GRENADA

IICA

Ministry of Agriculture (MOA) and
Inter-American Institute for Cooperation on Agriculture (IICA)

A Preliminary Study on the Golden Apple (*Spondia dulcis*) Production and Marketing in Grenada

IICA OFFICE IN GRENADA

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A Preliminary Study on the Golden Apple (*Spondia dulcis*) Production and Marketing in Grenada

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PREFACE

The Golden Apple (*Spondia cytherea*) is a fruit crop hardly known outside our Caribbean region. However, and despite the fact that until recently there were not organized orchards and that the production came from scattered trees, this fruit escalated to be the second most important exported fruit from Grenada. Today the fruit is being exported both regionally, mainly to Trinidad and extra-regionally to the United States and Europe.

The availability of baseline information on production, harvesting and marketing on most tropical fruits in the region has been not only scarce but in many cases unreliable. However, the move towards the diversification of the Agriculture Sector, has imposed a demand for this type of data. The scarcity of data is even more noticeable when dealing with a minor fruit species such as Golden Apple.

The present effort is a proven product of how much could be achieved when inter-programme and inter-institutional cooperation is used towards the analysis of the commodity system of a crop with potential but with practically no records.

All participants should be praised for this effort and we at IICA feel that this exercise will establish the path to many other similar studies to come.

Guillermo Villanueva
IICA Representative for ECS

Rafael Marte
Head of the Project
"Supporting the Development of
Tropical Fruit Crops in the Caribbean"

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A special thanks goes out to the personnel of the Ministry of Agriculture's Agronomy, Extension, Plant Propagation, and Pest Management Divisions, in particular Mr. Cecil Winsborrow, Ms. Indra Baldeo, Mr. Paul Graham, and Mr. Everest Ferguson. Also, we are grateful for the assistance of Ms. Cynthra Persad of the Caribbean Agricultural Research and Development Institute (CARDI/Grenada). We have gained much from their knowledge of tropical agriculture and Grenadian farming.

We would also like to thank Grenada's many Golden Apple exporters for contributing valuable information toward the document, particularly Ms. Esther Whiteman-Greene, Mrs. Linda Baptiste, Mr. John Veichweg and all other personnel at the Marketing and National Importing Board (MNIB), and Mr. Paul Francis of Productive Farmers Union (PFU).

Our sincere gratitude is extended to the staff of IICA Office in Grenada: Mr. Cosmos Joseph, Mrs. Merril St. John, Ms. Agnes Williams, and Mr. Emery Thorne. Their excellent administrative and office support made our efforts not only efficient but also enjoyable.

A final thanks is conveyed to the U.S. Peace Corps Associate Director for Grenada, Ms. Gwendolyn Pelletier. Her unwavering concern for Grenadian people and their culture has made this a special cross-cultural experience.

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INTRODUCTION

Golden Apple (*Spondias dulcis*) is a native fruit of the Society Islands in the South Pacific, but it has been widely distributed around tropical regions of the world, including the West Indies[1]. Since its introduction into the West Indies, the Golden Apple trees have adapted well to many of the Caribbean islands including Jamaica, St. Vincent, and Grenada, where they are said to be as plentiful as the common mango trees. There are several factors attributed to their successful adaptation but perhaps one of the most important is the climatic and topographic similarities between the Society Islands and the West Indian islands. For instance, the Society Island of Tahiti and the West Indian island of Grenada can both be described as rugged mountainous volcanic islands with high levels of precipitation and warm year-round temperatures. Not surprisingly, the fruit trees have over the years become a natural part of the West Indian landscape, just as the fruits have become a natural part of the West Indian diet.

Although the Golden Apple has become one of the favorite fruits among West Indian consumers in general, it has received little recognition from the scientific community in the region. In fact, very little documentation exists on this unique fruit which takes its common name from the way it turns golden yellow as it ripens. A literature review has revealed that only a few scientific studies have been conducted in the region regarding the Golden Apple. Moreover, no cultivars have yet been officially described and named and little selection has been done of the fruit[2]. Apparently, the general lack of regional scientific interest in the fruit seems to be a reflection of its relative insignificance as a commercial crop for the farmers.

Until recently, most farmers in Grenada and the region had no interest in growing Golden Apple as a commercial crop and exporters were wary about marketing such an obscure fruit. Even today, almost all of the Golden Apple trees in Grenada are traditionally grown in "backyard" settings for household consumption or used by farmers as shade for their cocoa trees. Because of their obscurity and insignificance outside the region, the Apples were not considered to have much commercial value or export potential in extra-regional markets. As a result, vast quantities of fruits were never even harvested, resulting in large amounts of spoilage. While small quantities of fruits were being harvested and sold on the local open-air markets and an increasing supply was being shipped from Grenada and St. Vincent to Trinidad by hucksters and traffickers, most of the fruits were left to spoil on the ground. It was not until extra-regional export markets were established in the late 1980's that the Golden Apple gained any recognition.

Grenada, being one of two islands (the other being St. Vincent) in the region that maintains an official fruit-fly free status from the USDA, was able to penetrate the lucrative fresh-fruit market of the United States. Linda Baptiste, an experienced trafficker of fresh produce to Trinidad, began to ship small quantities of Golden Apple to Baltimore, Maryland in 1985 and became the first extra-regional exporter of Golden Apple from Grenada. After receiving favorable market responses on trial shipments to New York, the Grenada Marketing and National Importing Board (MNIB) also began exporting increased quantities of Golden Apple in 1988.

Despite the dismal 2,850 lbs. (1,280 kg) of total Golden Apple exports that year, an increasing number of orders gave clear indication that a potential export market existed for the commodity. In the following year, Productive Farmer's Union (PFU) also started shipping Golden Apple overseas which helped boost Grenada's total Golden Apple export volume to nearly 175,000 lbs. (78,750 kg). With total export volume reaching close to 400,000 lbs (180,000 kg) in 1990, it was quite evident that Golden Apple was fast becoming a major export crop for Grenada. Subsequently, the list of Golden Apple exporters grew to include numerous smaller operations, while the overseas market was expanded to include Miami, London, and Rotterdam. By the end of 1991, the fruit that was once thought to have no export potential had achieved an astonishing annual export volume totalling nearly 1.5 million pounds (675,000 kg) and in doing so, replaced mango as Grenada's leading non-traditional export crop[3].

It was in light of Golden Apple's dramatic rise as a major export commodity coupled with Grenada's overall effort to develop non-traditional

[1]Weir, et al. 1982
[2]Id.

[3]Non-traditional export crop refers to all export crops other than nutmeg, cocoa, and banana.

fruit tree crops in Grenada that this Preliminary Study was commissioned. In response to Ministry of Agriculture's request, U.S. Peace Corps Volunteers, Thomas Bauer and Joseph Kim, working under Inter-American Institute for Cooperation on Agriculture's (IICA) projects, "Supporting the Development of Tropical Fruits in the Caribbean" and "Strenghening of Farmers Organizations in the OECS", in collaboration with Indra Baldeo (Agronomy/ MoA) conducted the Study to investigate the present status of Golden Apple production and marketing in Grenada. This document presents information based upon preliminary investigations and research carried out from September 1991 to May 1993. The purpose of this document is to provide baseline, decision-making information on Golden Apple production and marketing, upon which further research and development can be carried out.

SECTION I: AGRONOMIC CONSIDERATIONS

PART I: BOTANICAL CHARACTERISTICS

1.1 Classification

Family: Anacardiaceae
Scientific name: *Spondias dulcis* Parkinson (formerly *Spondias cytherea* Sonn.)
Other names[4]:

English	—	Jew Plum, June Plum, Golden Apple, Yellow Mombin, Otaheiti Apple, Vi-apple
French	—	Pomme cythere, Prune de cythere
Spanish	—	Ambarella, Jobo de la India
Dutch	—	Fransi mope
Portugese	—	Caja manga

1.2 Tree Characteristics

Results from preliminary observations find that the average height of a young productive tree (below 6 years) in Grenada is 30 ft. (9 m) and 46 ft. (14 m) for a mature tree (6 years and above). Average trunk diameter of a young tree was 7.6 in. (19 cm) and 10 in. (25 cm) for a mature tree. Average canopy diameter of a young tree was 34 ft. (10 m) and 47 ft. (14 m) for a mature tree.

Definitive information on yields is not yet available. However, preliminary results from yields studies showed that average mature trees (ages 6 and above) can produce between 600 to 1,000 lbs (270 to 450 kg) of fruits. It has been observed that some mature trees can even produce up to 2,000 lbs (900 kg) or more in a season.

Leaves were observed to be compound pinnate with jagged edges. Branches were quite brittle and tended to break easily. Bark of trees was either corky or smooth in appearance and tended to vary by region. Fruit settings were in clusters consisting on the average of 4 to 8 fruits. Sizes and stages of maturity varied within a cluster. Commercial harvest of trees propagated from volunteer seedlings usually began around the 5th year and most trees continued to produce marketable yields up to 25 years of age and beyond.

1.3 Phenological Characteristics (see Appendix I)

It was generally oberved that leaf-drop occurs from December through February; bloom occurs from February to March; flush and fruit-set occur from February to April; and fruit development occurs from April to November.

1.4 Fruit Characteristics

a) Shapes and Dimensions: There were generally three prominent shapes that were observed: oval (the most common), round, and pear (the least common). Oval and round fruits tended to be the largest in size. The different shapes appeared throughout the island and the shape was usually uniform throughout a given tree. In general, an average fruit was 2.5 in. (6.3 cm) wide and 3 in.°(7.5 cm) long while its weight varied between 5 and 8 oz. (140 and 224 g) However, fruits have been observed to weigh as much as 1 lb. (450 g). A spiny fibrous seed is produced at the core of each fruit.

b) Shelf-life and Appearance (see Appendix III): In trials carried out during the Preliminary Study, unrefrigerated fruits took 6 to 9 days to go from full mature stage to full ripe stage, while refrigerated fruits took 12 to 19 days to go from full mature stage to full ripe stage. Bruises became very noticeable as fruits reached

[4]Weir et al., 1982.

full ripe stage. Brown and black spots developed on both refrigerated and unrefrigerated fruits as they reach the over-ripe stage. Refrigeration of fruits tended to somewhat tarnish the natural golden yellow color.

c) Brix (Sugar Content), Acidity, and Taste: Average Brix of shelf-ripened fruits in the Study was approximately 12.0 with a range of 10.0 to 21.0. Brix also varied within a given fruit, with a higher Brix reading being recorded in the center of the fruit as opposed to the area near the bitter skin. Mature green fruits had a Brix in the proximity of 8.0 to 9.0. Acidity ranged between 11.0 to 15.0 g/ml. Taste varied from acidic, tart, to sweet.

d) Chemical and Nutritional Composition[5]: The following is a breakdown of the chemical and nutritional composition:

Component	Quantity/100 grams of fruit	
Water	83.4	grams
Food Energy	64	calories
Protein	0.2	grams
Fat	0.8	grams
Carbohydrate	14.0	grams
Calcium	10	milligrams
Iron	1.0	milligrams
Vitamin A (Betinol)	22	meg
Thiamine	0.12	milligrams
Riboflavin	0.03	milligrams
Niacin	0.0	
Ascorbic Acid	1.0	milligrams

PART II: PRE-PRODUCTION

2.1 Propagation

Most trees were propagated with volunteer seedlings from non-selected sources. Others came from cuttings and seeds (see Appendix IV). Prior to this Study (see Appendix V) no cultivars had been named in Grenada.

Seedlings were sold between June and September from two government-operated propagation stations at a price of EC$2.25/plant and the demand was said to be greater than the supply. A sexual propagation through large cuttings, budding and grafting are possible, but these methods are rarely used in Grenada.

PART III: PRODUCTION

3.1 Planting System

Aside from "backyard" production, trees were predominantly intercropped and scattered among cocoa, nutmeg, citrus, banana, and plantain fields. A number of farmers had up to 50 trees intercropped in a single holding, however, no pure stand cultivations were observed.

3.2 Location and Distribution

Major areas of production and their characteristics were as follows (refer to Figure 3.2 for the corresponding Zones):

Region A (Zone IIIb) — This region was observed to contain the highest-yielding, largest-fruited Golden Apple trees, perhaps due to the generally higher elevation and rainfall (see Table 3.2a and 3.2b). The trees were mainly used as shade for cocoa. Tree height tended to be greater due to the competition for sunlight from other trees.

Region B (Zone Vb) — In this region, trees tended to be shorter with broad canopy and produced high yields. Most were in backyard settings with little intercropping. Physical scarring and disease were more apparent on trees perhaps due to greater age. In general, gumming was more of a problem in this region.

Region C (Zones II, IIIa, IV, Va) — This region produced smaller fruits and had younger trees possibly because the farmers of this region were generally involved in more traditional crops and had only recently planted Golden Apples.

Region D (Zones I, II, VI) — Although this was a relatively dryer region, it produced large and sweet Apples. Fruits appeared very clean and were generally free of gumming. Premature yellowing possibly due to sun scalding was prevalent in this region.

3.3 Estimated Total Production

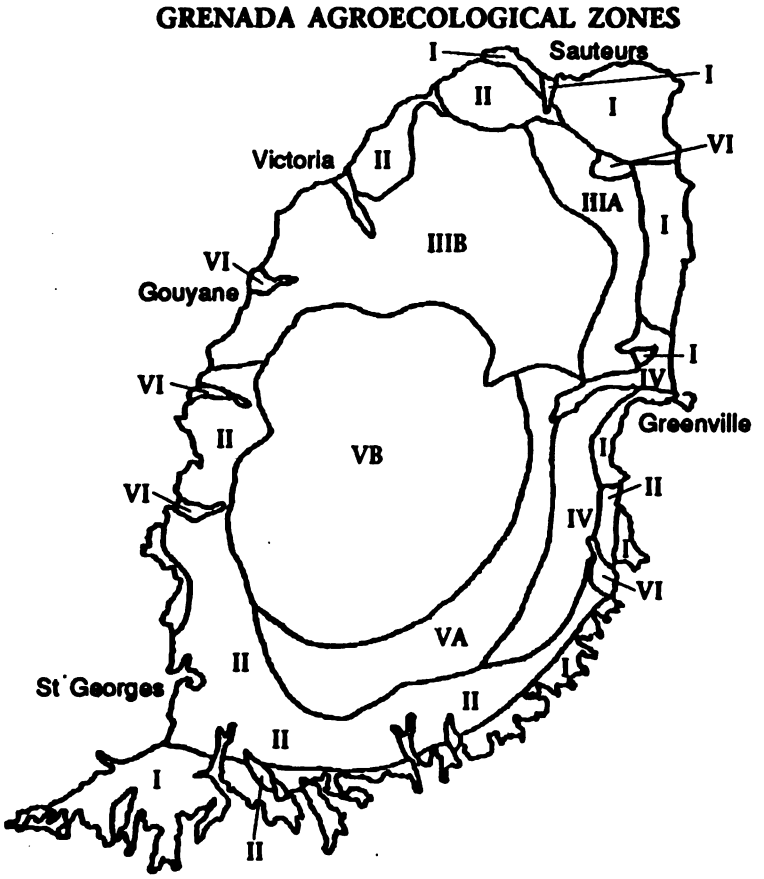
No accurate total production figures were available at the time of this Study but a rough estimate can be made from the export figures (Table 3.3a). Estimated total export volume for 1991 was 1.5 million pounds (675,000 kg) and taking a conservative assumption that only 50% of total production was exported in 1991, an estimated total production figure of 3 million pounds (1,350,000 kg) can be derived.

3.4 Production Cost (see Tables 6.1b and 6.1c)

Under the method of production used at the time of the Study, almost no cost was incurred since no inputs nor maintenance was applied.

[5]CARIRI, Composition of Foods.

Figure 3.2: Map of agroecological zones in Grenada.[6]



[6]Information obtained from CARDI/Grenada

Table 3.2a: Soil type and analysis[1] of pre-selected Golden Apple tree regions.

Area (Region)	Depth inches	pH	P ppm	K Meq/100g	Na Meq/100g	Ca Meq/100g	Mg Meq/100g	OM %
Tempe (C)	0-6	7.4	24.	0.4	1.6	34.5	15.4	2.7
	6-12	7.4	10.5	0.3	1.3	35.7	15.0	2.4
Vendome (B)	0-6	7.8	3.5	2.1	4.6	51.9	20.4	6.5
	6-12	7.8	3.5	2.0	4.8	50.4	20.2	6.1
Mt. Cenis (A)	0-6	6.2	7.0	1.7	3.0	16.6	4.5	3.4
	6-12	6.1	3.5	2.1	3.07	16.6	4.2	2.7
Grand Bacolet (C)	0-6	6.3	8.8	0.9	1.2	19.0	6.6	4.1
	6-12	6.2	3.5	0.6	1.6	18.3	4.2	4.0
Balthazar (B)	0-6	7.4	21.0	2.1	4.9	40.4	7.3	3.3
	6-12	7.5	17.5	2.0	4.6	43.6	7.9	2.3
Paradise (D)	0-6	6.8	35.0	1.1	2.5	28.7	7.7	5.0
	6-12	6.7	28.0	1.1	2.6	27.0	7.6	4.0
Brooklyn (A)	0-6	6.4	1.4	1.3	2.7	20.6	7.8	4.8
	6-12	6.4	1.0	1.0	2.2	19.2	7.6	4.1
Brothers (A)	0-6	6.0	49.0	4.2	7.2	14.8	5.4	4.8
	6-12	6.0	45.5	3.2	6.4	14.3	5.9	3.2
Molinere 1 (D)	0-6	7.3	1.0	0.9	1.2	34.3	11.4	3.1
	6-12	7.5	1.4	0.4	1.6	37.7	13.4	1.7
Molinere 2 (D)	0-6	7.5	2.1	1.2	1.7	40.1	14.2	3.5
	6-12	7.5	1.8	0.7	1.4	40.1	14.4	3.5

[1]Soil analysis carried at Mirabeau Soil Lab.

Table 3.2b: Elevation and rainfall by region for Grenada during 1988-1991.

Station (Region)	Elev. feet	1988	1989	1990	1991	Ave.
				inches		
Mardigras AG. ST. (B)	1150	138.64	108.55	101.83	Inc.	116.34
Ashenden Cocoa ST. (A)	1025	111.08	84.16	92.87	96.56	96.17
Hope Estate (D)	100	92.44	66.81	Inc.	66.09	75.11
Mirabeau Agro MET (C)	450	102.04	68.00	83.42	85.02	84.62
Paradise Estate (D)	115	Inc.	Inc.	75.56	69.17	72.36
Vendome (B)	1115	180.31	119.01	95.84	152.07	136.81
Annadale WW (B)	755	Inc.	116.10	Inc.	136.70	126.40
Clozier (A)	60	Inc.	Inc.	146.80	Inc.	146.80
Knoll Black Bay (C)	344	95.63	80.04	86.94	89.03	87.91
Concord WF (A)	1023	Inc.	Inc.	Inc.	Inc.	Inc.
Queens Park (D)	25	85.51	59.65	Inc.	Inc.	72.58
Dougladston WW (A)	229	Inc.	85.67	90.18	92.20	89.35
Mt. Alexander (C)	360	82.31	67.30	71.06	65.02	71.42
Mt. Reuil (C)	442	93.82	Inc.	89.7	85.25	89.59
Peggy's Whim (C)	816	Inc.	70.63	Inc.	Inc.	70.63
River Antoine (D)	131	Inc.	Inc.	Inc.	40.63	40.63
Mt. Horne (C)	300	96.01	72.88	77.66	78.20	81.88
Boulogne (D)	20	58.27	66.18	76.51	78.77	69.93

NOTE: Inc. = incomplete annual data

Table 3.3: Estimated[2] total export volume (lbs) by year and exporter.

Exporter	1992	1991	1990	1989	1988
MNIB	235,929	552,413	304,109	119,641	2,850
Private Exporters	700,000	550,000	100,000	80,000	5,000
Traffickers	200,000	400,000	500,000	350,000	120,000
Total	1,335,929	1,502,413	904,109	549,641	127,850

[2]All export figures (except MNIB figures) are estimates derived from interviews with various exporters and traffickers

Cost was incurred only during times of harvest when exporters charged an average of EC$0.10/ lb. to harvest and transport the fruits to the packing house.

3.5 Cultural Practices

Fertilization — It was observed that the majority of trees did not receive fertilizers directly. However, those trees intercropped with cash crops such as bananas and other perennials, indirectly received nutrients from the fertilizer applied to the main crop.

Pruning — A few farmers were practicing "topping" techniques for controlling height and canopy but most trees were not pruned. One of the disadvantages observed from the "topping" technique was the breaking of branches due to heavy fruit set. Also, it was hypothesized that premature topping lowers the number of branches, in turn lowering yields.

Weed and Insect Control — Virtually none were observed.

PART IV: PEST AND DISEASES

4.1 Pest

Scale Insects — On young green fruits, infestation by scale insects was observed primarily in the area of the fruit peduncle and shoulder. As a result of their feeding, pale-colored, light-green to yellow spots scattered the green surface of the fruit making them unmarketable. The incidence of scale infestation coincided with early fruit development during the dry season. Associated with scale insects was the presence of the black sooty mould deposit on green fruits.

Mites — From preliminary studies, mite infestation occurs while young fruits are developing; infestation leads to scarring with pale-brown to grey colored bands across the surface of the fruit. The presence of these non-green bands blemish the fruits and render them unfit for the export market. Heavy mite infestations leave corky deposits in the region of the blossom-end of the fruit and can lead to fruit deformity.

Ants — These insects are usually associated with scale insect infestation. Ants tend the scale insect population, removing the honey dew and are also attracted to the gum and sap of the tree.

Termites — As social insects, termites are attracted to golden apple trees and build large nests which eventually kill the branches.

Epiphytes — These plants are usually observed in high humidity, bushy areas and anchored themselves to branches and trunks of trees in large numbers but did not seem to injure the trees.

Others — There are other minor pests associated with golden apple trees such as birds, millipedes, beetles, and lizards but they were observed to cause relatively insignificant amount of damage.

4.2 Diseases

The following observations were made on diseases associated with Golden Apple in Grenada.

On Green Fruits: Small spots appeared on young fruits as dark green, round, water-soaked areas about 2 mm in diameter. Later, as these spots developed, lesions with a center pocket of dark brown to black gum appeared. Infection may occur on any part of the fruit surface attaining the maximum size of 8 mm in diameter.

Development of the lesion was relatively slow in size and depth. On a green fruit, the lesion occupied a depth of 3 mm into the fruit tissue without causing rotting or softening. As the fruit ripened, the area surrounding the lesion remained pale green and while some softening occurred, no extensive rotting was observed. The incidence of fruit spotting lesions increased during the rainy season from June - November; fruits harvested in July and August were observed to have a lower incidence of spots than those harvested later in the season.

Pathological examinations[7] of the fruit lesions have yielded the following fungi: *Guidnardia* spp., *Asteromella* spp. and *Colletotrichum* spp. Pathogenicity tests are to be carried out to identify the causal agent.

Sooty mould fungus covers the surface of fruits and the incidence increases during the harvest period from July–November. Fruits harvested early in the season are less likely to have the sooty mould deposits. This fungus is a secondary organism which grows on the surface of the fruits where honey dew has been deposited as a result of infestation by sucking insects such as scales, mealy bugs and aphids. While the presence of the fungus is unsightly, it is easily removed by washing and does not pose any injury to the skin surface of the fruit.

On Ripe Fruits: As the fruit ripens to a bright golden yellow color, scattered brown spots appear and coalesce, forming large brown lesions. These lesions are not associated with gum deposits and serve to hasten the rotting of the fruit. The fungus Colletotr*ichum* has been associated with this post-harvest infection.

Also observed on ripening fruits was an extensive soft rotting at the stem-end. Preliminary investigations have indicated that secondary agents such as bacteria enter through wounds at the stem-end and initiate the rotting.

[7]Studies carried out with CARDI/Grenada in association with CAB-IMI, International Mycological Institute.

SECTION II: ECOMOMIC FEASIBILITY

PART V. POST-PRODUCTION

5.1 Harvesting

The harvest season runs from August through November with the peaks occurring in September/October. Limited quantities of the fruit are however available in both July and January at the start and end of the crop.

Golden Apple harvesting remains a fairly labor intensive activity, with very little capital input being utilized. Besides the knife which is attached to the end of a bamboo pole, and the basket which is attached as a catchment device, almost no other capital input is used. Harvesting typically involves a team of two or three persons, constituting one climber and one

(two) catcher(s). The rod is used to pick the fruit which is collected in the catchment basket. Once filled, the basket is lowered to the ground and emptied into large sacks. After picking, the fruit is sorted and transported to market by light truck or pick-up.

5.2 Harvest/Post-Harvest Losses

Harvest losses continue to be a problem. Estimates indicate that up to 70% of the fruit is affected by inappropriate harvest and post-harvest practices. The majority of this is due to:

(a) dropping of fruits by shaking branches to minimise the amount of fruit left on the trees,
(b) non-uniform fruit clusters which often result in the harvest of premature fruit,
(c) difficulty in reaching fruit at the end of branches, and
(d) bruised fruit caused by poor handling and transportation.

5.3 Storage

During the Study, MNIB was the only exporter utilizing a cool storage facility where washed fruit can be stored for up to two weeks at 55° Fahrenheit and 90–95% relative humidity[a]. Two other institutions, PFU and Concord Marketing & Supply Center, will soon have cold storage facilities in operation. Other exporters minimize the storage time by harvesting and marketing fruits on the same day. This eliminates the need for cold storage.

5.4 Grades and Standards (see Annex II)

Fruits destined for the extra-regional market must meet certain minimum specifications. The fruit must:

(a) be 2.5 inches in diameter or larger,
(b) be 5 ounces in weight or greater,
(c) have no more than 15% surface scarring, and
(d) be pest and disease free.

The last fruit assessment done for Grenada in 1991 found that generally the quality of exports was good. Fruit yellowing and stem-rot were however noticeable in a small proportion of the fruit. In terms of grading, the assessment found that the size grading of the fruit was generally good and that the average shelf life was 5–6 days. However, yellowing and over-ripening of the fruit are areas in which attention should be focussed since the market demand exists for hard green fruit only.

5.5 Packaging

Currently fruit produced in Grenada is exported in two-layered telescopic "kraft" cartons. The cartons are two-pieced and can be obtained in full and half lengths. Tray packed, the cartons can hold from 20 to 40 lbs of fruit. The 40 lb carton is used most frequently by exporters. Boxes are acquired mainly from St. Vincent, St. Lucia, Trinidad, Guyana and Venezuela at an approximate cost of E.C $4/box. Indications are that the market would prefer a 10 lb carton instead of the usual 40 or 30 lb cartons currently being exported. Boxes of fruits destined for the U.S. market via Puerto Rico are sealed to avoid fruit-fly contamination.

The "kraft" box which is currently being used is adequate for exports to wholesalers and agents. However if consumer-ready exports are to be undertaken for sale at the retail level a more attractive carton will be required.

5.6 Transportation (See Table 5.6a)

At the time of the Study, extra-regional exports were transported by four main airline carriers. While American Airlines (AA), British West Indian Airways (BWIA), and British Airways (BA) handled all shipments to New York, Miami was serviced by AA, BWIA, and Amerijet (AJ). Shipments to London were handled by BA and BWIA. For shipments to Rotterdam, BA was the sole carrier.

All regional shipments to Trinidad were transported on boats which leave every Tuesday from Grenada, taking about 12 hours one-way. Shipping costs were determined by the type of container in which the fruits were shipped. The going rates were EC$15 per crate or basket, E.C$8 per banana box, and E.C$6 per pail or bucket.

PART VI: COMPETITIVENESS

6.1 Cost Competitiveness

In the OECS, Grenada and St.Vincent are the two principal exporters of golden apple. The evidence suggests that the market is large enough to accomodate current exports by both countries. Total exports to extra-regional sources from Grenada in 1991 were estimated at 1.5 million pounds of fruit.

[a]Fruits purchased by the MNIB are placed in a solution of Clorax, Benlate and water (approx. 3–5 ounces each of Clorax and Benlate to every 12 gallons of water) for washing and scrubbing. Recently, the use of Benlate has been discontinued due to concerns over chemical residues.

Table 5.6a: Air freight costs by weight range, destination, and airline[1]

Approx. weight range (kg)	New York			Miami			London		Rotterdam
	AA	BWIA	BA	AA	BWIA	AJ	BA	BWIA	BA
< 300	.64	.80	—	.60	.75	.67	—	—	—
300 to 499	.64	.75	—	.60	.70	.67	—	—	—
500 to 999	.60	.70	.70	.55	.65	.67	.94	1.06	—
1000 to 1999	.60	.70	.64	.55	.65	.67	.87	.94	.90
2000 to 3999	.60	.70	.62	.55	.65	.67	.79	.94	.90
4000 to 5999	.60	.70	.62	.55	.65	.67	.68	.94	.90
≥ 6000	.60	.70	.62	.55	.65	.67	.61	.94	.90

3Rates are in US$/kg as of October 2, 1992.
AA, American Airlines; AJ, Amerijet; BWIA, British West Indian Airways; and BA, British Airways

A fair degree of market segmentation exists by source of supply. While Grenada and St.Vincent export to markets in the U.S, U.K and Holland, the majority of golden apples sold in Canada originate in Jamaica.

Table 6.1a assess the revealed competitive advantage of countries in commodity production and trade in terms of its determinants. The table focusses attention on the factors germane to the maintenance or attainment of individual country competitive in commodity production and trade. In terms of absolute cost comparisons, technical production budgets developed in the AGSYS computer program for Grenada and St. Vincent suggested that neither of these countries had an absolute cost advantage in golden apple production.

According to data collected over the 1991/92 crop year, Grenada and St.Vincent have similar per acre establishment cost (refer to Table 6.1b). Table 6.1c indicates that the annual maintenance costs per acre were also quite similar across the two countries due to the similarities in marketable yields, the structure of costs and technology.[9] This led per unit costs of production between these two OECS producing countries to differ by only E.C.$0.01 per pound of marketable fruit.

Table 6.1d presents the net return range analyses for Grenada and St.Vincent. In addition to indicating that neither of the countries possesses a clear competitive advantage, Table 6.1d also suggests that producers in these countries can expect positive net returns for a wide range of yields when price exceeds EC$0.11 per lb.

[9]Since only a small proportion of golden apple trees have been planted by producers, cost comparisons are more meaningfully carried out on the basis of maintenance costs.

Similar cost estimates for the commodity at the point of entry in London and Rotterdam are given in the range analysis simulation (Tables 6.1e and 6.1f, respectively).

Since the simulation results for the Miami and New York markets yielded virtually the same results as the simulation for the London market, consequently they have not been included in the interest of brevity[10]. The results of the range analysis in Tables 6.1e and 6.1f suggest that the landed cost for Grenadian produced golden apples ranged from E.C. $0.51/lb for the London, Miami and New York markets to E.C. $0.62/lb for the Rotterdam market. Based on low seasonal prices in the Miami market of US$0.75/lb, for the producer/marketer, golden apple production appears to be economically viable from the standpoint of the producer/marketer.

Typically though, the production and marketing functions are performed by different entities. In assessing returns to individual producers it will therefore be necessary to make allowances for this. The variability in marketing margins, marketing arrangements etc., places such an assessment beyond the scope of the present study. The analysis based on the simulation results is intended only to indicate the economic viability of golden apple production for export.

6.2 Market Forecast

The majority of golden apple consumption is by ethnic groups from the Caribbean, Asia, Bangladesh and Pakistan who are familiar with the product. Available data for 1991 suggests that the level of golden apple consumption was

[10]Comparable cost for the U.S. markets ranged between E.C. $0.55 and E.C. $0.57 per pound.

70,000 kilos for the U.K. and 36,000 kilos for the Netherlands. Due to the classification of golden apple in the Non-Competing Other category in most U.S. data bases, no data on volumes traded are currently available for this market.

Annual wholesale prices vary between U.S. $0.45/lb–U.S..$0.99/lb for the market in the Netherlands and between U.S. $1.15/lb–U.S. $1.405/lb for the U.K. market. Comparatively, average annual wholesale prices of U.S. $1.13/lb and U.S. $0.75/lb were reported for the Boston and Miami markets, respectively, in the U.S. In Canada, annual wholesale prices for the period 1989–1991 were fairly stable deviating within a U.S. $0.10 band of the average price of U.S. $0.53/lb.

Table 6.1a: Importance of Selected Determinants of Competitiveness.

Competitiveness Issues	Production, Assembly, Transformation (Processing) and Final Distribution of			
	Undifferentiated Primary Commodities (Bananas, Sugar)		Differentiated Primary Products (Fruits and Vegetables)	
	Importance to Competitiveness	Research Attention	Importance to Competitiveness	Research Attention
Natural Resource Advantage, Factor Endowments	Generally critical, but the mobility of technology is likely reducing its importance.			
	Great	High	Great	High
Cost Reducing Technology	Technology is increasingly mobile		Product differentiation requires certain characteristics be reflected in production practices, technology generally mobile.	
	Mandatory	High	Some	High
Human Capital and Managerial Expertise	Skills in application of production technology important, many people involved			
	Some	Medium	Some	Medium
Quality Enhancing Technology	Quality, transportation, etc.		Quality/product form	
	Some	Moderate	Medium	Moderate
Product Characteristics and Non-price Factors	Grades and standards provide information		Product differentiation possible through quality differences.	
	Little	Some	Medium	Some
Firm Strategy	Minimum cost is only feasible strategy		Cost and differentiation are possible strategies.	
	Little	Little	High	Little
Industry Structure Input Supply Marketing and Distribution Channels	Markets provide vertical coordination.		Depends on economies of scale in economic activities other than production. Markets or hierarchies link primary product production. Often accomplished by single firms. Importance of end-use characteristics at farm level varies, and influences the vertical coordination of markets.	
	Little	High	Great	Low
Infrastructure	Important to cost competitiveness			
	Great	High	Medium	High
Regulatory Environment and Trade Policies	May determine trade patterns.		Policies greatly influence competitiveness and trade patterns. But, often the policy impacts are indirect. Technical barriers matter most.	
	Great, but declining	Highest	Varies greatly	High
Value Added	Little		Some	

Joint Ventures and International Competitiveness: A Caribbean Perspective. Antoine, P. 1992

Table 6.1b: Establishment costs for Golden Apple by OECS Territory. 1991 season.

Establishment costs	Grenada	St. Vincent
Operating Cost	EC$3,014.00	EC$2,995.61
Fixed Cost	EC$466.53	EC$463.54
Preharvest total cost	EC$3,481.52	EC$3,459.15
Harvest cost	N/A	N/A
Total cost per acre	EC$3,481.52	EC3,459.15

Source: Antoine and Taylor (1991).

Table 6.1c: Annual Maintenance Costs for a Mature Golden Apple crop by OECS Territory. 1991 season.

Annual Maintenance Costs	Grenada	St. Vincent
Operating costs	EC$494.17	EC$436.38
Fixed costs	EC$98.08	EC$79.44
Preharvest total cost	EC$592.24	EC$515.82
Harvest cost	EC$2400.00	EC$2350.00
Total cost per acre	EC$2992.24	EC2865.82
Yield per acre (lbs)	28,000	28,000
Preharvest cost per lb.	EC$0.02	EC$0.02
Harvest cost per lb.	EC$0.09	EC$0.08
Total cost per lb.	EC$0.11	EC$0.10

Source: Antoine and Taylor (1991).

While the information on prices and costs suggests modest returns to both producers and marketers of golden apples, current prospects for increased exports are uncertain. This is due to the levelling-off in the rate of growth among the ethnic segments of the European and North American market. This inference is also supported by the lack of market "cross-over" for golden apple in either the U.S of the European market. Golden apple continues to be consumed almost exclusively by the West Indian and Asian segments of the market. In addition cursory evidence appears to suggest a low degree of sensitivity to variations in market price[11].

While further market expansion, particularly in agro-processing, remains a possibility, considerable planning will be required to coordinate this demand with production. Other initiatives aimed at inducing increased consumption of the commodity extra-regionally, through consumer campaigns etc., do not appear feasible or practical. In the absence of new

[11]The demand for the product is fairly inelastic.

Table 6.1d: Estimated net Returns per acre for a Mature Golden Apple crop at various prices and yield combinations.

Yield (lbs/acre)	Farm-Gate Prices (EC$)				
	0.25	0.28	0.30	0.33	0.35
20000.00	2693.47	3193.47	3693.47	4193.47	4693.47
23750.00	3309.54	3903.29	4497.04	5090.79	5684.54
27500.00	3925.61	4613.11	5300.61	5988.11	6675.61
31250.00	4541.69	5322.94	6104.19	6885.44	7666.69
35000.00	5157.76	6032.76	6907.76	7782.76	8657.76

Source: Antoine (1993).

Table 6.1e: Golden Apple Simulation, London market.

Yield (lbs/acre)	CIF Prices (US$)				
	0.60	0.70	0.80	0.90	1.00
20000.00	1693.47	3693.47	5693.47	7693.47	9693.47
23750.00	2122.04	4497.04	6872.04	9247.04	11622.04
27500.00	2550.61	5300.61	8050.61	10800.61	13550.61
31250.00	2979.19	6104.19	9229.19	12354.19	15479.19
35000.00	3407.76	6907.76	10407.76	13907.76	17407.76

Source: Antoine (1993).

Table 6.1f: Golden Apple Simulation, Rotterdam Market.

Yield/Acre (lbs)	CIF PRICES (US$)				
	0.60	0.70	0.80	0.90	1.00
20000.00	-506.53	1493.47	3493.47	5493.47	7493.47
23750.00	-490.46	1884.54	4259.54	6634.54	9009.54
27500.00	-474.39	2275.61	5025.61	7775.61	10525.61
31250.00	-458.31	2666.69	5791.69	8916.69	12041.69
35000.00	-442.24	3057.76	6557.76	10057.76	13557.76

Source: Antoine (1993).

product development which utilizes the fruit, the prospects for increased export volumes beyond current levels appear doubtful. This trend of slow market growth is also borne out by data from importers, which suggests that consumption has been fairly constant over the last three years.

Acceptability of the commodity by the non-ethnic U.S. consumers is complicated by confusion of the "golden apple" with "gold apple", an exotic fruit of South East Asia. This is further complicated by the fact that Golden Apple does not conform characteristically to market perceptions of an apple. Discerning observers have pointed out that perhaps if the product was marketed as a plum, under the name "june plum" for example as it is popularly called in Jamaica, it may be more successful in penetrating the non-ethnic market.

6.3 Sustaining Competitiveness

It appears that in the context of Grenada the most feasible strategy for continued viability of the product is one geared towards simultaneously maintaining market share via improvements in product quality and reducing costs and harvest and post-harvest losses. As the data in Table 6.1a suggests, for undifferentiated primary commodities such as golden apples, the regulatory environment and trade policies hold greatest significance to the determination of competitiveness. This is of special significance to Grenada which has enjoyed a fruit-fly free status for some time. This status has enabled increases in the volume of export of golden apples and other exotics to extra-regional markets with stringent phyto-sanitary requirements.

The sustained competitiveness of Grenada therefore rests squarely on the maintenance of the status in international trade. However, in addition to this, efforts at improving the country's competitiveness through research aimed at reducing costs remain critical. The country's competitiveness will rest more heavily on its ability to pursue a minimum cost strategy, which is the only strategy available to producers of primary undifferentiated commodities. The data in Table 6.1a also suggests, that quality enhancing technology is likely to be a key factor in sustained competitiveness.

The results of a recent tree inventory, reported on elsewhere in this study suggest that if harvest and post-harvest losses were minimized, marketable yields would increase up to 60% as compared to current levels. Using 1991 as a base, this means that exportable volumes could easily have exceeded 2.0 million pounds (this is a conservative estimate). However, current demand trends do not suggest that the export market will accommodate increased volumes without declining market shares on the part of other actors in the extra-regional market.

In the immediate period, it is advisable for producers to seek assistance in improving post-harvest practices and in increasing the shelf life of the product rather than to concentrate on increasing acreage. Current acreage of the commodity should however be maintained through a well conceived system of replanting old or diseased trees. In the longer term, depending on both market trends and price signals, a more informed decision on acreage expansion can then be made.

It is important to reiterate that Grenada has no clear advantage in terms of costs over other producers of the product. In addition, current golden apple production in Grenada is disorganized and scattered. Another salient factor is the entrance into the market of new participants drawn by high returns and encouraged by the existance of low/no barriers to entry.

Finally, the global market-place is dynamic, the fruit-fly free status enjoyed by Grenada today will be pursued by other countries, some of which currently have eradication programs, while others lack only certification. Grenada's current status which facilitates the economic viability of golden apples extra-regionally, must be bolstered by other factors if the country is to continue enjoying success in the production and trade of this commodity.

SECTION 111: CONCLUSIONS & RECOMMENDATIONS

PART VII: CONCLUSIONS AND RECOMMENDATIONS

Over the past several years golden apple has provided Grenadian producers with an opportunity to generate substantial income at almost no cost. With the development of the extra-regional market, golden apple exports from Grenada have increased substantially.

Producers have also benefitted as indicated by the net returns analysis presented in Table 7.4. Prices paid to producers range from E.C $0.30/lb. to E.C. $0.55/lb. depending on the domestic supply of the product. In 1988, MNIB was the only extra-regional exporter of golden apple, however in 1992 about ten other small exporters have entered the market attracted by the modest returns and relatively low set-up cost. In addition to contributing to the incomes of the farmers, the success of golden apple has boosted exports of other fresh produce. The export of such produce has led to a fiercely competitive industry.

While a fair degree of uncertainty still exists about the future prospects of golden apple, some important information has been gleaned from this one-year long study in Grenada. This document has attempted to present preliminary findings on the botanical characteristics, current production and marketing activities. It is important to note that much of the preliminary findings are based on various studies, informal interviews and observation. There is therefore a need for further work in this area. The following comments should serve to direct any future research agenda in regard to the critical areas and issues surrounding the production and marketing of this fruit.

I. Pre-production

CONCLUSIONS

Presently, majority of the Golden Apple plants are being propagated through the inefficient process of collecting volunteer seedlings. While several trials of sexual propagation using seeds have been carried out at the local nurseries, they have resulted in very poor germination rates.

Although there is a possibility that inhibitors are present in the pulp or peel of the fruit, the fact that other countries (eg. Trinidad, Dominican Republic) have reported good germination percentages suggests that some other external factors may be involved. These factors might include the amount of moisture in the seed, the planting depth of the seed, and the seasonal variability of germination.

The selection program initiated by this Study has pre-selected 33 high yielding trees and from them 5 trees were selected as exhibiting the most superior qualities (ie. large fruit size, high Brix, disease resistance).

RECOMMENDATIONS

- Further seed viability studies such as testing for the possible existence of chemical inhibitors within the seed or fruit should be conducted.

- New propagation by seed trials should be set up incorporating external factors which might affect germination including manipulating the amount of moisture surrounding the seed, varying the planting depth of the seed, and controlling the climate and environment around the seed.

- Since Golden Apple can be propagated with relative ease using large cuttings, training of nursery staff on this and other propagation methods should be conducted in the near future.

- Although the selection process is still in its initial stage of development (characterization of clones) and the work should continue, the five clones already pre-selected in the selection program should be used as sources of planting materials which will significantly improve the quality and yield.

- The selection program should be used as an on-going, long-term process and as new and better quality trees are located, they should be used for propagation purposes which in turn will improve the quality of fruits produced.

- Trees exhibiting superior qualities should be selected within each of the major regions in Grenada and propagated in other regions to identify specific genetic traits such as disease resistance.

II. Production

CONCLUSIONS

Although annual export volume has reached 1.5 million pounds, almost all production still comes from either "backyard" or shade trees scattered throughout the island. While this present mode of scattered production has made cost of production almost non-existent for the farmers, harvesting and collecting of the fruits has been highly inefficient and costly for the exporters. Since most farmers do not view Golden Apple as an important commercial crop, the trees have received little or no attention in the way of maintenance.

In addition, the use of Golden Apple trees as shade for other crops has allowed the trees to grow to enormous heights. Consequently, critical pruning, fertilizing and pest management practices have been difficult and have essentially been ignored. Furthermore, with proper cultural practices by farmers much of the harvest and post-harvest losses can be reduced and production can increase without expanding the acreage.

RECOMMENDATIONS

- More efficient and manageable production systems must be tested and introduced such as pure-stand cultivation.
- The possibility of reducing the height of the tree by inter-stocking with a dwarf Golden Apple tree should be further explored.
- Trials should be done to observe the effects of "topping" on canopy development and yields of trees with different maturity.
- Fertilizer trials should also be carried out in conjunction with a cost/benefit analysis.
- A pest and disease management program should be initiated to find solutions to the mites/thrips and fungal disease problem.

III. Harvesting

CONCLUSIONS

The local method used for harvesting Golden Apple is very labor intensive and inadequate for selective harvest of fruits within a cluster. The use of the pole and basket method leads to many indiscriminate harvest of unmarketable immature fruits. In addition, the current method leaves behind large amounts of marketable fruits due to the enormous height and brittle branches of most trees.

Incidences of harvesting small pre-mature fruits early in the season have been rising dramatically. In addition to farmers losing potential higher income opportunities from harvests of larger mature fruits, it has added to some export market perceptions of Grenada as an exporter of fruits with inconsistent quality.

The scattered production system has also contributed to problems associated with harvesting and collecting of fruits. For instance, exporters incur high transportation cost in collecting the fruits because they usually must locate many farmers throughout the island just to purchase enough fruits to make one shipment.

Currently, most purchases are made through an informal oral agreement with a farmer before the harvest season that when the fruits mature the crop will be sold to the respective exporter. However, much confusion and frustration have been felt by many farmers and exporters whose agreements have been breached. The informal nature of the agreement makes it easy for a farmer to sell the crop to another exporter or for an exporter to not purchase the crop from a farmer. When a purchase is made most exporters dump the harvested fruits onto unpadded and unlayered beds of trucks and transported to the packhouse without much care. This practice has resulted in large amounts of mechanical damage and physical injury to the fruits.

RECOMMENDATIONS

- Research and development should be carried out to introduce more appropriate tools and training should be given to fruit pickers on how to improve their techniques on selective harvesting.
- Joint efforts must be made by the farmers and exporters to deter the use of inappropriate methods of harvesting such as early/pre-mature harvesting, indiscriminate/non-selective harvesting, and shaking/breaking of branches.
- The present informal agreements made by a farmer to sell his/her fruits to a particular exporter must be formalized to avoid other exporters from purchasing the fruits.

— Exporters must train their harvesting/ collection teams and use padding/ layering or crates on trucks to reduce mechanical damages when transporting the fruits.

IV. Post-Harvest Handling

CONCLUSIONS

Since no care and maintenance are given to the trees during production, it was observed from the post-harvest surveys that as much as 70% of fruit loss occurred at harvest and post-harvest stages. The three main factors attributed to the high levels of produce loss were mites/ thrips damage, fungal disease damage, and unmarketable small fruits (less than 2.5 inches in diameter or 5 ounces in weight).

Currently, MNIB is the only exporter using a cool room storage facility which has been shown to increase the shelf-life of the fruits by several days. This has enabled MNIB to harvest fruits throughout the week with less concern on spoilage.

RECOMMENDATIONS

— If Golden Apple is to expand its market into the non-ethnic consumers, much more emphasis must be placed on the uniform quality and packaging of the commodity.

— The fiber board box which is currently being used for packaging is adequate for exports to wholesalers and agents. However, if consumer-ready exports are to be undertaken for sale at the retail level more attractive, smaller cartons (10 lb) will be required.

V. Marketing

CONCLUSIONS

Within the last four years, the number of Golden Apple exporters have jumped from one to an estimated twenty. This has created fierce competition among them and have made Golden Apple a sought after commodity. In turn, the farmers have benefitted from this extra source of income at almost no cost.

However, the growing number of exporters has created some serious marketing problems as well. The lack of coordination and timely market information among the exporters has led to constant flooding of markets and price depreciations as well as causing shortages in the already limited air cargo space. Without official quality standards among exporters, much of the fruits arriving in the markets have little uniformity and a number of complaints noting inconsistent and poor quality have been made.

In addition, almost all exporters have experienced corrupt importers who delay or default on payments. Exporters have also complained that some dishonest importers have refused to pay for the shipments deceitfully citing that the fruits arrived in bad unmarketable condition.

RECOMMENDATIONS

— A comprehensive, in-depth marketing study should be undertaken to examine the current status and potential of Golden Apple exports both within and outside the ethnic markets.

— The association of exporters should be strengthened to facilitate and encourage exchange of vital information and ideas affecting the export industry.

— Airline shipment schedules should be coordinated among exporters to avoid shortages in air cargo space.

— Other means of transporting the commodity should be looked at such as freight shipments by sea which can provide a low cost alternative to air shipments.

APPENDICES AND REFERENCES

ANNEX I: PHENOLOGY STUDY

Background/Objectives

While most Golden Apple trees are harvested between August and November, some trees were observed to bear fruits earlier or later than most trees. If those early and late bearing trees can be identified, they can be used to lengthen the harvest season. Therefore, the objective of this study was to document the phenological characteristics of Golden Apple trees in order to note the variations among trees and to identify possible early and late bearing trees.

Materials/Methods

Monthly visits were made to 33 designated trees located in various regions of the island. Starting from January 1992, careful monitoring was done by three observers and progression of each tree's phenology was noted each month by estimating percentages (ex: 10% flush, 50% flush, 90% flush, etc.). An average percentage was derived from the three observers. The monitoring was stopped on trees when they reached 100% fruit development.

Results

By March, leaf drop was 100% for all trees in the study. For the most part, bloom phase was noticed a short time before any flushing for most trees. Blooming occurred in February and overlapped with the end of the leaf drop phase and the start of the flush phase. In general, trees that had high leaf drop percentage in January had high bloom percentage in February and similarly, trees with low leaf drop percentage in January had low bloom percentage in February. Highest bloom percentages were observed in February and by April all blooming had ended. Flush phase started in February for most trees and with some exceptions most trees had 100% flush by April. Fruit setting began as early as February on some trees but most trees started this phase in March and ended in May. The fruit development phase began in April and by May, most trees had 100% fruit development.

Conclusions

The results seem to show that the month of March seems to be a good indicator of whether a tree is an early, normal, or late bearer of fruits. Therefore, trees that had 90% or more fruit set in March were concluded to be early bearers, trees that had 10% or less fruit set in March were concluded to be late bearers, and all the rest of the trees were concluded to be normal bearers. Consequently, 11 trees were identified as early bearers, 8 trees as late bearers, and 14 trees as normal bearers.

Phenology data on pre-selected trees.

	Tree Code (E,N,L)[4]	Leaf Drop	Flush	Bloom	Fruit Set	Fruit Develop
1	BedBCSTJRB1 (L)	5 Jan	1 Mar	1 Mar	1 Apr	2 May
		30 Feb	15 Apr	20 Apr	1 May	40 Jun
		99 Mar	90 May	0 May	100 Jul	
			100 Jun			
2	BedBCSTJRB3 (N)	10 Jan	45 Mar	10 Feb	40 Mar	100 May
		100 Mar	100 Apr	30 Mar	5 Apr	
			0 May			
3	BedBCSTJRB4 (N)	50 Jan	40 Mar	5 Feb	90 Apr	100 May
		100 Mar	90 Apr	50 Mar	0 May	
			95 May			
4	BedBCSTJRB5 (L)	5 Jan	2 Feb	45 Mar	5 Mar	100 May
		70 Feb	20 Mar	60 Apr	40 Apr	
		100 Mar	95 Apr	0 May	0 May	
			100 May			
5	BedBCSTJRBX (E)	100 Jan	25 Feb	80 Feb	100 Mar	100 Apr
			90 Mar	0 Mar		
			100 Apr			
6	PetBCSTJC1 (E)	90 Jan	5 Feb	30 Feb	10 Feb	60 Apr
		100 Feb	85 Mar	2 Mar	98 Mar	100 May

Phenology data on pre-selected trees. *(continued)*

	Tree Code (E,N,L)[4]	Leaf Drop	Flush	Bloom	Fruit Set	Fruit Develop
7	PetBCSTJC6 (E)	100 Jan	20 Feb	55 Feb	5 Feb	80 Apr
			80 Mar	0 Mar	100 Mar	100 May
			95 Apr			
			100 May			
8	PetBCSTJC4 (E)	100 Jan	15 Feb	40 Feb	100 Mar	90 Apr
			90 Mar	0 Mar		100 May
			100 Apr			
9	RobBCSTJSR1 (L)	5 Jan	15 Mar	25 Mar	10 Mar	99 May
		100 Feb	75 Apr	10 Apr	25 Apr	100 Jun
			85 May	0 May	1 May	
10	GusBCSTJKG1 (E)	100 Jan	90 Feb	85 Feb	100 Mar	100 Apr
			95 Mar	0 Mar		
			100 Apr			
11	GusBCSTJKG2 (E)	100 Jan	30 Feb	85 Feb	100 Mar	100 Apr
			95 Mar	0 Mar		
			100 Apr			
12	GusBCSTJKG3 (N)	80 Jan	2 Feb	40 Mar	95 Apr	
			15 Mar	60 Mar	5 Apr	100 May
			90 Apr			
13	BelMtCSTJBel1 (N)	90 Jan	55 Mar	50 Feb	60 Mar	100 Apr
			100 Apr	40 Mar		
14	RodBSTJHR1 (N)	60 Jan	50 Mar	45 Feb	40 Mar	100 May
		100 Feb	80 Apr	60 Mar	80 Apr	
			90 May	0 Apr		
15	NoeBSTJMN1 (E)	95 Jan	10 Feb	90 Feb	100 Mar	100 Apr
		100 Feb	90 Mar	0 Mar		
			100 Apr			
16	McQBSTJEM2 (E)	95 Jan	5 Feb	40 Feb	90 Mar	100 Apr
		100 Mar	95 Mar	10 Mar		
			100 Apr			
17	McQBSTJEM3 (E)	100 Jan	15 Feb	90 Feb	100 Mar	100 Apr
			95 Mar	0 Mar		
			90 Apr			
18	StPBSTJLSP1 (N)	5 Jan	10 Mar	5 Feb	20 Mar	60 May
			60 Apr	30 Mar	40 May	100 Jun
			95 May	40 Apr		
				0 May		
19	StPBSTJLSP2 (N)	100 Jan	10 Feb	90 Feb	40 Mar	100 Apr
			85 Mar	0 Mar		
			100 Apr			
20	FerVSTGMF1 (N)	100 Jan	30 Feb	85 Feb	5 Feb	100 May
			60 Mar	20 Mar	60 Mar	
			100 Apr		100 Apr	
21	ColGBSTA (N)	85 Jan	20 Feb	15 Feb	10 Feb	100 Apr
		95 Mar	40 Mar	50 Mar		
			100 Apr	0 Apr		
22	BauBSTA (N)	95 Jan	90 Mar	90 Feb	10 Feb	100 Apr
			100 Apr	20 Mar	35 Mar	
					100 Apr	
23	TekBSTJ (N)	100 Jan	95 Mar	80 Feb	50 Mar	100 Apr
			100 Apr	0 Mar		
				0 Apr		
24	BalBSTJ (N)	100 Jan	95 Mar	80 Feb	50 Mar	100 Apr
			100 Apr	0 Mar		
				0 Apr		
25	FreTSTGF1 (N)	100 Jan	5 Jan	60 Feb	75 Mar	100 Apr
			50 Feb	20 Mar		
			100 Mar			

Phenology data on pre-selected trees. (*concluded*)

	Tree Code (E,N,L)[4]	Leaf Drop	Flush	Bloom	Fruit Set	Fruit Develop
26	BriTSTGJB1 (L)	5 Jan 75 Feb 100 Mar	5 Mar 100 Apr 0 May	40 Mar 10 Apr 0 May	5 Mar 70 Apr	100 May
27	MitMSTGJM1 (L)	40 Jan 85 Feb 100 Mar	5 Mar 40 Apr 60 May	30 Mar 20 Apr	10 Mar 80 Apr	100 May
28	MilMSTGM1 (L)	5 Jan 15 Apr	5 Mar 15 Apr	10 Mar 75 Apr	2 Mar	100 May
29	MilMSTGM2 (L)	5 Jan 20 Feb 100 Mar	0 Mar 5 Apr 50 May	0 Mar 5 Apr	0 Mar 20 Apr	100 May
30	MilMSTGM3 (L)	5 Jan 40 Feb 100 Mar	10 Mar 75 Apr 80 May	5 Mar 5 Apr	0 Mar 30 Apr	100 May
31	MilMSTGM4 (N)	10 Jan 65 Feb 100 Mar 70 May	5 Feb 10 Mar 40 Apr	2 Feb 3 Mar 4 Apr	15 Mar 70 Apr	100 May
32	LohPSTALL1 (E)	100 Jan	100 Apr	5 Jan 90 Feb 0 Mar	10 Feb 100 Mar	100 Apr
33	LohPSTALL2 (E)	90 Jan	100 Apr	2 Jan 90 Feb 0 Mar	5 Feb 90 Mar	100 Apr

[4]E = early bearer; N = normal bearer; L = late bearer

ANNEX II: POST-HARVEST LOSS STUDY

Background/Objectives

Post-harvest loss of Golden Apple is thought to be a major constraint on the export industry but no data exists to accurately quantify the magnitude and character of the problem. This study was set up to estimate the rejection rate at the pack house and to identify the factors that contribute to the rejection.

Materials/Methods

A total of 5 surveys were conducted at the pack house of 3 major exporters (MNIB, PFU, and Greene). In each of the 5 surveys, careful measurements were made of the total weight of harvested fruits before the washing and grading took place. After the grading process, all the rejected fruits were collected in large crates and weighed. The rejected fruits were then individually examined and having determined the reason or factor for its rejection, each fruit was placed into one of 8 smaller crates according to its rejection factor: 1) mites/thrips; 2) fungus; 3) small size; 4) mechanical damage; 5) over-ripe; 6) deformity; 7) scales; 8) bacteria. When all the fruits were sorted into the 8 crates, each crate was weighed. Finally, the total post-harvest loss rate and rates for each of the 8 rejection factors were calculated using the total weight figures.

Results

The total rejection rates varied drastically in the 5 surveys, ranging from a low of 6.1% to a high of 51.0%. Among the 8 rejection factors, mites/thrips, fungus, small size, and mechanical damage, were the most common. These 4 factors accounted for over 50% of total rejection in most surveys.

Conclusions

The study indicated that the quality of Golden Apple is highly inconsistent and sometimes results in more than half of the harvested fruits being rejected at the pack house. Much of the high rejection rates can be attributed to the lack of pest and disease control for the trees and rest of the rejection to inappropriate harvesting and handling techniques. It is clear from the study that more effort needs to be placed in improving the maintenance of the trees as well as the harvesting and handling of the fruits.

Post-harvest loss survey total rejection rates.

Exporter	Date of Survey	Total quantity (lbs)	Total rejected (lbs)	Rejectioon rate %
MNIB survey 1	21/11/91	7887	1849	23.4
MNIB survey 2	27/11/91	1050	535	51.0
MNIB survey 3	15/7/92	543.5	163.5	30.0
PFU	13/1/92	426	26	6.1
Greene survey 1	8/1/92	934	125	13.4
Greene survey 2	21/7/92	1124	124	11.0

NOTE: MNIB — Marketing and National Importing Board; PFU — Productive Farmer's Union Greene — Esther Whiteman-Greene

Post-harvest loss survey rejection factor rates.

Rejection Factors	MNIB survey 1	MNIB survey 2	PFU	MNIB survey 3	Greene survey 1	Greene survey 2
Mites/Thrips	34.2	14.2	19.2	8.5	20.8	46.8
Fungus	30.9	35.1	11.5	10.2	14.4	12.9
Small Size	17.7	19.4	15.4	5.2	40.0	13.7
Mech. Damage	9.1	16.6	7.7	4.2	16.8	26.6
Over-ripe	3.2	7.5	38.5	0.2	8.0	—
Deformity	2.3	3.7	7.7	1.5	—	—
Scales	1.4	1.7	—	0.4	—	—
Bacteria	1.1	1.7	—	—	—	—

NOTE: MNIB - Marketing and National Importing Board; PFU - Productive Farmer's Union; Greene - Esther Whiteman-Greene

ANNEX III: SHELF-LIFE STUDY

Background/Objectives:

At the time of the Study, only MNIB was utilizing a cool room storage facility and the other exporters relied on same-day harvesting and shipping techniques to minimize the storage time of the fruits. This shelf-life study was conducted to determine the number of days it took for mature green fruits to ripen under refrigerated and non-refrigerated conditions.

Materials/Methods:

Two separate trials were run for this study at two locations using green mature fruits harvested from the same tree for both trials. One trial was at the MNIB pack house while the other was at the IICA office. At the MNIB pack house, 25 fruits were placed in a fiber board box that was set on a table in room temperature (approx. 85°F). At the same time, 90 fruits were placed in another fiber board box that was set inside the MNIB refrigerated storage room (5°F/90% relative humidity). At the IICA office trial, 25 fruits were also set aside in room temperature while another 100 fruits were placed inside the kitchen refrigerator. In both trials, each of the unrefrigerated fruits was carefully monitored daily to record the number of days it took for fruits to reach full-ripe and over-ripe stages and Brix measurements were made when they became over-ripe. As for the refrigerated fruits, a random sample of 10 fruits were taken out of refrigeration on the 5th, 7th, 9th and everyday thereafter to record how many days it took for each fruit to turn full-ripe and over-ripe. Brix readings were made for each fruit at the over-ripe stage.

Results

In the MNIB trial, the 25 unrefrigerated fruits took an average of 8.9 days to reach full-ripe stage and a total of 10.7 days to reach over-ripe stage. As for the refrigerated fruits, the average number of days to full-ripe ranged from 9.7 to 15.2 and the average number of days to over-ripe ranged from 12.0 to 16.1. At the IICA office, the 25 unrefrigerated fruits took 6.3 days to full-ripe and 9.5 days to over-ripe. The refrigerated fruits took an average of 9.1 to 19.0 days to full-ripe and an average of 12.5 to 19.0 days to over-ripe.

Conclusions:

Results of the two trials lead us to conclude that refrigeration can expand the shelf-life of a green mature fruit by as much as 10 days before it turns full-ripe.

Shelf-life study data at Marketing Board (Jan. 1992)

Days in Refrig.	Days to full ripe	Days to over ripe	Brix at over ripe	Days to FR after refrig.	Days to OR after refrig.
0 (n=25)	8.9	10.7	11.6		
5 (n=10)	9.7	12.0	11.7	4.7	7
7 (n=10)	11.1	14.5	11.9	4.1	7.5
9 (n=10)	12.1	14.1	11.6	3.1	5.1
10 (n=10)	11.3	14.4	11.4	1.3	4.4
11 (n=10)	12.0	14.1	11.8	1.0	3.1
12 (n=10)	13.3	14.9	12.3	1.3	2.9
14 (n=10)	14.6	15.2	12.4	.6	1.2
15 (n=10)	15.2	15.4	12.11	.2	.4
16 (n=10)		16.1	12.3		.1

Shelf-life study data at IICA office (Jan. 1992)

Days in Refrig.	Days to full ripe	Days to over ripe	Brix at over ripe	Days to FR after refrig.	Days to OR after refrig.
0 (n=25)	6.3	9.5	12.4		
5 (n=10)	9.1	12.5	12.8	4.1	7.5
7 (n=10)	12.2	14.7	12.3	5.2	7.7
9 (n=10)	12.6	15.5	12.6	3.6	6.5
10 (n=10)	—	—	—	—	—
11 (n=10)	16.2	18.5	12.3	5.2	7.5
12 (n=10)	16.7	18.3	12.7	4.7	6.3
13 (n=10)	16.5	18.5	13.2	3.5	5.5
14 (n=10)	17.2	19.0	12.5	3.2	5.0
15 (n=10)	18.0	19.0	12.9	3.0	4.0
16 (n=10)	19.0	19.0	12.4	—	3.0

ANNEX IV: SEED VIABILITY STUDY

Background/Objectives:

Three trials were carried out at the Ashenden Propagation Station to investigate the viability of Golden Apple seeds. Two were done to determine whether stage of maturity and amount of flesh surrounding the seed had any affect on the viability of the seed, while the third was done simply to observe how dwarf Golden Apple seeds from Trinidad would fair in local conditions.

Materials/Methods/Results

Trial #1

A total of forty (40) fruits were randomly selected in which half of the selected fruits were at their green mature stage and the other half were at their full ripe stage. Within these two groups of twenty fruits, all flesh were removed from ten (10) fruits so that only the seeds remained; the other ten fruits in each group were left as whole fruits. Therefore, the forty (40) fruits selected for the study were divided up into four groups of ten (10) fruits:

Group	Description of Planting Material	Number of Fruits
A	green mature; whole fruit	10
B	green mature; seed only	1
C	full ripe; whole fruit	10
D	full ripe; seed only	10

On January 23rd, 1992, the whole fruits and seeds from groups A, B, C, and D were planted in black polythene potting bags filled with fertilized soil. The fruits and seeds were planted 1 to 1.5 inches deep with their proximal ends ("heads") pointing down. The bags were placed under canopy in four rows, containing groups A, B, C, and D, respectively. Watering was done twice a day using a garden hose, and the groups were monitored once a week.

On April 22nd, 1992, having observed no signs of germination in any of the four groups since the time of planting, it was concluded that the seeds were either sterile or had just dried up and died. To make room for volunteer seedlings that were being collected, seeds (by this time flesh from whole fruits planted had decomposed so that only seeds remained) from all forty bags were dug up and dumped onto a nearby concrete seedling bin filled with sawdust/sand medium. Subsequently, the Trial was thought to have ended.

On a routine visit to Ashenden on July 23rd,1992, it was noted that seven (7) of the forty seeds dumped into the bin had germinated and were showing signs of leaf formation. It is interesting to note that most of the germinated seeds were just above or barely below the surface of the soil. Polyembryosis was noticed to have occurred on four (4) of the germinated seeds producing two to five separate seedlings from a single seed.

Trial #2

On January 15, 1992, forty (40) dwarf Golden Apple seeds brought in from Trinidad were planted at Ashenden using the same method and set up used in Trial #1.

On April 7, 1992, one seed out of the forty seeds planted had germinated producing a single seedling. The other 39 seeds showed no signs of life and so they were discarded.

Trial #3

In November of 1991, approximately a hundred (100) fruits were collected for the trial. Flesh were cut out from all fruits and the seeds were washed under running water to remove most of the remaining flesh. Immediately afterwards, the seeds were scattered in a random fashion onto a seedling bin such as the one used in the study above. Positions of the seeds in relation to the surface of the soil ranged from totally above to about an half inch below. The spacing between the seeds were quite small since the bin space was limited.

It was observed during the months June and July that about half of the planted seeds had germinated and were producing seedlings. It is important to note that the seeds in Trial #1, although planted months later, germinated around the same time; possibly implying that a seasonal variable exists in the viability of Golden Apple seeds. It was also observed that most germinated seeds were above or just below the surface of the soil and in addition, polyembryosis was very prevalent. Again, both these observations are highly correlated to the observations noted in Trial #1.

ANNEX V: SELECTION STUDY

Background/Objectives:

The Golden Apple trees grown in Grenada are propagated from non-selected materials and therefore, the production and quality of fruits tend to be highly inconsistent. It was the hope that through a selection program, superior clonal materials of local Golden Apple can be identified and propagated to produce high yielding and consistently high quality fruits.

Materials/Methods:

An initial selection program was started in September of 1991, in which observations were made of over a hundred trees that the MNIB harvesting team thought were the best yielding trees on the island. From those trees, 33 trees throughout the island were pre-selected on the basis of high yield. Among the 33 trees, five trees were identified for exhibiting superior qualities.

Results:

The five selected trees were as follows:

Tree Code	Superior Quality	Location
BEDBCSTJRB5	large fruit size	Bois Congo, St. John's
STPBSTJLSP1	exceptional yield	Brothers, St. John's
STPBSTJLSP2	exceptional yield	Brothers, St. John's
MILMSTGM1	late bearing	Molinere, St. George's
LOHPSTALL1	early bearing	Paradise, St. Andrew's

Conclusions:

In observing the many trees throughout the island, it was clear that most of the high yielding and large fruit sized trees were located in the western side of the island, primarily in St. John's parish. The relatively drier areas seem to produce trees that bear clean and sweet fruits but are somewhat smaller in size than those of trees grown in the wetter areas. More selection should be done on an on-going basis to further identify trees with other superior qualities such as disease resistant, high brix, and low seed to flesh ratio.

Profile of pre-selected Golden Apple trees on Grenada.

Farmer	Area, Parish	Age	Tree tag#	Code
Roy Bedeau	Bois Congo, STJ	12	RB1	BedBCSTJRB1
Roy Bedeau	Bois Congo, STJ	12	RB3	BedBCSTJRB3
Roy Bedeau	Bois Congo, STJ	12	RB4	BedBCSTJRB4
Roy Bedeau	Bois Congo, STJ	12	RB5	BedBCSTJRB5
Roy Bedeau	Bois Congo, STJ	12	RBX	BedBCSTRBX
Chappy Peters	Bois Congo, STJ	18	C1	PetBCSTJC1
Chappy Peters	Bois Congo, STJ	15	C4	PetBCSTJC4
Chappy Peters	Bois Congo, STJ	12	C6	PetBCSTJC6
Sonny Robertson	Bois Congo, STJ	18	SR1	RobBCSTJSR1
Kingsley Gustard	Bois Congo, STJ	5	KG1	GusBCSTJKG1
Kingsley Gustard	Bois Congo, STJ	10	KG2	GusBCSTJKG2
Kingsley Gustard	Bois Congo, STJ	10	KG3	GusBCSTJKG3
Belfon	Mt. Cenis, STJ	10	Bel1	BelBSTJBel1
Rodjeric Hector	Brooklyn, STJ	25	HR1	RodCSTJHR1

Profile of pre-selected Golden Apple trees on Grenada. (concluded)

Farmer	Area, Parish	Age	Tree tag#	Code
May Noel	Brooklyn, STJ	15	MN1	NoeCSTJMN1
Eluta McQueen	Brooklyn, STJ	10	EM2	McQCSTJEM2
Eluta McQueen	Brooklyn, STJ	20	EM3	McQCSTJEM3
Matthew St. Paul	Brothers, STJ	20	LSP1	StPBSTJLSP1
Matthew St. Paul	Brothers, STJ	20	LSP2	StPBSTJLSP2
Mary Ferguson	Vendome, STG	20	MF1	FerVSTGMF1
Warrial Collier	Grand Bacolet, STA	15	WC1	ColGBSTA
Baubau	Balthazar, STA	15	Bar1	BauBSTA
Elma Teka	Brothers, STJ	8	ET1	TekBSTJ
Verna Baldeo	Brothers, STJ	8	VB1	BalBSTJ
Fredericks	Tempe, STG	20	F1	FreTSTGF1
Joseph Brizen	Tempe, STG	—	JB1	BriTSTGJB1
Joseph Mitchell	Molinere, STG	—	JM1	MitMSTGJM1
Miller	Molinere, STG	—	M1	MilMSTGM1
Miller	Molinere, STG	—	M2	MilMSTGM2
Miller	Molinere, STG	—	M3	MilMSTGM3
Miller	Molinere, STG	—	M4	MilMSTGM4
Larry Lohar	Paradise, STA	13	LL1	LohPStALL1
Larry Lohar	Paradise, StA	13	LL2	LohPStALL2

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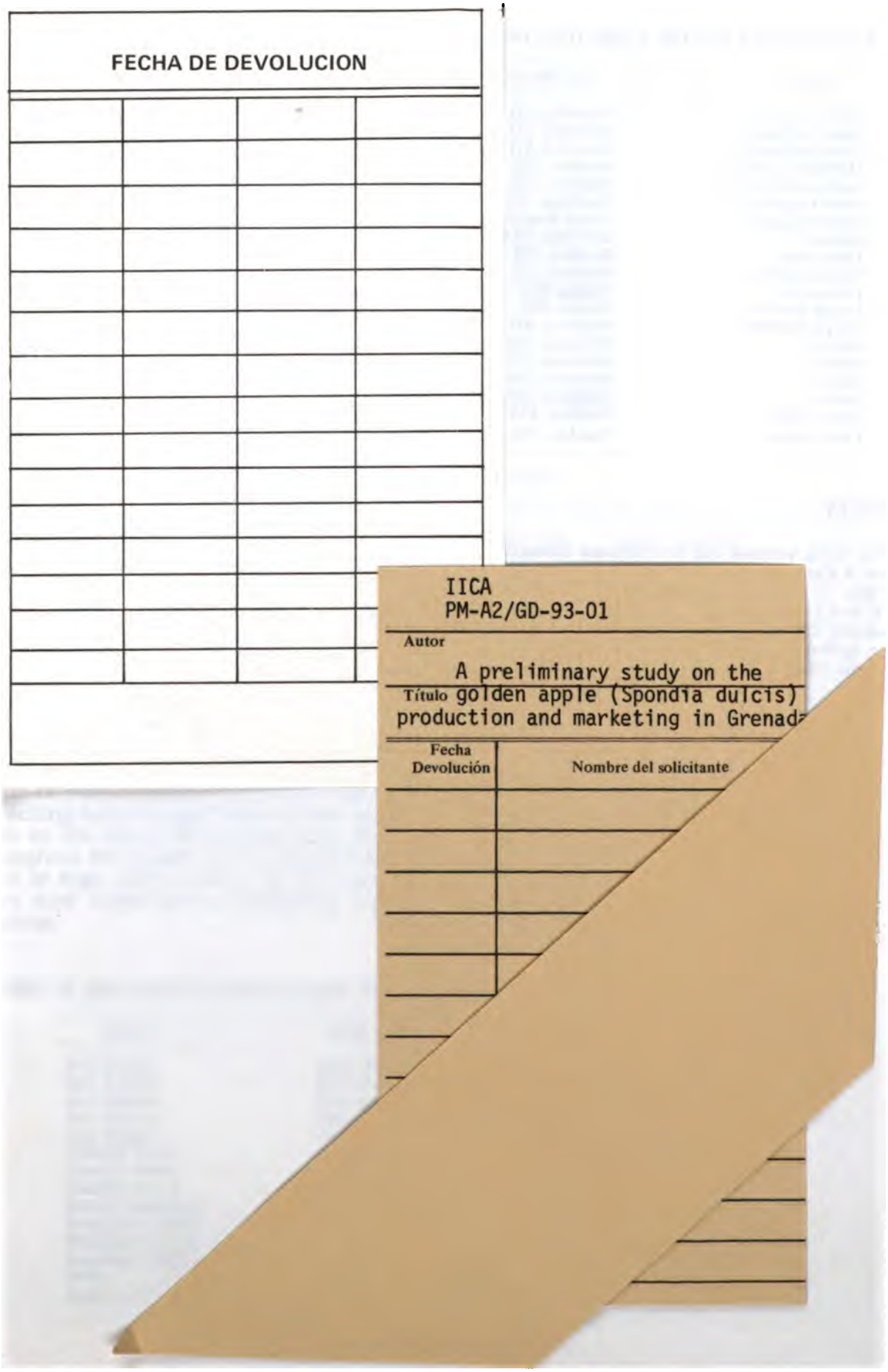
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