean nations to compete in the US market will represent a major challenge. The market linkages between the Dominican Republic producers and US importers are well established, and history demonstrates the ability of the Dominican Republic to provide virtually all of the US consumption requirements. As such, it does not appear that most other Caribbean nations are likely to gain access to the US market.

Conclusions

In rendering conclusions concerning the tropical fruits that have been the focus of the present analysis, several important factors must be reiterated. First, the goal of agricultural diversification in the Caribbean is to reduce the region's dependence on traditional agricultural exports as a source of foreign exchange earnings and employment. As such, one must not only address the issue of present competitive potential, but also the potential for sustained competitive presence in the market in the absence of substantive government support. Additionally, one must also consider the growth potential of non-traditional crops.While some crops investigated such as golden apple have found export

Table 9: US imports of soursop by selected countries, 1984–1989

Country	1984		1985		1986		1987		1988		1989	
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%
Total world	23,235		128,454		280,602		110,471		112,606		141,612	
Dom. Republic	22,901	98.5	121,890	94.8	242,468	86.4	107,893	97.6	104,611	92.9	131,808	93
Costa Rica	0	0	3,381	2.6	641	0.02	155	0.01	7,411	6.5	9,804	7
Venezuela	0	0	3,183	2.4	36,434	12.9	0	0	0	0	0	0

markets, it is not clear that considerable expansion of these markets is likely. Hence, while production of this crop affords some increase in foreign exchange earnings, its magnitude may be insufficient to provide a viable alternative to traditional exports.

The crops considered in the present analysis may be utilized in both fresh and processed form. As such, conclusions regarding potential competitiveness must be made for each of these two markets. Similarly, regional and extra-regional markets, due to their differing institutional and operational characteristics, must be considered separately.

The US market for fresh tropical fruits has grown rapidly. However, with the notable exception of golden apple produced in Grenada and St Vincent, the potential for Caribbean producers to compete in this market appears limited, unless the industry is restructured and modernized. There are numerous factors supporting this conclusion. First, is the fact that the low and sporadic volumes likely to originate from the Caribbean make market access questionable. Market access is made further difficult by the substantial production capacities of both Central America and the Dominican Republic and their ability to provide consistent product supply to the US market. Finally, with the exception of Grenada and St Vincent, producers in the Caribbean face phytosanitary restrictions that effectively close the US fresh market for many of the soft fruit considered here.

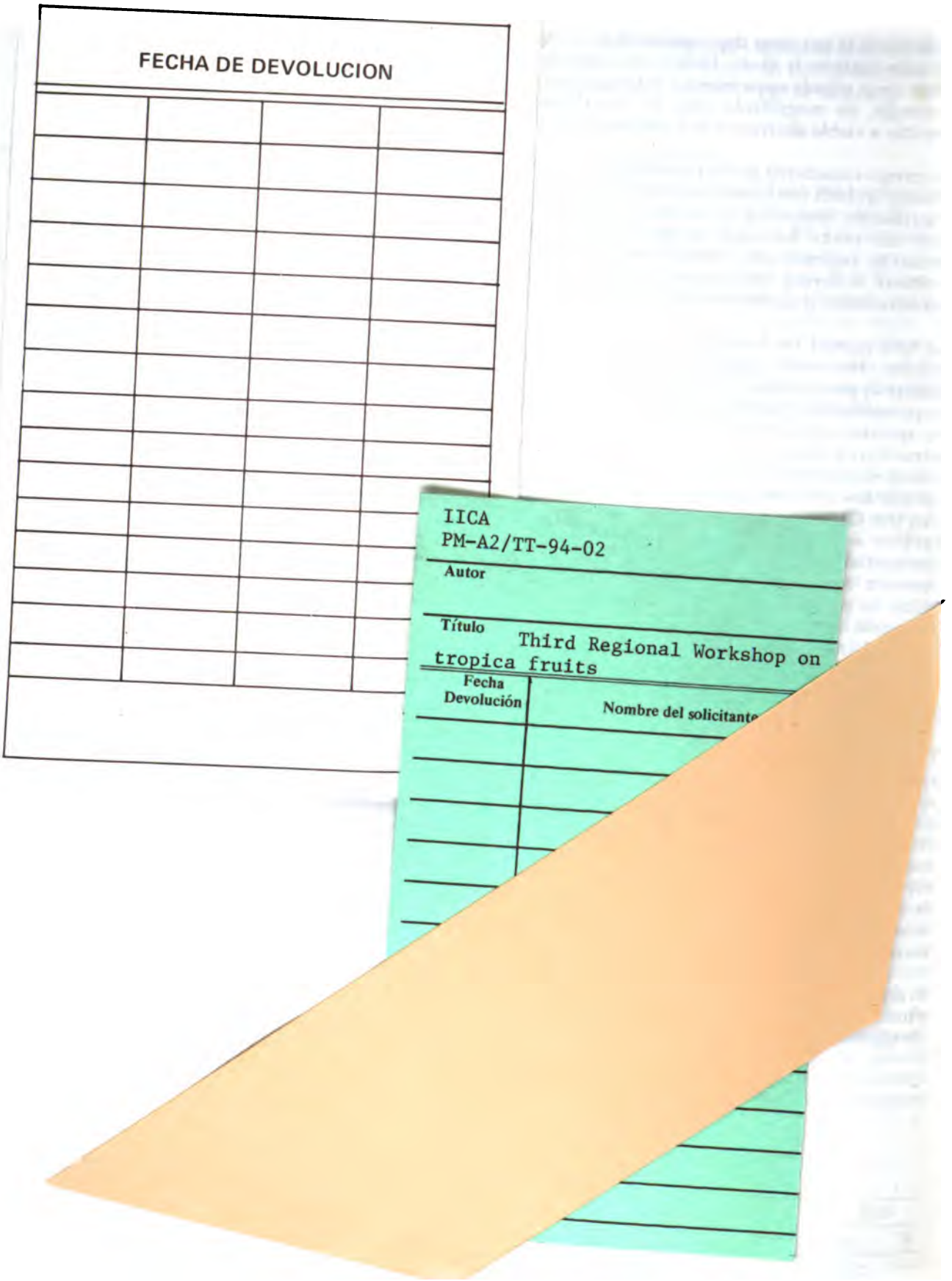
The potential for expanded intra-regional trade appears to exist for certain crops such as golden apple, guava and soursop. A large potential market, generated in part by the tourism sector, exists. However, for expanded trade to occur, improvements in intra-regional transportation infrastructure, especially maritime transport and cold storage facilities are critical if the volumes, quality and reliability of supply required by the market are to become attainable.

In assessing the general competitiveness of Caribbean producers for processed products it is necessary to divide the market into two segments, tropical juice concentrates and pulp, and value-added products. There appears to be very little potential for Caribbean producers to compete in external markets for tropical juice concentrates and pulp. At present external markets for these products are not expanding significantly. This, in combination with the existing supply capabilities of large producers in Central and South America, as well as in Asia, have resulted in very competitive markets. Given the relatively small volumes likely to originate from the Caribbean, and the lack of product differentiation in concentrate and pulp markets, the region is at a considerable competitive disadvantage.

However, the competitive outlook for value-added products, such as, jams, jellies and other preparations, is more promising. There exists a small market for such products in the US and with increased product promotion in the tourism sector, increases in both regional and extra-regional demand are possible. It should be noted that the recent success of Caribbean pepper sauces in the US market serves as an example of the ability of Caribbean-based products to achieve product differentiation and develop market niches.

Development of a significant value-added product sector for tropical fruit products, will require the development of processing facilities that capture the necessary scale and scope economies to be cost competitive. Alternatively, efficient quality and specificity control facilities must be established to monitor production from cottage industries. This could be done in the context of a regional and/or national level.

Successful development of markets for value-added products will also require significant product promotion. Consumer awareness in external markets regarding tropical fruits remains low. As such, promotion strategies should be directed not only towards creating product differentiation on the basis of 'Caribbean produced', but also towards increased consumer awareness. Regarding the latter, increased utilization and marketing of such products to the tourist sectors would provide a natural platform from which to increase consumer awareness and intereSt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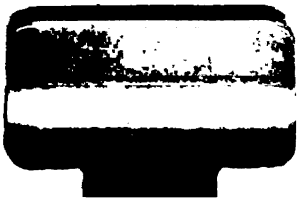


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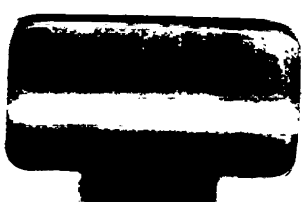

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