Ministère des Affaires Etrangères
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IICA

DIAGNOSIS OF THE PINEAPPLE INDUSTRY IN GUYANA: MAJOR CONSTRAINTS AND PERSPECTIVES

By
Natacha Rouffiange
ENSIA-SIARC

September 1993

IICA OFFICE IN TRINIDAD AND TOBAGO

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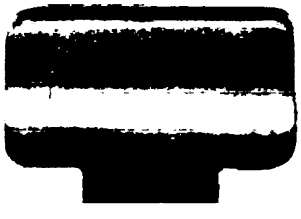

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FOREWORD

This study on the pineapple industry in Guyana was conducted by Natacha Rouffiange, a French student, as part of the requirement for her Master of Science degree at the Ecole Nationale des Industries Agro-Alimentaires (ENSIA), Section Industries Agro-Alimentaires Région Chaudes (SIARC), Montpellier, France.

Ms Rouffiange was born in Madagascar where she spent her youth. Then she went to study in La Reunion Island and eventually in Montpellier, France.

In Guyana she was attached to the IICA Office under the supervision of Mr. Jerry la Gra, IICA representative in Guyana and Mr. Chandrahat Baichoo, officer in charge of the fruit project. She was also assisted periodically by Mr. Franck Marie, a pineapple agronomist at CIRAD/FLHOR in Martinique.

We have to recognize that she did a wonderful job in difficult conditions, but her dynamism and determination helped to solve all the difficulties. We are pleased to present the results of her work and hope that it will be helpful in solving some of the problems that were identified.

Gérard Barbeau
Regional fruit project IICA/France for the Caribbean
IICA Office in Trinidad and Tobago

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R. Marte,	Generation and Transfer of Technology Specialist,
M. Reynes,	Fruit Processing Specialist (CIRAD-FLHOR, Montpellier)

I wish to express my appreciation to the staff of the IICA Office in Guyana, for their participation and company during my stay in the country.

ABSTRACT

Pineapple production, the third export crop after rice and sugar cane, has been decreasing since 1990, in terms of volume and quality, resulting in a large reduction of exports of fresh fruit and a significant increase in the selling price.

The survey consists of a descriptive analysis of the whole pineapple industry, aimed at identifying the main constraints, clarifying the need for technical assistance and training, and determining the actions to be undertaken.

The methodology adopted consists of an evaluation of the local genetic resources; investigation of production; local and export marketing of fresh fruit and processed products; agronomic observations of the plots according to the pedo-climatic areas and experiments with Flower Induction Treatment (FIT).

The major constraints of the whole industry are encountered during the production process. The main constraint is the lack of appropriate technology and general knowledge by the different individuals involved in the industry, which results in very low productivity (due to non-existance or inadequate cultural techniques) and direct losses (during production and after harvesting).

RESUMÉ

Troisième culture d'exportation après le riz et la canne à sucre, la production d'ananas en Guyana a notablement chuté depuis 1990, aussi bien en terme de quantité que de qualité, ce qui a entrainé une baisse considérable des exportations en frais et une très forte hausse des prix sur le marché local.

La présente étude est une analyse descriptive de la filière ananas, avec pour objectifs d'identifier ses principales contraintes, de préciser les besoins en appui technique et formation et de detérminer les actions à engager.

La méthodologie employée a consisté en une évaluation du patrimoine génétique, en la réalisation d'enquêtes auprès des producteurs, commerçants, exportateurs et industriels, en des observations agronomiques des parcelles par zones pédo-climatiques et en la mise en place d'essais de Traitements d'Induction Florale (TIF).

Pour l'ensemble de la filière, les contraintes principales ont été identifiées au niveau de la production. La plus importante réside dans le manque de technicité et de connaissances générales des différents acteurs, ce qui se traduit par une faible productivité (due à des techniques culturales inadaptées ou inexistantes), et des pertes directes à la production et durant la phase post-récolte.

INTRODUCTION

This survey of the pineapple industry was done in the context of the project Supporting the Development of Tropical Fruit Crops in the Caribbean, which is a part of the programme Technology Generation and Transfer of the Inter-American Institute for Cooperation on Agriculture (IICA), aimed at promoting sustainable agricultural development.

The main purpose was to develop a survey which covered all aspects of the industry, such as the characterization of local varieties, the description of existing cultivation systems, the determination of the impact of various pests and diseases as well as fresh fruit marketing and processing.

The collected data allowed a diagnosis of the main constraints of the industry to be made along with the consequences and costs, in order to provide guidelines for further research and training of individuals involved in the industry.

1. GENERAL INFORMATION

1.1. WORLD, REGIONAL AND LOCAL PRODUCTION AND TRADE OF PINEAPPLE

1.1.1. World production and trade of pineapple

World production of pineapple is estimated at more than 11 million tonnes per year, and is dominated by Thailand, the Philippines, Brazil, the Ivory Coast, Hawaii, Mexico, South Africa and to a lesser extent Costa Rica and Kenya. The fresh fruit trade (500,000 to 600,000 tonnes per year) is dominated by the Philippines, Hawaii and the Ivory Coast. Canned pineapple and pineapple juice which represent at an average 1,100,000 tonnes are produced mainly by Thailand, the Philippines, Indonesia and to a lesser extent Japan.

The main importers are the USA, EC, Canada and Japan (See Appendix 1). (Barbeau, 1992; New, 1991).

1.1.2. Regional production

The area cultivated with pineapples in the Caribbean was estimated at about 3,000 ha in 1991. The varieties cultivated are mainly Smooth Cayenne, Montserrat from Guyana and Antigua Black. (The importance of their production is shown in Appendix 1).

The major producing country is the Dominican Republic, which exports fresh fruits to the USA, Cuba and Martinique. In the case of Martinique, 90% of the fruits is designated for canning. The other 10% is either sold on the local market or exported to St Lucia, Guadeloupe or France (Marie, 1991). Trinidad imports Guyana's pineapple for canning and local consumption.

There is a regional market for fresh fruits since Antigua, Barbados, St Lucia, Monsterrat and other regional islands do not produce enough pineapple for local consumption. In Barbados there is a heavy demand for this fruit and as a result, 95% of consumption is supplied by Guyana. However, Guyana has to compete for price and quality with other islands which have a potential for exporting fresh pineapples.

1.1.3. The importance of the pineapple industry in Guyana

General data about the country are given in Appendix 2.

1.1.3.1. Fresh pineapple

Pineapple production decreased drastically in 1990 (from 11,200 tonnes in 1989 to 7,600 tonnes in 1990), but is on the increase again (Appendix 3).

The reasons for this decrease were mainly:

— a reduced market, resulting in huge spoilage of fruits in the field.
— appearance of the wilt disease caused by a virus and gummosis caused by *Thecla basilides*.

During this period all the agricultural inputs required were not available; this resulted in huge losses. At present the total area cultivated is estimated at more than 600 ha and production was about 8,800 tonnes in 1992. Even when agricultural inputs are available, yields are still very low (less than 15 tonnes/ha).

The total exports of pineapple to Barbados and Trinidad were about 390 tonnes in 1992.

1.1.3.2. Processed pineapple

Export of processed pineapple started in 1990, with about 25 tonnes of chunks. In 1992, 192 tonnes of chunks and 16 tonnes of jam were exported (mainly to Trinidad), which represents a value of about G$7.5 million (US$60,000).

Processed pineapple imports for 1991 were not large and consisted mainly of preserved pineapple, concentrated pineapple juice and unfermented pineapple juice.

1.2. EXISTING SUPPORT TO THE PINEAPPLE INDUSTRY

1.2.1. Public sector policies

The overall economic condition of Guyana had deteriorated in the 1980s. Thus, in order to reduce its internal and external debt (respectively US$245 million and US$1.8 billion in 1988), the Government Economic Recovery Programme (ERP), was introduced to promote a new financial and economic policy. The objective of this programme was to conclude an agreement with the IMF in late 1989. This agreement was to be a major boost to the agricultural sector, facilitating foreign exchanges.

The ERP has been the justification for the privatization of several public sector corporations. Consequently, special investment incentives have been put in place for locally incorporated companies that have been granted 'approved status' (Appendix 4).

Agro-industry has been identified as one of the areas in which the Government of Guyana is seeking to attract investments. The motivating concerns in this area include: the desire to establish a vibrant export base for primary commodities as well as for processed value-added products; the recognition that the development of the agro-industry sector can contribute to diversified development of the economy and the concept of food self sufficiency within the Caricom region as well as within Guyana. (Anon. 1991).

The agriculture sector is oriented to achieve a greater degree of self-sufficiency and self-reliance through a strategy utilizing to the greatest extent possible, indigenous raw material and human resources. A major

investment programme was instituted whereby emphasis was placed on the strengthening of research, education, training and institutional support activities (IICA 1992).

1.2.2. Institutions involved in the industry

Various organizations and institutions are working in order to achieve the above expectations (see Appendix 5). They are mainly:

- **NARI** (National Agricultural Research Institute of Guyana)
- **MoA** (Ministry of Agriculture)
- **New GMC** (New Guyana Marketing Corporation)
- **IICA** (Inter-American Institute for Cooperation on Agriculture)
- **CARDI** (Caribbean Agricultural Research and Development Institute)
- **IFAD** (International Fund for Agricultural Development)

1.3. AVAILABILITY OF GENETIC MATERIAL IN GUYANA

The origin of pineapple production in Guyana goes back to 1920 with the establishment of different varieties (Baichoo, 1993). Since then various attempts have been made to introduce varieties such as the Smooth Cayenne from Hawaii, Puerto Rico and Martinique, or to extend the cultivation of local varieties on different soils.

Because of poor management of the cultivation and unsuitable soils, the foreign varieties which are more susceptible to diseases and water conditions did not perform well. The Guyanese Montserrat variety, which is more robust than Smooth Cayenne, for example, performed well on different soils (sands, clays) and was consequently retained in the major areas.

During recent investigations, different varieties were observed and collected and some may have good potential. (General information on pineapple is given in Appendix 6).

1.3.1. The Montserrat variety

The Montserrat variety represents more than 90% of the pineapples cultivated in Guyana. For this reason observations were made to define its characteristics and variability. The Guyanese Montserrat variety (which belongs to the Pernambuco group) is not the same Montserrat which is registered in the pineapple collection of Martinique; the latter belongs to the Spanish group.

1.3.1.1. Description of the plant

The plant is erect with long spiny leaves with a darker tint (brownish) in the centre of the leaves.

The peduncle is longer than Cayenne and numerous developed slips (seven on average but may be as many as 15) are attached around the base of the fruit.

The plant naturally produces only a few suckers (two to three on average) which develop late. The flowers are purple/blue in colour.

1.3.1.2. Description of the fruit

Generally, fruits are conical in shape and turn yellow to orange when they are ripe. However, there is great variability in the characteristics between the first and second crops and even within the same crop (pict. 1, and 2; Appendices 7 and 8).

In order to define those variabilities, a statistical classification of fruits was made. It shows that for the first crop two types of fruit are encountered within the same plot.

- Conical fruits which are generally large (1–2 kg) and can be classified into two sub-groups:
  - fruits with a small crown (weight of the fruit/ weight of the crown >11) (Type 1).
  - fruits with a larger crown (weight of the fruit/weight of the crown = 7) (Type 2).
- Fruits that tend to be cylindrical which can be classified into two sub-groups:
  - medium size fruits (800 g) (Type 3).
  - large fruits (>1.3 kg) (Type 4).

The above classification shows the possible variation in fruit characteristics which also depends on the management of the cultivation; fertilizers can affect the shape and size of the fruit. Nevertheless, it is important to note that fruits with a tendency to be cylindrical in shape do exist. These are more suitable for processing since mechanized peeling is possible.

Research should be done to select the right clone for the different markets such as that for processing and that for fresh fruit. NARI, which has a tissue culture laboratory, could be involved in this research.

1.3.1.3. Ripeness and post-harvesting conditions

*** Maturity**

Observation of fruits showed the different characteristics of the Montserrat variety at each stage of maturity (pict. 3; Appendices 9 and 10).

Because fruits which are fully yellow are almost over-ripe, harvesting should be done at an earlier stage — Maturity Stage 1 is the best.

*** Post-harvest conditions**

In order to determine the post-harvest conditions, batches of standard fruits for export were bought (average weight 1.5 kg). The observations were made on fruits at Maturity Stages 1, 2 and 3 stored at ambient temperature (25 to 30 °C). Five fruits were peeled every

2 days and chemical analyses (brix, titratable acidity, ascorbic acid rate) were conducted when possible.

Generally, the shelf-life of pineapples harvested at Maturity Stage 1 is about 15 days; for fruits harvested at Maturity Stage 2, it is about 10 days and for fruits harvested at Maturity Stage 3, about 7 days. When fruits exceed their shelf-lives they are over-ripe but can still be used to make jams and beverages. However, after a delay of 3–4 days fermentation occurs quickly. The above shelf-lives are for fruits that are not damaged or affected by diseases when harvested.

In the case of infection by *Penicillium* sp., after a delay of 4 to 5 days, up to a quarter of the fruitlets show black spots (see Appendix 18). The disease spreads very quickly because of the high temperature and makes the fruit unsuitable for immediate consumption or export.

Chemical analyses show that the sugar content does not increase after harvesting but decreases slowly while at the same time the titratable acidity is increasing.

* **Potential of the Montserrat variety**

(a) Processing

At present, peeling is manual since most of the fruits do not meet the standards for size and shape. If mechanized peeling were used 30% of the fruit (the top) would have to be removed and used to make jams or juices which do not have the same value as chunks or slices. Fruits with a cylindrical shape are more suitable.

The Montserrat variety has a high ratio of sugar content/titrateable acidity (2.37) which gives a lower aromatic quality than the Smooth Cayenne (sugar/acidity, 1.5). Canned products are less tasty.

The pulp of Montserrat is characterized by a total acidity of 6.6 meq/100 ml, an ascorbic acid rate of 3.4 meq/100 ml and a sugar content of 15.7 g/100 ml (brix, 17°).

(b) Fresh market

Since this variety is very sweet it is appreciated by most Caribbean consumers. It also has a long shelf-life and therefore a good potential for the fresh fruit market.

For the export market, the conical shape of the fruits is a constraint only in packing. If fruits are packed in an upright position, it results in a waste of space in the cardboard box.

1.3.2. The English Pine (Bakra or Cheese-Pine) variety

English Pine is cultivated only in the Amerindian settlements, namely Moraikobai (Region 5) and Orealla (Region 6), where it is the most prominent variety (90% of the pineapple cultivated). It seems to belong to the Pernambuco group.

1.3.2.1. Description of the plant

The plant is erect and has spiny, long, narrow leaves which are greater in number than in the Montserrat variety. The leaves are grey/green in colour. The peduncule is longer than the Cayenne with numerous slips attached around the fruit. The flower has the same colour as Montserrat.

1.3.2.2. Description of the fruit

The fruit is conical in shape and has a bottleneck at the base of the crown. The average weight of the fruit is 1 kg and it is about 17 cm long. The crown is short, erect and weighs about 45 g (pict. 4).

The ripe fruit is dark-green to brown. However, the colouration tends to be orange to reddish when the fruit is over-ripe. The flesh is yellow and the carpellary loci are not full. This fruit cannot be stored for more than 4 days since it decomposes very rapidly. The characteristics of the fruits are given in Appendix 11.

This fruit has a taste which is not appreciated by everyone, but contains a good rate of ascorbic acid (18 mg/100 ml of pulp). The sugar content is relatively low, about 11.2 g/100 ml of pulp (brix = 12.9°) while the total acidity is 8.7 meq/100 ml of pulp.

1.3.3. The other local varieties

Many other varieties were encountered during the investigations in the field (Appendix 11). Sugar Loaf represents about 5% of the pineapple harvested at Region 4, but even though it is appreciated for its sweetness, it is not preferred by the consumers (pict. 5).

Some data are missing, since fruits were not always available. Guyana has some potential for genetic resources. For example, varieties such as Bush-head or Tiger-head are interesting, as their fruit weights can reach 4 kg or more (pict. 6). However, the flesh of these varieties is mostly fibrous and this reduces the quality. They also mature too quickly to be stored for as long as Montserrat (pict. 7 and 8).

Nevertheless, more precise investigations should be done to make an evaluation of the real potential of these varieties, in terms of sensitivity to diseases, adaptability to the soil and climate, internal characteristics and post-harvest behaviour.

1.3.4. Constraints due to the varieties planted

As mentioned above, the Montserrat variety (Pernambuco group) is mostly planted. In Region 3, all the plots are cultivated with this variety, while at Region 4, Sugar Loaf (which belongs to the Spanish group) represents 10% of the area. At Orealla and Moraikobai, the English-pine is mostly cultivated but it is mixed with about 10% of other local varieties.

Normally, pineapple is self-sterile within the same variety but not between two varieties. This is not

confirmed for the Montserrat variety, since about 40% of the fruits from Regions 3 and 4 have more than 20 seeds, without any significant difference between the cycles and the areas. Nevertheless, the survey for the characteristics of Montserrat showed the existence of possible clones within the same variety. A strict selection of one clone should reduce the possibility of cross-pollination and consequently the number of fruits containing seeds.

In Orealla and Moraikobai, where more than 12 varieties, (which belong mainly to three groups Pernambuco, Spanish and Perolera) are planted in the same plots, most of the fruits contain seeds in a large number (almost half of the fruitlets). Consequently, farmers from those areas should be trained to separate the varieties into different plots as far as possible in order to reduce the number of fruits containing seeds.

Pineapple seeds cannot germinate under natural conditions; consequently, they are not suitable as propagation material. In addition, they pose different disadvantages:

— The presence of seeds is not suitable for the fresh fruit market since consumers are accustomed to seedless pineapple fruits.

— The main disadvantage is for processing. When peeling, seeds are not removed and remain deep in the flesh of the fruit (1 cm from the skin). Consequently, such fruits are not suitable for the production of chunks since each seed must be removed.

— When processing into jams and jellies, very careful straining is obligatory since otherwise the final product would contain seeds and not be accepted by the consumer.

Pineapple seeds measure about 3 mm in length and 2 mm in width, are dark and shining and may be confused with small insects.

In conclusion, more precise research should be done on the determination of the genetic resources within the Montserrat variety (see Section 1.3.1.), and the potential to improve the overall quality of the fruit, with reference to shape, flavour, absence of seeds, internal characteristics and suitability for processing.

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2. PINEAPPLE PRODUCTION

The methodology used for the survey on pineapple production in Guyana is given in Appendix 12.

2.1. BACKGROUND

As stated in Section 1.3., the interest in pineapple production goes back to the 1920s when attempts were made in various regions with different varieties. From that time to the 1960s, pineapples were cultivated mainly in Region 3 because of its easy access to Georgetown.

With the opening of the Soesdyke-Linden Highway in the late 1960s, pineapple production shifted to Region 4, since suitable lands were available and access to Georgetown facilitated. The area of pineapple in that region reached a peak of about 700 ha in 1976, but collapsed the following year (Baichoo, 1993). Yield at that time was very low (2.5 tonnes/ha) due to various factors:

— Pineapple was a secondary crop and not the main one. Consequently, it was intercropped with more vine crops than it is now.

— Inadequate cultural techniques due to a lack of knowledge.

— Few outlets for fresh fruits, due to lack of infrastructure (Baichoo, 1993).

Agricuitural inputs and associated services became available in the 1980s with the establishment of companies which were facilitated by a freeing up of the global economy (Ramsammy, 1992).

On the other hand, the latter permitted an improvement in the marketing of fresh and processed pineapple. Consequently, pineapple production reached a peak of 11,200 tonnes in 1989. After slowing down for about 2 years, this production is on the increase again and reached 8,800 tonnes in 1992.

The previous decrease in production was also due to the change of crops by farmers from Region 3, mainly at Parika and Naamryck Backdam, who had reduced their pineapple areas and adopted a new strategy which consisted of growing a short cycle crop such as cabbage; the advantage of this practise is the guarantee of regular income.

2.2. ENVIRONMENTAL REQUIREMENTS

Pineapples are cultivated mainly in three regions: Essequibo Islands/West Demerara (Region 3); Demerara/Mahaica (Region 4); East Berbice/Corentyne (Region 6); and in different Amerindian settlements in Region 1 and 2 where the production is increasing very rapidly (see map in Appendix 2).

2.2.1. Region 3: Essequibo Islands/West Demerara

This Region is divided into three areas and the pineapple average production area can be seen in Table 1.

Table 1: Average area of pineapple at Region 3.

Site	Average area (ha)
Essequibo Islands/Left Bank Essequibo	30–40
Bonasika/Boerasirie	72
Lower West Demarara River	
Canals Polder 1	90
Canals Polder 2	148

Source: Baichoo, 1993.

2.2.1.1. Essequibo Islands/Left Bank Essequibo

The following soils were encountered:

— Everton silty clay
— Brickery clay
— Tushen clay
— Inki clay

The soils consist of river alluvium over old marine sediment and organic deposits. They have a relatively low potential for agricultural development because of the poor nutrient status, toxic chemical conditions in the lower sub-soils and substratum, poor drainage and very high acidity. Their characteristics are described in Appendix 13.

The climate is typically tropical, rainy:

Average rainfall = 3,200 mm/year
Average humidity = 85%
Average temperature = 27.1 °C

For more details see Appendix 14.

2.2.1.2. The Lower West Demerara River, Bonasika/Boerasirie

Two soils are predominant:

— Mara clay (on which mainly pineapple is cultivated).
— Whittacker clay (front land clay) which is associated with Brickery clay.

The Mara clay is a soil developed from brackish alluvium deposited from marine water sediment. The soil is extremely acid, slowly permeable and difficult to drain. It has a fairly high clay content and is low in plant nutrients. This soil contains one or more layers of material enriched with iron sulphides which, on draining, oxidizes and hydrolyses rapidly to produce sulphuric acid and high quantities of the toxic trivalent aluminium ion. For additional information see Appendix 13.

Infrastructure in this area includes an internal primary drainage system that discharges surplus rain-water through tidal drainage which flows into the river or sea. However, these channels are invaded by weeds and do not function properly. A rehabilitation of the system is needed. (Khan, et al., 1989).

Climate:

Average rainfall = 2,300 mm/year
Average humidity = 85%
Average temperature = 28.9 °C.

Details of the climatic data are given in Appendix 14.

2.2.1.3. Constraints due to flooding

Drainage is one of the major constraints in this area. Pineapple fields are sometimes covered with 30 cm of water for several days. Huge losses resulting from flooding occur during the rainy season mainly at Canals Polder, Parika and Naamryick backdam for reasons such as:

— Poor maintenance of the drainage system.
— Subsurface layers of soil which are very rich in clay, resulting in poor permeability. This is also aggravated by the use of tractors for ploughing which results in compaction of those layers.
— At Canals Polder the land is very low and flat, resulting in difficulty in drainage.

Some consequences of flooding are:

— The slowing down of mature plant growth due to damage affecting the root system. Pineapple roots are very sensitive to asphyxia, resulting in wilting of the entire plant. The main symptoms are a reddish tint and loss of turgidity resembling the symptoms of wilt disease. This increases the difficulties in differentiating the effects due to viral disease, nematode attacks and flooding (see Section 2.3).
— The young plants are stressed, resulting in precocious flowering.
— Difficulty in sustaining cultivations, since no work can be done at that time.
— For inter-cropping with permanent crops, only a few types of trees can be planted since others (such as citrus) cannot endure flooding.

When plots are flooded, the underground fauna (nematodes, symphilids, etc.) are destroyed. However, their eggs are not destroyed so when the environment becomes suitable the eggs hatch resulting in a recharge of the pest population.

In order to rehabilitate the primary drainage system, channels were excavated and cleared as part of a project conducted by IFAD. However, aquatic weeds are invading the area very quickly due to the exceptional biotope found in the channels.

In order to improve productivity in Region 3 proper management is needed. Nevertheless, the main advantage of this Region is its accessibility to Georgetown, which is made possible by well-maintained tarmac roads connected to the capital city by a floating bridge, 1.6 km long, across the Demerara River.

2.2.2. Region 4: Demerara/Mahaica

This Region is divided in two zones:

— Moblissa/La Reconnaissance

— Buxton/Mahaica

Pineapples are cultivated mainly in the first zone with an estimated area of about 35 ha.

The soil in most of the pineapple producing areas is a deep, excessively drained sand (Regosols), which consist of stratified, unconsolidated white quartz sand deposits on ground water podzols. This soil is very poor in plant nutrients and has a poor capacity for retaining nutritive compounds; consequently, the fertilization strategy will be different to that in Region 3. But, in terms of structure, this light soil is favourable to production of a well developed pineapple root system.

Climate:

Average rainfall	=	2,594 mm/year
Average humidity	=	70%
Average temperatures	=	26.1 °C

Details of climatic data are given in Appendix 14.

2.2.3. Region 6: East Berbice/Corentyne

The pineapple producing area in this Region is an Amerindian settlement named Orealla. The total area is about 60 ha divided into two zones of equivalent size; the first is situated close to the village downstream the Corentyne River, while the second is situated 3-4 km away from the village in the bushy area. The soil is mainly White Sand as in Region 4, but some brownish sands are also encountered.

2.2.4. Other areas

Pineapples are also cultivated in all the Amerindian settlements but in small plots for family consumption. However, in Region 2 the cultivation seems to extending rapidly.

2.3. PHYTOSANITARY CONSTRAINTS

It is important to present the phytosanitary problems first, since this will help in understanding some aspects of cultivation management and in evaluating the costs of production for the main producing areas.

2.3.1. Diseases and pests which affect the plant

2.3.1.1. Plant wilts

Plant wilts observed are the wilt disease caused by a virus and the plant wilt due to nematode activities.

*** The wilt disease caused by a virus** (pict. 9 and 10)

This wilt is widely distributed throughout the world and is common in Guyana. It seems to be one of the main causes of the decrease in pineapple cultivation which has occurred since 1976 on the White Sands (Region 4). The number of plants affected in any one planting varies considerably. The disease frequently attacks more than 50% of the plants. If the affected plant nevertheless produces a fruit, it is generally unusable, and consequently yield losses can be very high (Py et al., 1987). For more information see Appendix 15.

*** The plant wilt caused by nematodes** (pict. 11)

Nematodes, which are endoparasites vermiform in shape, are found in all types of soil. According to an analysis carried out by the Phytopathology Department of NARI, the species present in Guyana is *Pratylenchus brachyurus* (Godfrey) which is known for its virulence. Its presence has a marked impact on production since it damages the root system, affecting the development of the plant. It has been reported in Hawaii, the Antilles, Australia and South Africa but appears to cause most damage in the Ivory Coast (Py et al., 1987). Losses can reach 60% of the yield in cases of high infestation. The ratoon crops are even more sensitive and their yields are very low or non-existent. For more information see Appendix 16.

*** Local impact of plant wilts**

According to the area, and consequently to the soil, it is difficult to make any comparison between the viral disease and the plant wilt caused by nematodes since the symptoms are very similar and plants are usually affected by both. Effects of flooding and signs of potassium deficiency (see Section 2.6.2.3.) increase these difficulties. Observations conducted in various pineapple-growing areas have shown that:

— On the White Sands (Region 4), the wilt disease caused by the virus is characteristic and losses can range from 0 to 30% for the first crop and from 15 to more than 50% for the first ratoon crop.

— At Canals Polder (Region 3) symptoms are not always characteristic of viral or nematode attack. Consequently, results are given in terms of plants wilted. Nevertheless, nematodes seem to be prevalent in those areas and partly hide the symptoms associated with viral attacks.

— At Parika and Naamryck (Region 3) only first crop plantations were observed. The amount of plants wilted ranged from 0 to 20% of the total area.

— At Orealla (Region 6) only the viral disease is present but affects less than 5% of the plantations.

Table 2: Percentage of plants wilted at Canals Polder 1 and 2

	First crop			First ratoon crop		
Area	Min. (%)	Max. (%)	Avg. (%)	Min. (%)	Max. (%)	Avg. (%)
Canals Polder 1	5	15	12	15	20	18
Canals Polder 2	10	30	17	15	50	30

2.3.1.2. Symphylids

*** General information about the pest**

Symphylids are small Myriapodae that eat root tips causing a slowing down of growth, which depresses yields and facilitates pathogenic infestations. This pest has an economic impact only in localities which are suitable for its development. For more information see Appendix 17.

* **Local impact of the pest**

Symphylids are present in Guyana. Roots showing either 'witch's broom' or 'club' aspects were observed in the different areas. This pest does not have a great economic impact because the ecological conditions in the bedded soil are not suitable for its development. Nevertheless, studies should be conducted to follow the evolution of its distribution and effect in the different production areas.

2.3.2. Diseases or pests which affect the fruit

2.3.2.1. Diseases due to *Penicillium* sp. and *Fusarium* sp.

* **General information**

The economic impact of fruit diseases (black spot, leathery pocket, inter-fruitlet corking) can be considerable, depending on the fruit maturity and the number of fruitlets attacked (pict. 12). Data on the occurrence of these pathogens and their control are few (Appendix 18). Only processors and consumers are concerned directly with these diseases since the symptoms are not visible from the outside of the fruit.

* **Local impact of the diseases**

Observations made on the different samples show that there are no differences between the prevalence of these diseases in Regions 3 and 4, nor between the plant crop and the first ratoon crop. The quantity of mature fruits affected by either black spot or leathery pocket is estimated at about 58%.

For processing, each affected part of the fruit is removed manually causing direct losses and wastage of time. In order to reduce losses, local processors tend to buy immature fruits or fruits that have reached Maturity Stage 1. The main consequence is the addition of large amounts of sugar, resulting in final products with less aroma.

2.3.2.2. Diseases caused by *Thielaviopsis paradoxa*

* **General information**

Infestations take different forms on the fruit-base rot, black rot, water blister, etc. These rots have the same agent, the fungus *Thielaviopsis paradoxa*. This organism is undoubtedly the one that can have the greatest economic impact if no control measures are taken. Damage occurs particularly on fruits that have been stored (Appendix 19).

* **Local impact of the fungus attack**

(a) The fresh fruit market

With regards to wholesaling, most of the fruits are sold between the second and third day after harvest. Losses range from 0 to 40% depending on many factors such as:

— harvest and post-harvest handling
— storage conditions at the farm (duration, temperature, containers).
— conditions of transportation (means, containers, duration) from the field to the farm and from the farm to the main market (Stabroek or Parika).

In retailing losses can be very high (more than half of the pineapples) if fruits are stored for several days in bad conditions (in bulk under the stall for example) and handled very often by sellers and consumers.

(b) Fresh fruits for export

The above factors are of course valid here. In order to reduce the losses, all damaged fruits are discarded. They represent around 15–20% of the batches. Selected pineapples are trimmed and dipped in a solution of fungicide (Benlate®) before packaging and shipping. Nevertheless, losses can reach 50% of the shipment due to careless handling during and after packaging.

(c) Impact on planting material

For the fresh fruits, losses of planting material depend on handling and the conditions of storage. In Guyana, the impact of fungus on suckers is not important since a minimum care is given.

2.3.2.3. Gummosis caused by *Thecla basilides* (Geyer)

* **General information**

Thecla basilides (Geyer) is a Lepidoptera (butterfly) widespread in Latin America, but not in the Caribbean islands (with the exception of Trinidad) nor other continents. Detailed information is given in Appendix 20.

Damage to the pineapple crop can be extensive if preventive measures are not taken (pict. 13 and 14). This fact seems to be one of the main reasons why the Latin American pineapple industry did not expand, as expected, at the beginning of this century (Py et al., 1987).

* **Local impact of the pest**

Observations conducted in the field and on the samples of fruits show that there are no significant differences between the number of affected fruits in the first crop and the first ratoon crop. But, plots in Regions 4 and 6 are more affected than those in Region 3 - respectively 57 and 50% of the fruits as against 40%).

On the other hand, there is a difference between the amount of misshapen fruits in Region 3 (11%) and in Region 4 (29.5%). This difference could be explained by the use of insecticides against mealybugs in Region 3 which also helps to control the larvae activities.

2.3.2.4. Disease caused by *Saccharomyces* sp.

Yeast fermentation occurs in the fruits while they are still on the plant and also during storage. It only appears in over-ripe fruits (see symptoms in Appendix 21) and sporadically on fruits that have not been harvested.

This disease is encountered in all producing countries and has no significant economic impact on Guyana, because of the Montserrat variety. The other varieties

which exist locally have a short shelf-life (3 to 4 days, according to the Amerindians). Consequently, losses can be very high, since villages are often far from the main markets in the country.

2.3.3. Other pests

Peculiar names are given to two problems encountered in Guyana since their true nature is not known.

2.3.3.1. Diamond-back bug

A bug, determined by the Entomology Department of NARI to be *Plutella xylostella*, was found on all wilted plants. The bug (named diamond-back) measures about 1.2 cm long and 0.5 cm across and is orange in colour. It has a black spot in the shape of a diamond at the back of its wings when they are closed (pict. 15).

This insect is suspected to transmit the virus from one plant to another by feeding on the fruit; however, this fact must be confirmed by precise research. Nevertheless, other bugs from the same genus are known to spread viral diseases (on corn for example) since they have an adequate digestive system for the internal preservation and multiplication of viruses.

On the other hand, the presence of this bug causes external blackening due to its droppings (which may be invaded by fungus) and internal damage due to the feeding points. These feeding points facilitate opportunist infection by other potential pathogens.

2.3.3.2. Fruit fly

In all the pineapple producing areas visited in Guyana there is an unusual problem affecting fruits. The true nature of it is unknown, but the symptoms and a hypothesis are given below.

A condition exists where there are no visible symptoms of infection on the leaves of the plant and it seems to be healthy. The fruit, even though normal in shape, displays a heterogeneous external colouration-green stripes, brown to reddish spots. The flesh is firm, yellowish brown and translucent with fine cavities (filled with a reddish gum) which are mainly located on the outside of the fruit (pict. 16). This problem occurs mainly in the bushy areas.

At first a bacterial or viral infection was suspected; samples were analysed in Martinique but no bacteria were found. It was observed that very fine worms, like fruit-fly larvae were found on most of the affected fruits. Samples were given to the Quarantine Department of the Ministry of Agriculture but they unfortunately decomposed before a test could be carried out.

2.3.3.3. Birds, monkeys and wild animals

Birds damage the fruit by feeding in the heart of the crown at an early stage resulting in fruits without crowns which are thus not suitable for fresh fruit export. This damage is equally prevalent in all the producing areas.

In the bushy areas, losses of about 10% of the young plantation (in Orealla for example) are due to monkeys that feed by pulling out the central leaves and eating their tender parts.

Wild animals such as 'the savannah fox' cause for some losses (up to 5% of the yield in some far-away areas) by feeding on the ripe fruits.

2.3.4. General losses due to pests and diseases

Only the general losses for Regions 3 (Canals Polder) and 4 were calculated, firstly because they are the main producing areas and secondly because more precise data are available.

The Table in Appendix 22 shows that direct losses can be more than 50% and are more serious for the farmers in Region 4 than in Region 3. The main reason for this difference is obviously the use of chemical control for pests and diseases which is carried out in the second area. Most of the losses are due to the viral wilt disease and the prevalence of *Thecla basilides*. It is very important to note that the losses in income are more than the earnings, except in the case of the first crop in Region 3.

Adequate treatment against the main pests and diseases should drastically reduce these losses and consequently increase profits and fruit quality.

2.4. PRODUCTION

2.4.1. The land

2.4.1.1. Potential area

Lands that could be cultivated in pineapple are estimated to cover about 56,000 ha and are divided as follows:

— Soesdyke-Linden highway (Region 4): 24,000 ha
— Parika Backlands and Naamryick (Region 3): 12,000 ha
— Mainstay-Bartica/Potaro (Regions 7 and 10): 20,000 ha (Baichoo, 1993)

It should be noted that Regions 1 and 2 are coming into the business very strongly.

Lands are available, but the infrastructure required to convey the raw materials to the main towns is poor.

2.4.1.2. Facilities for establishment

State lands are available on long-term leases. Interested individuals have to make a request to the Lands and Survey Department (MoA). This department makes the necessary investigations to ensure that the requested land is vacant and suitable for pineapple production and submits the file to the DLSC and then to the RLSC (District and Regional Land Selection Committee) for recommendations. If there is another

interested applicant, a selection is done according to the reliability of the individuals and their purposes.

After this process, the Ministry of Agriculture delivers an authorization for exploitation and fixes the lease from G$5–37/ha per year according to the terms of the lease 20 years and over. The duration of the lease ranges from 20 to more than 25 years. The entire procedure takes an average of about 3 months. However, this period can be extended up to a year. During this time, the vacant land may be squatted on by other individuals who do not think the legal procedure necessary.

The second way to acquire land is by purchasing it. After an evaluation of the land made by the Chief Valuation Officer, the price is fixed and the land proposed for sale. In order to keep control of the land use, the area sold to an interested individual is generally not more than 4 ha.

2.4.2. The labour force

The labour force comprises mainly the family for the general maintenance of the plots. Labourers are employed at different stages of the cultivation-clearing of the land, weeding, harvesting.

They can be daily paid workers (G$300–500/day) or task-workers; the price depends on the arrangement between the labourer and farmer. The number of labourers needed on each plot is variable and depends on:

- The size of the plots.
- The use of chemical control.
- The degree of attention the farmer wants to pay to the plot.
- The purchasing power of the farmer.

In Region 3, workers are more available than in Region 4 or Region 6, due to the location of the plots. This has an effect on the general maintenance of fields.

2.4.3. Technology and infrastructure

2.4.3.1. Technology

In Region 3, small equipment such as spray-cans belongs to the farmers. However, few farmers have their own tractors (about 10%); the others borrow from their family or rent. Ploughing the land with a tractor costs about G$5,000/ha per passage.

For conveying raw material from the field to the farm, bull-carts are usually used. In Region 3, 50% of the farmers have their own bull-cart; the others may rent one for about G$2,000/day.

For all Regions, the main equipment used for planting, weeding, harvesting, etc. is the cutlass.

2.4.3.2. Infrastructure

In Region 3, the infrastructure consists of roads and drainage trenches that are used for the transportation of raw material from the plots to the main roads and then to Georgetown.

Farmers must design their own drainage system when preparing the land, as careless maintenance results in flooding and huge losses.

In Regions 4 and 6, there is no infrastructure and the tracks that are used are sometimes in very poor condition.

2.5. MANAGEMENT OF AVAILABLE LAND FOR THE PRODUCTION OF DIFFERENT CROPS

2.5.1 Region 3

Three ways of distributing land are encountered:

- Inherited lands (60% of the farms) which are relatively small in area (5.5 ha on average).
- State lands on lease (25% of the farms) which range from 8 to 25 ha with an average of 20 ha.
- Private lands (15% of the farms) of up to 36 ha in area.

In Canals Polder, most of the farms have direct access to the main roads but that is not the case in Parika and Naamryck backdams.

The area of pineapple ranges from 0.2 to 4 ha for the first crop and (or) 0 to 2.8 ha for the first ratoon crop. Most of the farms have separate plots with about 0–2 ha of sugar cane, 0–2 ha of ground provisions or 0.5 ha of old coffee plots and some fruit trees (mango, avocado, citrus, etc.), but sugar cane and pineapple cultivation remain the most important sources of income.

The future of the plots in those areas is linked to various factors such as the choice of the farmer, possible outlets, soil fertility and drainage.

Generally, plots are replanted with pineapple after the second cycle and this can be done two or three times. As the soil becomes really unsuitable for a good pineapple yield (with consequent high cost in fertilizers) two strategies are applied:

- Plots are abandoned (altogether or for a fallow of more than 8 years). Also this depends on whether the land is easily flooded or not.
- Permanent crops are planted during the last pineapple crop.

2.5.2 Region 4

In Region 4, the average size of land distributed to each farmer is about 12 ha. On each farm the average area of pineapple is about 1.5–3 ha for the first crop and 1–3 ha for the first ratoon crop, depending on the date of establishment; 30% of the farmers interviewed have just started to grow pineapples.

For each farm, an average of 1.6 ha is cultivated every year, twice, during the dry periods. The cut

bushes have to be dried before being burnt. Old farms are abandoned resulting in a shifting cultivation. However, only one of the farmers interviewed does not abandon his plot; after the third cycle of pineapple, coconut trees are planted.

Most of the farmers do not have separate plots cultivated with another crop for commercial purposes. However, half of the farmers practise inter-cropping with vine crops or cassava. For home consumption, farmers have a few fruit trees, plantains, yams, etc.

2.6. CULTURAL TECHNIQUES

2.6.1. Planting

2.6.1.1. Land preparation

(a) Region 3

The land preparation depends on the previous crop cultivated:

- On virgin land, the debris resulting from land clearing is allowed to dry for about 3–4 weeks and then burnt (pict. 17). Under these conditions only one ploughing operation may be done, at times however, this is usually not done.
- On land previously cropped, three ploughing operations are usually performed, to a depth of 30–40 cm. Between each ploughing, the soil is left to dry for about 3 to 4 weeks. Generally, the size of a plot is not more than 0.2–0.4 ha, since drainage channels are dug every 10 m on average. This, results in plots of pineapples, 30 m long, 10 m across with drains 30–40 cm in depth.

These practises present some disadvantages:

- Clearing by fire results in destroying a large quantity of organic matter in the surface soil, thereby reducing its fertility and increasing its fragility by modifying its primary structure.
- The top layer is only 30 cm deep so when ploughing the subsurface layers, which are rich in acid clays containing toxic sulphate anions, are raised up resulting in:
  - acidification of soils in the bed.
  - reduction in the ability to drain excess water, suggesting that ploughing should not be done too deep).
  - compaction of the soil resulting in a more impermeable layer.

Some advantages also exist:

- burning the previous vegetation destroys pests and diseases which may be present and the resulting ashes (rich in potash) enrich the soil.
- the heat resulting from burning breaks down some of the chemical compounds in the soil. As such, minerals which were previously unavailable to the plant can be released and taken up.
- Ploughing breaks the soil into a fine tilth.

(b) Regions 4 and 6

In these Regions, as previously stated clearing is always done by cutting and burning the vegetation. No ploughing or tilling is done due to the sandy texture of the soil. In both cases, no fertilization or other treatment is carried out before planting.

2.6.1.2. Planting material

*** Availability of planting material**

Basal slips are used by all farmers as planting material. They are available in large quantities since each plant bears an average of seven slips — frequently 10–15 slips for the Montserrat variety (Appendix 8). Those weighing more than 150 g) represent good planting material. In Region 3 and 4, the slips are harvested with the fruits. Pineapple slips are sold for G$3–5 each, according to size.

At Region 6, the fruit is harvested by cutting it at the base, leaving all the slips to develop on the plant. Healthy planting material of a very good size is then available.

Side-shoots and ground suckers are rarely used. However, they represent very good planting material since they are bigger than slips and it is already known that the bigger the suckers, the shorter the first cycle (Py et al., 1987).

Crowns are not used by farmers since the duration of the first cycle would be extended to more than 2 years instead of the usual 19 months duration when slips are employed.

NARI is producing disease-free planting material using tissue culture. NARI, the MoA and IFAD set up a demonstration plot (May 1992) at Parika backdam with rows planted with different types and size of suckers and with tissue-cultured plantlets about 9 cm tall. When visited, the tissue culture plants were about 14 months old but were only about 20–30 cm high, despite the care given to the plot. Tissue-cultured plants should be used only to start a disease-free foundation block or to obtain homogeneous planting material according to its genetic potential but cannot be used for commercial purposes. The cost of maintenance of the plantation is enormous (more than twice the normal cost) since the duration of the cycle is doubled and the plants are so small that weeds can compete easily with them.

*** Storage and preparation of planting material**

Farmers of Regions 3 and 4 use almost the same practices: the planting material is either stored under a tree or a shed for a period that ranges from 7 days to 3 months (this practice is followed by 30% of the farmers) or the planting material is left in open areas in an upright position with the bottom touching the soil for a period ranging from 2 weeks to 6 months. The slips are gathered together as in a nursery.

No treatment or trimming is done before planting, only a grading exercise according to the size of the slips.

The other farmers of this area as well as the Amerindians from Region 6 and Moraikobai (Region 5) do not store the slips for more than 2 weeks. The slips are systematically trimmed; basal dried leaves are removed and the bottom is cut flat before planting.

Trimming the suckers is a very good practice since emergence of the roots is accelerated and colonies of mealybugs can be seen. Nevertheless, the slips should be also dipped in a solution of insecticide to kill all mealybugs in order to avoid spreading the viral wilt disease (Appendix 15).

The nursery practice is unsuitable for various reasons:

— The suckers root easily at the nursery but lack nitrogen, potassium and several other minerals due to the root competition. When these suckers are planted the roots suffer a stress which results in a delay in the normal growth cycle.

— If a disease, caused by *Thielaviopsis paradoxa*, for example, infects one sucker, then the entire batch will be infected quickly (Appendix 19) .

The best way to store planting material is to leave it in a covered, dry and airy place, if possible, on a wire netting.

2.6.1.3. Planting

* **Situation**

(a) Region 3

The average planting density is about 15,000 plants/ha with drains every 10 m. The single row planting system is practised; with 1.1 m between two rows and 50 cm between two plants. Only a few farmers interviewed were practising, with great success, the double-row system with a density greater than 20,000 plants/ha.

Pineapples are planted in the furrows throughout the plot by moulding the plants with the soil. About 60% of the farmers practised inter-cropping as follows:

— First, short-cycle crops such as plantains, bananas, hot peppers, ground provisions are planted in between the pineapples (pict. 18 and 19).

— After the short-cycle crop is harvested, permanent crops are planted such as citrus, avocado and cinnamon trees. Meanwhile, after the second cycle of pineapple, an orchard is established and the permanent crops benefit at their young stages from the care given to the pineapple crops (weeding, etc.)

This inter-cropping practice is best since land-use is optimized.

(b) Region 4

In this Region, pineapples are also planted in single rows with an average density of 14,000 plants/ha. No drainage channels are necessary and consequently there is no wastage of space.

The distance between plants within the row is about 60 cm and it is about 1.2 m between rows. More space is left between the rows since vine crops (pumpkin, watermelon, etc.) or corn are planted between the pineapple rows by more than 50% of the farmers.

Generally, a cutlass or a piece of wood is used to dig holes for the planting and one person can plant an average of up to 1,000 plants a day.

* **Discussion**

In both cases, there is an evident waste of space. Pineapples could be planted closer since their root systems are not extensive. Even if space is needed between the rows to allow for weeding (pineapple leaves are very spiny and erect) or inter-cropping, pineapples should be planted 40 cm within rows which should give on average, the densities shown in Table 3.

Table 3: Possible densities (plants/ha) for pineapple in Guyana

Spacing type	Region 3	Region 4
Single row	20,000	21,000
Double row	24,000	26,000

With single row spacing, the distance between rows is 1.1 m, while with double rows the distance between rows on the ridge is 40 cm.

Region 3 farmers said the reasons why they plant pineapple suckers in the furrows of the ridges are to prevent the entire plant from falling and also to limit the effects of a drought. However, all the fallen plants show defective root systems (due to nematodes or symphylids and/or the acidity of the soil (see Appendices 16 and 17). On the other hand, the dry periods are very short and cannot have any real effect on the plant whereas during the rainy seasons the plants are covered with water and are damaged. Thus, pineapples should be planted on the top of the ridge and not in the furrow and should also be treated against pests and diseases which affect the root system (see Sections 2.3.1. and 2.6.2.5.).

2.6.2. Management of cultivation

2.6.2.1. Management of production cycles

(a) Region 3

Most of the farmers interviewed said they had no interest in a third crop since the yield is too low and as a result they replough the plot after the second cycle.

Generally, farmers take care with the first crop and neglect the others and as a result, only weeding and sporadic treatments are carried out for the first ratoon crop and no care is given to a second ratoon crop. In the latter case, occasional picking of fruits is done since the plots are usually plagued by weeds, pests, etc.

(b) Region 4

The land is not replanted with pineapples and is generally abandoned. However, farmers may harvest fruits from a third-cycle crop. As in Region 3, this cycle

does not benefit from any care which results in very poor yields. Only one farmer interviewed is maintaining a third-cycle crop with successful results.

With the exception of two farmers, almost the same maintenance is provided to the first two crops in this region.

(c) **Region 6**

Farmers from Orealla maintain only the first crop. The 'picking' practice is done from the second-cycle crop. In view of the fact that plots are almost abandoned after the first cycle, the yield from the third cycle is non-existent since most of the fruits are infested with diseases or damaged.

In both areas, when fruits from the first crop are harvested the leaves are cut back to an average of 30 cm in order to stimulate and facilitate the growth of the side-shoots (according to the farmers) and shorten the cycle.

2.6.2.2. Duration of the cycles

In natural conditions without any flower induction treatment, the average duration of the cycles using slips of about 200 g) at planting is as follows:

Table 4: Duration of natural cycles

Crop	Duration of the cycle (from planting to harvesting)
First cycle	19 months
Second cycle (1st ratoon crop)	12 months
Third cycle (2nd ratoon crop)	12 months

The duration depends on the size and type of planting material (the whole cycle is about 30 months when using crowns), and the growing conditions (lack of nutrients, weed competition, diseases and pests).

With the use of flower induction hormones, the cycle is reduced from 19 months to 15 months for the first crop. Only farmers from Region 3 practise flower induction, and then only for the first cycle (see Section 2.6.2.6.)

2.6.2.3. Fertilizing

Generally, two fertilizing regimes exist: the medium-term which aims to preserve and/or improve the soil fertility, and the short-term which is aimed to satisfy plant requirements. In Guyana only the short-term is used by farmers of Region 3 while no fertilizing is done in other areas.

Varying fertilizer application to satisfy the crops requirement is essential for the preservation of soil fertility. Also, it is the best way of ensuring that fertilizers are effective. Requirements for the production of one fruit are approximately:

— 4 g N/plant per cycle,
— 1–2 g P_2O_5/plant per cycle,
— 6 g K_2O/plant per cycle,
— 2 to 3 g MgO/plant per cycle.

Calcium and other mineral elements are necessary, but the needs depend on the chemical and physical characteristics of the soil (Py et al., 1987).

* **Nitrogen fertilization**

Nitrogen applications are used for regular growth and resistance of the plant. Thus, they should be done before periods of stress (excess water or drought) in order to reduce the impact of extreme conditions on plant growth.

A quarter of the farmers apply the right dosage; the products used are mainly sulphate of ammonia, and to a lesser extent urea and NPK (15-15-15 or 12-12-17). Another 25% apply 7–10 g N/plant per cycle which is a waste of resources, while the remainder apply inadequate dosages, about 1 g N/plant per cycle.

Fertilizers are applied far from the base of the plant but because pineapple plants do not have an extensive rooting system, fertilizers should be placed either at the axil of the old leaves (pineapple plants have aerial roots around the base of the stem) or at the base of the plant on the soil. The local practice is not efficient enough and results in a significant waste of resources.

The two main consequences of poor nitrogen fertilization are a slow-down in growth which increases the duration of the cycle and a thinner stalk resulting in the lodging of fruits, which are consequently exposed to sunburn. This last case is prevalent in the second cycle crop and mainly on the White Sand areas.

* **Phosphate fertilization**

Only a quarter of the farmers interviewed apply Phosphate fertilizers (triple super-phosphate) at approximately 1 g P_2O_5/plant per cycle. This fertilizer is not essential in pineapple cultivation; thus no effect of lack of fertilizer was visible when visits were paid to the field.

* **Potash fertilization**

Potash fertilizer is used for various reasons:

— To improve the fruit aroma and flavour.
— To increase the peduncle diameter, which increases the resistance to lodging.
— To increase the firmness of the flesh and consequently the resistance of the fruit to handling and its ability to be sliced.
— To stimulate nitrogen absorption. (Py et al., 1987).

This fertilizer is rarely used in Guyana, even if the soil fertility is very poor. Consequently, plants show pronounced signs of potassium deficiency. This is less prevalent on plants of the first crop which follow the cut-and-burn of the previous vegetation, since ashes contain some potash. This occurrence is prevalent at Region 3.

Symptoms that result from a lack of this fertilizer are:

— Leaves develop small yellow spots that increase in size, multiply and may run together at the margin of the leaf blade.
— Drying out of the leaf tips.
— Fruit peduncules with a small diameter.

Almost no calcium fertilizer is applied in Guyana.

2.6.2.4. Weed control

(a) Region 3

The species of weed present in Region 3 can be placed in different groups:

— The grasses (*Gramineae* and *Cyperaceae*) which are very difficult to control and spread very quickly:

Bahamia grass	—	*Capriola dactylon*
Fine grass	—	*Leersia hexandra*
Jussia	—	*Fimbristylis miliaceae*
Razor grass	—	*Rhynchospora* sp.

Others were observed such as *Paniculum* sp., *Digitaria* sp., and the very resistant specie, *Imperata brasiliensis.*

— The other weeds which are more easily controlled are:

Wild starch	—	*Thalia geniculata*
Fern	—	*Blechnum* sp.
Black sage	—	*Cordia curassavica*
Moco moco	—	*Pleurospa arborescens*
Bisi Bisi	—	*Eliocharis interstinca*
White cedar	—	*Tabebuia insignis*
Congo pump	—	*Cecropia* sp.

(Khan et al., 1989; Baichoo, 1993)
and also *Solanum stramonifoliium* and many other unidentified weeds.

In this Region, most of the farmers use both manual methods of weeding and weedicides to control weed growth. Chemicals that could be used and dosages are given in Appendix 23).

Fifty percent of the farmers interviewed use Karmex® alone throughout the cycle as a post-emergence weedicide, but its use is strictly for pre-emergence treatment. In order to obtain results, the farmers apply very strong dosages (about twice that recommended) which burns the leaves but does not necessarily eradicate the weeds. Frequently, weeding has to be done afterwards. Also Karmex® is not efficient against grasses that belong to the Cyperaceae family.

The same technique was observed with the use of Gesapax®. Nevertheless, this product is efficient as a post-emergence weedicide, but only for Dicotyledonae and Gramineae, and not against Cyperaceae which invades most of the local plots. Nevertheless, a test was carried out at Canal Polder 1, using a mixture of Gesapax® (3 l/ha) and Karmex® (3 kg/ha), to show the synergic effect of these two chemicals. It gave very good results. Only a few farmers use Gramoxone® at the right dosage; it is very effective against Monocotyledoneae. However, more precautions (such as using a shield) must be taken when spraying as the chemical burns the leaves.

Since farmers do not use the appropriate chemicals, they compensate for the lack of effectiveness by over-dosing. In this case, treatments are not aimed at killing the weeds but to make weeding easier as the leaves become dry and brittle. Weeding and chemical treatments are done three to five times per cycle for the first crop but only two to three times for the following crops.

When only pineapples are planted in a plot, the lower the density the more difficult is the weed control. But, when pineapple rows are inter-cropped, the use of chemicals is much more difficult because of risks of phytotoxicity.

These treatments reflect the practices of most of the farmers of Region 3; however, at Naamryck Backdam a farmer tried to apply many others products such as Round-up® and 2,4-D with good results. On the same farm an attempt was made at mulching with dark, non-UV treated polyethylene. Even if the film becomes brittle and fragile, results are very good in terms of weed control and plant growth.

The same farmer, again in order to control the weeds, is growing some sweet potato (*Ipomea batatas*) between the pineapple rows. This is possible because of the excellent quality of the soil which is a Pegasse soil. This practice has three advantages:

— To provide suplementary income (potatoes can be harvested every 5 months).
— A good covering of the surface of the soil between the pineapples that permits moisture to be retained.
— To compete with the weeds.

This farmer is a good example for other farmers to follow.

(b) Regions 4 and 6

Almost the same weeds are found in these areas as in Region 3. However, other species are encountered such as:

Blood wood	—	*Vismia* sp.
Sedge	—	*Lielanthus grandiflora*
Sand bitters	—	*Malanpodium compherires*

(Baichoo, 1993)

In both regions, no chemical treatments are applied, only regular weedings. For the first crop, weeds get established only 4—6 months after planting due to the method of land preparation; fire burns most of the seeds and roots present on the soil. This delay depends also on the wind and environmental vegetation. On the other hand, since other crops (mostly vine crops) are planted between the pineapple rows, a better covering of the soil exists resulting in a delay of weed invasion.

Dicotyledoneae are easily controlled by manual weeding but not the Gramineae and Cyperaceae (grasses) since they grow and spread very quickly and weeding stimulates their growth. Consequently, if invasion by grasses can

be delayed, the plot may remain clean for 6–8 months with the aid of occasional weedings.

During the first second cycle crop, most of the farmers do not weed very often — only three to four times per cycle. Consequently, a dense vegetation (with species such as *Cecropia* sp., for example) rapidly invades the plot.

At Orealla, *Solanum stramoniifolium* is left by some Amerindians during the dry season in order to protect the pineapple fruits against sunburn.

In all the regions, weed control is not adequate, due to the ignorance of farmers about the availability and specifications of the weedicides, and thus their method of application. The cost of alternative weedicides can not be taken as the main reason for farmers using only Karmex® since this chemical is more expensive than many others.

2.6.2.5. Pest control

No treatment is carried out on plots in Regions 4 and 6. In Region 3, about 25% of the farmers interviewed do not yet use any chemical since they are new in the business or do not have too many losses due to diseases and pest attacks.

*** Control of the mealybugs**

Twenty-five percent of the farmers are using only one type of chemical for insect control - Karate®, a synthetic pyrethoid. The strength used is very low - 0.0025% instead of 0.02%. The effectiveness of these treatments is very poor. On the other hand, using the same active ingredient may entail the selection of insects that are resistant to the product.

All other farmers who are more experienced use two or three types of chemical according to their apparent effectiveness, their availability and, of course, their selling price.

Treatments are made usually two or three times per cycle during cultivation and mostly only for the first crop. Karate® and Malathion® which are more often used, are insecticides that work on contact; treatments should be repeated more often during the cycle. Control of the target pests is consequently very poor.

On the other hand Vydate L® is a systemic nematicide but can have some effect on the mealybug population, if used correctly.

*** Control of ants**

Effective baits are available either at NARI or at various agricultural shops, but farmers hardly use them, neglecting the increase in the number of ants. Most of them are not aware of the role ants are playing in spreading the viral wilt disease. Treatments carried out for the control of mealybugs also aid in limiting the ant population.

*** Control of nematodes**

The Ministry of Agriculture and NARI were carrying out some experiments on nematode control on one of the farms visited. Different dosages of Mocap® have been tried, but no results have yet been obtained.

*** Discussion**

Some treatments aimed at controlling pests and diseases are used by 75% of the farmers from Region 3, but most of the time with inappropriate pesticides and/or the wrong application method and dosage.

Farmers are not aware of the true nature of pests and diseases which are affecting their crops. Consequently, they are doing their own experiments with various inappropriate chemicals. Also, they are not aware of all the pesticides available in the country, their specifications and prices while this information is available at Regional Offices of the Ministry of Agriculture and agricultural shops.

If all those farmers could have easier access to the information they need (by the way of booklets or by receiving regular visits from field assistants), they would optimize the pesticides used and in so doing reduce their losses.

2.6.2.6. Flower induction treatment (FIT)

Only farmers of Region 3 are practising FIT; they started using NAA tablets in 1976.

The hormone used in the country is NAA (naphtalene acetic acid) in a tablet form (0.5 mg active ingredient/tablet). The latter is broken into two parts and inserted into the heart of the pineapple plant during the day when the plant is about 11–12 months old. Since plots are not homogeneous, farmers choose the plants that have reached an adequate size for FIT individually. No replication is done to ensure success as is usually done in pineapple producing countries.

Time is wasted in the treatment since farmers have to return several times to the same plot due to its heterogeneity. Nevertheless, there is some production of fruits that are out of season and which are sold at a better price.

In Regions 4 and 6, harvest is staggered over 2 months, twice a year (June–July and November–December), since only natural flowering occurs.

*** The chemical used**

FIT using NAA usually produces less satisfactory results than induction with hydrocarbons:

- Gain in time is at the most 2.5 months compared to natural flowering.
- Fruits have a lot of fruitlets and are heavier, but the fruitlets at the top may not be properly filled resulting in more conical fruits, which are less satisfactory for processing.
- Fruit stalks may be longer, which increases the risk of lodging.
- Harvesting is delayed. (Py et al., 1987).

NAA is somewhat out of date and not very effective. It should only be used in regions furthest from the equator, or at high altitudes and only during periods that are favourable to natural flowering.

Nevertheless, it has an advantage — because it is sold in tablet form, it is easy to use since no preparation has to be done before treatment.

* **Method of application**

In Guyana FIT is conducted during the day which reduces its effectiveness for two reasons:

— During the day most of the pineapple stomata are closed resulting in a very low absorption of the chemical.

— NAA decomposes in light and at high temperatures.

Thus the best results are obtained in cloudy or rainy weather and particularly during the evening or night (Py et al., 1987).

* **Experiment on flower induction treatment**

Some experiments, aimed to make a comparison between the effectiveness of different chemicals were conducted in Region 3 and Region 4 as described in Appendix 24. Three types of application were tested: NAA tablets, calcium carbide in a granulated form (1 g/plant) and a solution of calcium carbide (50 g/15 l; 50 ml/plant). The experiments were successful since more than a 95% response was obtained with the calcium carbide in a granulated form. For the solution of calcium carbide, results were different according to the area. A description and results are given in Appendix 24.

Since this product does not affect the shape of the fruit and is very cheap, the cost of FIT could be reduced eight times. That would allow a saving of more than G$21,000/ha, which could be utilized in purchasing other agricultural inputs. The costs of labour for the treatments are almost the same and the product is safe; it has been used for several years in the different producing areas. Therefore farmers should be trained to utilize this product instead of tablets.

2.7. HARVEST AND POST-HARVEST HANDLING

In this part only a description of the activities is given. Information on losses appears in Section 3.1. that deals with marketing of fresh fruits. The post-harvest handling of fresh fruits for export is discussed in Section 3.2.

2.7.1. Activities

(a) Region 3

Harvest and post-harvest handling techniques depend on the destination of the fruits.

With fruits for export (more than 90% of the farmers from Canals Polder supply the main exporter) or for processing, harvesting is done when the fruits have reached Maturity Stage 1 ('full pineapple'), 1 or 2 days before the shipment.

Fruits for the local market are harvested the day before the sale. Only fruits that have reached Maturity Stage 2 and more ('turn' or 'red' pineapples) are harvested.

In both cases, fruits are harvested by cutting the stalk with a cutlass, or by breaking them. Fruits are placed into baskets and gathered at the border of the field every five to six rows. Afterwards, each fruit is trimmed (slips are removed, and the stalk is cut flat at about 1 cm from the bottom) and thrown to another worker either singly or in twos. The latter packs the fruit into a bull-cart (90% of the farmers; pict. 20) or in bags (15–20 fruits) or baskets (10–12 fruits). The use of a stretcher was also observed on one farm at Canals Polder 1.

Fruits are then conveyed to the farm where they are stored, mostly in bulk, under a tree or a shed. Some farmers leave the fruits in bags or in bulk at the border of the road where the exporter's truck collects them. No special treatments are done to the fruits except a little cleaning to remove foreign matter such as mealybugs or mud.

Finally, at Canals Polder, fruits are packed in vehicles; trucks and cars travel regularly from these areas to Georgetown. More than 50% of the farmers from Canals Polder have their own means of transportation. For transportation by van or truck, fruits are packed in bulk; when using cars or mini-buses, they are either placed in bags or baskets.

In Naamryck and Parika (Region 3), the farms are situated in the backdam. Fruits, after harvesting, are placed in bulk in small boats and covered with banana leaves, to protect them against sunburn during the transportation from the backdam to the main roads. Then they are transported to Parika; the journey lasts more than 3 hours.

In the Essequibo Islands (Leguan and Wakenaam), fruits are directly conveyed to Trinidad by boat, or transported by the regular steamer to Parika in bags or baskets for the local market.

(b) Region 4

Almost the same procedures as in Region 3 are used during harvesting. Afterwards, various situations are encountered such as:

— Fruits are conveyed to the farm by donkey-cart, or car, etc. before supplying the closest market (Linden, Timehri, etc.).

— Fruits are collected by wholesalers at the farm or directly from the plots if the trails are in good condition.

— Fruits are processed, etc.

For further details see the marketing and processing Sections 3 and 4.

(c) Region 6

At Orealla, fruits are also harvested the day before the sale. They are broken at their base, leaving the slips de-

veloping on the plant, and packed in baskets. They are stored on the farm during the night and then shipped to Nickerie (Suriname) or Corriverton market via boat.

In both cases, travel lasts longer than 6 hours and fruits may be damaged by the heat. According to the Amerindians, losses during transportation are about 10% for fruits at Maturity Stage 1 and can reach 50% of the shipment in the case of over-ripe fruits.

2.7.2. Discussion

Frequent handling of fruits increases the risk of damage caused by bruising. Fruits suffer from very poor handling:

- Firstly, when they are thrown from one worker to another, part of the flesh may be damaged due to the impact when caught.
- Secondly, no care is taken when packing the fruits in the bull-cart or in the bags thus entailing more damage. This is also true when fruits are unloaded at the farm.
- Finally, fruits that are left at the edge of the roads suffer from high temperatures.

The effect of all the bruises caused by fruit impacting on each other during handling becomes apparent 2 or 3 days later. More than 90% of the fruits can be sold the day after harvesting, and the buyer (exporter, processor, retailer, etc.) is directly affected by the resulting losses.

This is true for fruits at Maturity Stage 1. For fully-ripe or over-ripe fruits, farmers may have up to 50% losses from the time of harvest to the time of sale on the local market.

In Orealla, damage is also caused by very poor handling but the effects are increased because the varieties present in that area are characterized by a fast post-harvest evolution; their shelf-life is rarely more than 1 week.

Also, the method of harvesting fruits by breaking them at their base favours pathogenic infections such as *Thielaviopsis paradoxa*.

2.8. COSTS OF PRODUCTION

2.8.1. Methodology

In this Section only the calculation of production costs for Regions 3 and 4 (not including the cost of transportation to the various markets and resultant losses) are given. The costs of production for Regions 4 and 6 are expected to be similar.

For both cases, standards of production are considered:

- Farmers do not have to purchase planting material (each sucker costs about G$3–7)
- The density of planting is about 15,000 plants/ ha,
- The cost of labour is about G$400/day.

Some irregularities exist according to area; they are considered in the calculation:

- In Region 3, for land preparation, ploughing the land was considered, and for harvest, renting a bull-cart.
- In Region 4, the farm is assumed to be close to the field, which is mostly the case.

For starting a new activity, supplementary costs must be considered: the purchasing of planting material, its transportation and small equipment such as spray-cans, gloves, cutlasses, etc. In total G$100,000 more are necessary.

Details of the cost of production are given in Appendices 25 and 26.

2.8.2. Discussion

The costs of production are about five times higher for Region 3 than Region 4 in the case of the first crop and about three times for the second crop. But farmers from Region 3 are making a better profit.

In Region 4, the missing earnings represent about twice the profits, while for Region 3 it is equivalent to the profit. This fact shows the necessity for pest and disease control. Losses can be reduced significantly by only carrying out protection against *Thecla basilides* and the wilt disease.

3. THE FRESH FRUIT MARKET

3.1. LOCAL MARKETING

The survey mainly concentrated on marketing at Georgetown, since it is the trading centre of farm produce. Four markets exist: Stabroek, known as the big market, which is mainly a wholesale market; Bourda, which is relatively important; and La Penitence and Kitty which are small markets compared to the former two. The marketing networks are given in Appendix 27.

In the following Sections, a difference was observed between sales made directly by the farmer (wholesale or retail) and retail sales made by other individuals.

3.1.1. Direct sale by the farmers

3.1.1.1. Canals Polder (Region 3)

Almost all the farmers from these areas sell their produce directly at a market, as wholesalers or retailers. On average, 90% of them sell their produce at Stabroek, 5% at Bourda and the remaining 5% at the two other markets or at the side of the main roads.

At Stabroek market, farmers mostly wholesale their produce outside of the building from 4 a.m. to 9 a.m. once to three times a week (the main market-day is Thursday). Some farmers (six or seven) retail their fruits inside the building where they rent stalls.

For wholesale, fruits are either left in the van or placed in bulk on the ground in batches according to their size, ripeness and quality. The amount offered for sale ranges from 60 to 250 fruits. This amount can be sold in less than 2 hours according to the ability of the farmer to attract customers. Generally, pineapple fruits represent more than 80% of the produce offered for sale, when in season.

At Bourda market, established farmers retail pineapples and also any other fruits they cultivate (citrus, papaya, mango). Consequently pineapples were evaluated as representing 10–40% of sales when in season. The pineapples are conveyed two or three times per week from the farm. Thus, fruits may be stored up to 3 days either in baskets or in bulk below the stall.

Every Wednesday evening farmers from Canals Polder and Parika travel to Bourda to sell their produce on Thursday which is the most prominent market day.

3.1.1.2. Naamryck and Parika (Region 3)

Some farmers retail their produce directly on the quay at Parika, while others transport it to Georgetown by renting a truck or a minibus. Fruits are either sold wholesale at Stabroek or retailed at Bourda, as stated in the previous Section.

3.1.1.3. Region 4

Fruits can be sold wholesale either to an intermediary or directly at the closest market, or retailed on roadsides, whole or sliced.

3.1.1.4. Orealla (Region 6)

Three types of marketing network exist:

— The fruits are sold directly by the farmers at Corriverton (downstream of the river) for G$10–40/fruit according to size and variety, when in season.
— The fruits are sold to wholesalers from Corriverton for G$3–20/fruit according to size and variety.
— The fruits are sold for G$10–20/fruit at Nickerie (Suriname) once a week.

Each sale, which occurs once or twice a week for each farmer when in season, represents about 100–300 fruits. Pineapples are packed in bulk in a boat; transportation from Orealla to Corriverton and Nickerie takes about 6–8 hours.

3.1.2. Resale by individuals

3.1.2.1. Retail at Georgetown markets

Retailers, mainly women, purchase fruits on mornings at Stabroek market. Fruits are chosen carefully and packed in bags or baskets. According to the purchasing power and/or transportation means, pineapples are purchased every day in small quantities (10–30 fruits) or once or twice a week in larger quantities (150–200 fruits). Transportation used to convey the pineapples from Stabroek to the retail market is either by car or cart.

3.1.2.2. Retail markets of Region 6

Three main markets exist in this region: New Amsterdam, Rose Hall Town and Corriverton.

At New Amsterdam, all the fruits are transported from Stabroek, where they are purchased in large quantities (120–700 fruits) once a week. Fruits are generally bulk-packed on a truck. The journey from Georgetown lasts about 3–4 hours or more, according to the ferry-boat schedule (which permits travel across the Berbice River) and the availability of trucks.

At Rose Hall Town, which is situated between Corriverton and New Amsterdam, fruits from both Stabroek and Orealla are sold.

At Corriverton, all the fruits come from Orealla: Amerindians sell the pineapples directly at the market or via an intermediary.

At the various markets, fruits are sold in bulk on stands, without protection from the sun, and stored under the stall during the night or just covered with a plastic sheet.

3.1.3. Economic aspects

The average selling price, taxes and cost of transportation are given in Appendix 28.

It is difficult to make an evaluation of the real profit of farmers at the market, since the price depends highly on the quality of the fruits. The taxes shown in Appendix 28 are averages because most sellers do not pay the obligatory taxes by not declaring the correct amount of fruits or selling most of them before the tax is collected. Nevertheless, severe observations can be made about the marketing of fresh fruits in the country.

3.1.3.1. Fruit quality and losses

The general comment is that transportation, storage and handling are most of the time inadequate. Careless handling results in bruises which are not always visible immediately but which facilitate opportunistic pathogen infestation. Storage in an enclosed and warm environment (under the stall) during the night favours the rapid multiplication of the pathogenic agents which are on or in the fruit (*Thielaviopsis paradoxa* or *Saccharomyces* sp. mostly).

Individual retailers suffer minimal losses (about 5%) since fruits are chosen carefully when bought and purchasing is done in small quantities. This is true at Georgetown markets. Whenever fruits are to be stored for more than 2 days or transported over long distances, losses increase and may reach 20–30% (e.g. at New Amsterdam).

Amerindians suffer most losses, since their fruits have to be conveyed by boat over a long distance and the varieties they grow are very sensitive to poor handling. Losses were evaluated at 10%, for fruits at Maturity Stage 1 and at 50% for fruits that are fully ripe or overripe.

3.1.3.2. Selling strategy

Retailers make G$5–10 profit per kg, depending on losses and the situation at the selling point. When asked why they chose to sell pineapple fruits, the following answers were given:

— pineapples are easy to supply, store and sell
— at present, farmers supply mainly pineapples.

It is evident that farmers make a better profit by selling their produce themselves at the market than for export; wholesale price = G$49/kg; retail price = G$40–60/kg; selling price for export = G$33/kg.

When retailed by the farmers, pineapples are not sold alone but with other products, which explains why, in some cases, fruits have almost the same price as the wholesale one.

The Amerindians from Orealla, even if they apparently get a better price at Corriverton, prefer selling their produce to Nickerie for two reasons:

— they transport their shipments together with other farmers, which reduces the price of transportation
— by way of exchange (they are paid in guilders) and by bartering they get a better profit (the amount was not revealed).

3.2. EXPORT MARKET

As was pointed out in Section 1.1.3., the export market decreased to 390 tonnes in 1992. Pineapples were exported mainly to Barbados (approximately 70%) and Trinidad (29%) and to a lesser extent, other Caribbean islands. In 1992, 2 tonnes were exported to St Vincent and the Grenadines.

In 1992 there were three exporters, however one stopped operating in 1993.

3.2.1. Export to Barbados

Fruits are shipped to Barbados by air once per week. In 1992, the amount exported was approximately 274 tonnes. The activity started in 1990 with export of 218 tonnes. Trial shipments of pineapples were sent to Europe, without success.

3.2.1.1. Purchasing pineapple at Canals Polder

A company is growing about 13 ha of pineapple at Canal Polder 1. However, yields are not sufficient to supply the needs so fruits are purchased from different farms at Canals Polder 1 and 2, normally 2 or 3 days before the shipment.

Pineapples are collected in bulk by the company's truck from remote farms or conveyed directly by farmers in bulk using bull-cart. Only fruits that weigh more than 1.3 kg are bought at an average of G$33/kg. Grading is done when the fruits are collected.

3.2.1.2. Preparation of pineapple for export

A second grading is undertaken at the packing shed. About 15% of the fruits are discarded, since they are misshapen, diseased or damaged (crushed, mashed).

The fruits are trimmed (the stalk is properly cut and the crown is reduced) and brushed in order to take off all foreign matter such as mealybugs and mud. Then they are dipped in a solution of fungicide (Bennex® or Benlate®) to avoid contamination by *Thielaviopsis paradoxa* (see Appendix 19). They are then allowed to dry in an upright position before being packed vertically in cartons. The carton price is G$157 per unit holding 15 fruits.

The labour force costs about G$15,000 per shipment.

3.2.1.3. Shipping

The cartons are shipped from Timehri airport; each shipment represents 4–5 tonnes of fruit. At the airport, the shipment is stored at ambient temperature, the duration depends on the air traffic.

According to the airline companies (LIAT and Laparkan), the cost of shipping ranges from US$350/tonne (G$44,000) to US$800/tonne (G$100,000). In Barbados an average of G$2,000 has to be paid for clearing each shipment.

On arrival, pineapples are immediately sold to four intermediaries who retail the fruits to restaurants, hotels and supermarkets.

3.2.2. Export to Trinidad

Pineapples for Trinidad from Guyana are mainly shipped by boat. They are designated to two main factories for processing: Chase Food Ltd. (about 15 tonnes/month in 1991) and Superior Foods (70 tonnes in 1991).

3.2.2.1. Purchasing the pineapples

One of the exporters has his own motor launch and purchasing is done directly from farms at Essequibo Islands (Leguan and Wakenaam) and Parika. The other exporter purchases fruits from Canals Polder.

3.2.2.2. Preparation of fruits

One exporter cleans, trims and treats his fruits with a fungicide, while the other simply cleans the fruits.

3.2.2.3. Shipping

No precise data are available on shipping. Nevertheless, when hiring a boat, the cost of transportation is about G$4,000/tonne. In Trinidad, G$2,500 has to be paid to clear the shipment.

Some checks are made by the Trinidad quarantine department. If the fruits are not regarded as acceptable, in terms of sanitary conditions, the entire shipment is destroyed or sent back to Guyana.

3.2.3. Major constraints of exporting fresh pineapples

Both in Barbados and Trinidad, half of the shipments are refused on arrival because of quality problems (fungal infections, squashed fruits). The main causes of such losses due to the handling process and the presence of black spots which are not visible from the exterior of the fruit.

On handling, the main observations are:

- Fruits are handled too often in the field, at the packing shed and during their preparation. The Montserrat variety has a very sensitive flesh, thus more care should be taken to prevent damage.
- Packing sheds are cleaned regularly but not disinfected with a solution of formaldehyde as should be done in order to avoid losses caused by *Thielaviopsis paradoxa*.
- When fruits are packed in bulk in boats, those at the bottom are crushed by the weight of the others.
- When fruits are packed vertically in cartons, individual separators are required.
- When fruits are packed for shipment and stored in a warm, enclosed environment for hours before being transported, pathogenic infections can develop. Adequate ventilation is required to ensure that the fruits arrive in perfect condition.

The general conclusion is that losses may be very high due to poor handling and consequently major improvements should be done in this area.

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4. PROCESSING PINEAPPLE IN GUYANA

4.1. GENERAL INFORMATION

4.1.1. Production of processed pineapple fruits

The first processing unit appeared in the early 1930s but only started its operation in 1935 due to many problems in production which were not under control at that time (Baichoo, 1993).

Generally three types of processing unit exist in Guyana:

- Family production of preserved fruits.
- Cottage production of pure juice.
- Production of preserved fruits by small-scale factories.

4.1.2. Exportation

Exportation of processed pineapple started in 1990 with shipments of chunks to Trinidad (about 26 tonnes). Export of pineapple chunks increased rapidly and reached 112 tonnes in 1991 and 192 tonnes in 1992. Jam exports were about 3 tonnes in 1991, this increased to 16 tonnes in 1992. To facilitate and increase exports taxes and duties are excluded at departure.

4.2. THE PROCESSING UNITS

4.2.1. Family production of preserved pineapple

Individuals, at Yarrow-Kabra (Soesdyke-Linden Highway) utilize all the fruits they cultivate to make jams and jellies, due to the reduced outlet of fresh fruits.

Their end-products consist mainly of buckets of pineapple jam (sold at an average of G$330/kg) and, to a lesser extent, buckets of pineapple jelly. The containers are purchased for G$200/unit. They supply

by order to different bars and pastry shops in Georgetown.

They use the same equipment as that for producing casreep (juice extracted from bitter cassava). Fruits are harvested, washed in the creek, peeled and grated on a grill which is placed over a half-wooden cylinder. The first juice is collected in a bucket while the pulp is placed in a hanging basket-work cylinder or 'matapee', which is about 15 cm in diameter and 1.5 m long. At the bottom there is a hook or ring through which a small wooden log is placed. A longitudinal traction is applied to the matapee by sitting on the log, thus squeezing the pulp; the extracted juice is collected in a bucket.

The pulp is cooked with sugar and spices (cinnamon) in a 'karahi' (pot) on a wooden stove. The same method is used to make the jelly. The mixture is poured hot into new buckets and sold the following day.

The small operations are very efficient but the sanitary conditions are not perfect since some pulp remains in the matapee even after washing.

4.2.2. Cottage production of pure juices

A few individuals are producing fresh pineapple juice which they retail or wholesale to restaurants and hotels. This production represents 20 kg/day of fruit for the small units and 100 kg/day for the larger ones. Pineapple juice does not have the same demand as cherry juice or passion fruit juice.

Raw materials are usually purchased at the closest market or directly at the farms, and the final products are sold within a day. The juice ferments very quickly since no preservatives are added.

4.2.3. Small-scale factories

The five factories are, in increasing order of importance:

— Anse Flowers Limited
— Tandy's Enterprise Limited (TEL)
— Guytri
— BS & K Company Limited
— Adventure Manufacturing Company Limited (AMCL)

A more precise description of two of the processing units is given in Appendices 29 and 30.

4.2.3.1. Purchases

Generally the factories, the largest of which cannot produce more than 2 tonnes of product a day, purchase raw materials in Region 3 (fruits), locally for the sugar, and directly from the United Kingdom for the preservatives and pectin. The containers are bought from Trinidad & Tobago or Jamaica.

4.2.3.2. Destination of the products

Some of the products are designated for export (Trinidad and Barbados), but most are sold locally at supermarkets (such as Guyana Stores) and other grocery stores.

4.2.3.3. Process and equipment

All the factories utilize manual equipment for various reasons:

— The amount processed does not require sophisticated equipment.
— The labour force is relatively cheap (G$300–400/day); daily-paid workers are mostly employed since the factories do not work every day.
— The variety of pineapple (Montserrat) is not suitable for mechanized peeling because of its conical shape.

The process is very simple and the main pieces of equipment are adaptable to any kind of production which is an advantage. However, the equipment used is old model, second-hand; consequently spare parts cannot be obtained easily.

4.2.3.4. Quality of the products

Generally the quality of the products is satisfactory. However, the preservative used (sodium benzoate) is not considered healthy for humans (Cheftel et al., 1991).

Also the water used in the entire process is either rain or tap-water, which is not reliable; the water should be treated in order to make it drinkable before use.

Quality control is very poor because only chemical checks are done regularly on the products (pH, brix); generally microbiological controls are not conducted. Nevertheless, these products are pasteurized. Every year, before starting the activity, the operator must obtain a licence from the Analysis Department where microbiological tests are conducted. Some checks may be conducted randomly.

In order to obtain a licence for processing, factories have to comply with various basic recommendations such as the use of tables covered with aluminium sheet for trimming instead of a wooden surface, and the use of head bonnets to reduce risk of contamination.

To avoid losses due to black spots and to facilitate the trimming, fruits are bought at Maturity Stage 1 or lesser stages of maturity. Consequently, chunks have a poor quality, compared with other competitive products (from Thailand, for example).

4.2.3.5. Market

The outlets for products such as jam and jellies are limited for two main reasons:

— These products are not competitive on the Caribbean market compared with foreign products.

In addition, the recent devaluation which occurred in Trinidad resulted in a decrease in that market. To overcome this problem, one of the factories reduced its selling price and consequently, its profit.

— The Guyanese market is limited since people prefer making their own jam.

Nevertheless, there is the possibility of diversification by producing dehydrated pineapple slices for the USA and EU markets.

One person has created a convection dehydrator which can dry pineapple slices, also shrimps, mangoes, snails, with the sun as the only source of energy. More than 87 products were successfully dehydrated.

The quality of the products is excellent in terms of preservation of organoleptic characteristics (flavour, colour), nutritive (vitamins) qualities and shelf-life. This is very encouraging for remote areas that have transportation problems.

The equipment is simple, but funds are needed to train the farmers to dehydrate their products.

4.2.3.6. On-going projects

Two projects concerning pineapple chunks and juice exist: Demerara Distiller Limited and Astral Wax Limited. These factories are to work on a larger scale, but no data were revealed.

The existing pineapple processing projects in the country are beneficial to the development of the industry. However, the possibility of establishing large-scale factories is very low due the lack of infrastructure and outlets. In addition, efforts must be made to improve the organoleptic and microbiological quality of the products.

5. CONCLUSION

The general conclusion is that losses in the pineapple industry are huge, due mainly to a lack of knowledge by those involved in cultivation management and post-harvest handling. On the other hand, some farmers do not want to extend their operations because of marketing problems.

Nevertheless, Guyana has good potential for pineapple cultivation due to the vast extent of land and the successful establishment of the Montserrat variety. Consequently, action should be taken by the relevant institutions to support all interested individuals in order to improve the quality and quantity of pineapple production. Intensification of production and marketing rationalization should be achieved by disseminating information on appropriate cultivation and handling techniques.

Support to the improvement of production should include:

— Improvement of the maintenance of the general infrastructure.

— Selection of pineapple clones suitable for different markets such as fresh fruit and processing.

— Precise investigations on some diseases and pests (fruit-fly).

— Training programmes for farmers and field assistants on fertilizing, pest, disease and weed control, and flower induction treatment.

— Enlightening the different actors of the industry by creating an awareness of the consequences of poor post-harvest handling.

— Establishment of a farmers' organization.

These improvements are necessary to make Guyanese products (fresh fruits and canned products) competitive on the Caribbean market in a sustainable manner.

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APPENDIX 1

DATA ON PINEAPPLE PRODUCTION AND TRADE

Total quantities imported by USA, EC, Canada and Japan (1991)

Importing countries	Fresh fruit (tonnes/year)	Canned fruit (tonnes/year)	Pineapple juice (tonnes/year)
USA	100,000	300,000	292,000
EC	240,000	300,000	90,000
Canada	9,000	16,000	9,000
Japan	120,000/140,000	11,000	

Regional planting areas and production (1991)

Countries	Area (ha)	Pineapple production (tonnes/year)
Antigua	45	900
Barbados	7	
British Virgin Islands	1.2	
Cuba	2,000	22,000
Dominica	8	
Guadeloupe	200	
Guyana	600	8,800
Martinique	480	17,000
St Lucia	30	
Trinidad	52	
Total	3423.2	

Sources: Barbeau (1992); Anon. (1991); New (1991)

APPENDIX 2

GUYANA AND ITS ECONOMY

1. GEOGRAPHY

After gaining Independence in 1966, Guyana became a Cooperative Republic within the Commonwealth States.

Guyana's total area covers 214,969 km² divided into 10 administrative Regions. Three geographical zones are encountered:

1. The coastal plain, 60 km wide, which consists of fluvio-marine sediments. Part of this area is empoldered.
2. The central region, which consists of the intermediate savannahs and virgin forests.
3. The plateau of Guyana which is granitic and covered by tropical rain forests.

Guyana is characterized by an equatorial climate (average rainfall: 1,700 to 2,200 mm/year, average temperature: 26—29°C).

Source: Anon. (1989)

2. GLOBAL ECONOMY

2.1. Natural Resources

The main source of income is bauxite. Guyana's mines are among the largest in the world. Gold is also mined in Guyana (1.92 tonnes in 1992) also diamonds (4000 carats exported in 1989). In 1992, a contract was signed between a Netherlands firm and a lumber company in Guyana for the exploitation of 54,600 tonnes of wood products out of the tropical forest.

2.2. Agricultural situation

Only 2% of Guyana's land area is cultivated, mainly in the coastal belt. The agriculture sector is dominated by the rice industry (171,000 tonnes in 1992) and the sugar cane industry 247,000 tonnes of sugar in 1992).

The pineapple industry has a good place as the third export crop. Dairy and livestock breeding exist in the country but are not sufficient to cover the local demand. The infrastructure does not permit a good distribution of the products.

2.3. The sugar industry

The sugar industry is controlled by the state, as is the bauxite processing industry. The food processing factories exist only on a small and medium scale.

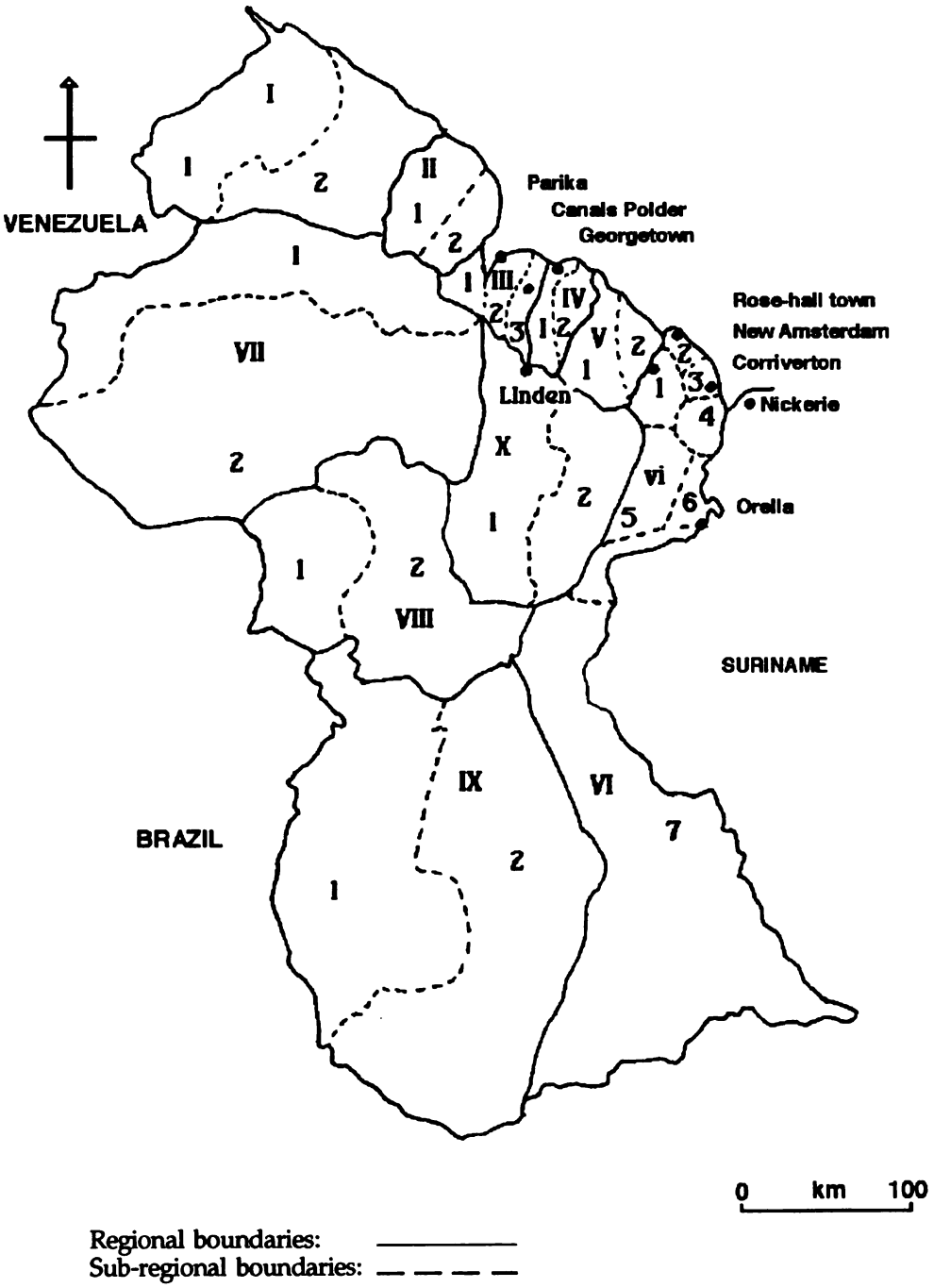
Description of the 10 Administrative Regions in Guyana

1. **BARIMA-WAINI**
   1. Barima-Amakura
   2. Waini
2. **POMEROON-SUPERNAAM**
   1. Moruka-Pomeroon
   2. Somerset and Berks-Supernaam River
3. **ESSEQUIBO ISLANDS-WEST DEMERARA**
   2. Bonasika-Boesarie
   3. Lower West Demerara River
4. **DEMERARA-MAHAICA**
   1. Moblissa-La Reconnaissance
   2. Buxton-Mahaica
5. **MAHAICA-BERBICE**
   1. Mahaica-Mahaicony
   2. Mahaicony-Berbice
6. **EAST BERBICE-CORENTYNE**
   1. East Berbice-West Canje
   2. East Canje-East Coast Berbice
   3. Black Bush Polder frontlands and extension
   4. Lower Corentyne River-Canje
   5. Left Bank upper Canje-Ikuruwa-Corentyne
7. **CUYUNI-MAZARUNI**
   1. Cuyuni
   2. Mazaruni-Left Bank Essequibo River
8. **POTARO-SIPARUNI**
   1. Ireng-Upper Potaro
   2. Lower Potaro-Ladysmith
9. **UPPER TAKUTU-UPPER ESSEQUIBO**
   1. Essequibo Islands-Left Bank Essequibo
   2. Rupununi West
   3. Rewa Upper Essequibo
10. **UPPER DEMERARA-BERBICE**
    1. Right Bank Essequibo-Upper Demerara
    2. Torani-Bulletwood Creek

Source: Land and Survey Department, Ministry of Agriculture.

APPENDIX 2 (CONTINUED)

ADMINISTRATIVE REGIONS IN GUYANA
(Source: Land and Survey Department, Ministry of Agriculture)



Picture 1: Montserrat.

Picture 1bis: Montserrat.

Picture 2: Shape variability of Montserrat fruit (1st crop).

Picture 3: The different stages of maturity (from left to right – 1, 2, 3, and 4).

Picture 4: English-pine (Bakra or Cheese-pine).

Picture 5: Sugar-loaf.

Picture 6: Tiger-head.

Picture 7: Kikichero – Region 6.

Picture 8: Water-pines (Warakabra) – Region 6.

Picture 9: Plant affected by the 'Wilt' disease.
(By permission of F. Marie, 1993).

Picture 10: Wilted plants on a plot – Region 4.
(By permission of F. Marie, 1993).

Picture 11: Plot showing signs of nematodes attack – Region 4.
(By permission of F. Marie, 1993).

Picture 12: Black spots and leathery pockets.

Picture 13: Gummosis.

Picture 14: Cavity due to the activity of a larvae of *Thecla basilides*.

Picture 15: *Plutella xylostella*.

Picture 16: Internal symptoms of possible attack of fruit fly.

Picture 17: Land clearing.
(By permission of F. Marie, 1993).

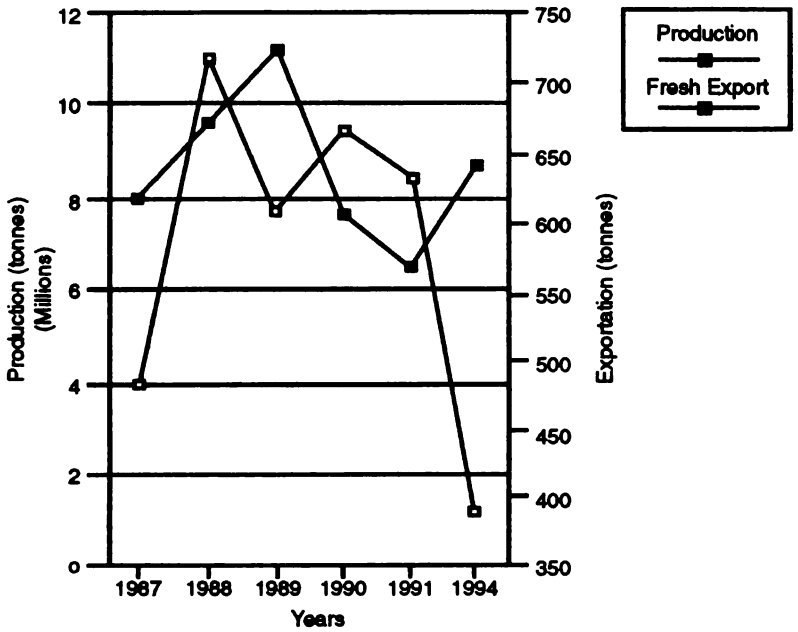
Picture 18: Inter-cropping with plantain – Region 3.
(By permission of F. Marie, 1993).

Picture 19: Inter-cropping with vine crop – Region 4.

Picture 20: Transportation of pineapple in bull cart.

APPENDIX 3

DATA ON GUYANA'S PINEAPPLE INDUSTRY



Production and export of fresh fruits. (Source: Ministry of Agriculture)

Average wholesale price of pineapple fruits.

Year	Average price (US$/kg)	Average price (G$/kg)
1989	0.17	21.8
1990	0.09	10.8
1991	0.2	24.4
1992	0.3	34.0

Source: New GMC.

APPENDIX 4

INVESTMENT INCENTIVES

TAX HOLIDAYS:

(1) Exemption of profit from tax for up to 10 years
(2) Exemption from consumption tax
(3) Exemption from property tax
(4) Exemption from capital gain tax
(5) Exemption from customs duties for up to 5 years

EXPORT ALLOWANCES:

Export allowances of up to 50% of export profits are allowed on a number of exported products.

ACCELERATED DEPRECIATION:

Rates of 100% for plant and equipment in the first 5 years.

LAND DEVELOPMENT EXPENDITURE:

Capital expenditures incurred on any agricultural land is deductible in equal installments over a period of 10 years.

Sources: Anon. (1991)

APPENDIX 5

RELEVANT INSTITUTIONS INVOLVED IN GUYANA'S PINEAPPLE INDUSTRY

NARI

NARI was established in 1984. It offers unconventional services such as:

(a) Library and agricultural research information
(b) Laboratory diagnosis control and management recommendations for plant diseases, insects, pests and weeds
(c) Soil and land-use surveys
(d) Soil, water, plant tissue and feed analysis

It also provides practical training in methods of plant protection and produces baits for acoushi ant (*Atta* sp.) control. (Library Information Unit, NARI).

MINISTRY OF AGRICULTURE (MOA)

The MoA has the capacity to support the development of the pineapple industry since field assistants and agricultural officers can do follow-up work. It also provides other services such as economic surveys and lease on lands. A regional office is located in each region, thus making agricultural inputs available in marketing centres.

NEW GMC

The New GMC materialized in late 1985. It was charged with the responsibility to improve the competitiveness of the marketing system by creating better access to potential participants who might need marketing services. It has been engaged in:

(a) Circulating better price and related information for consumers producers and marketing agents,
(b) Analysing trends in wholesale and retail food prices and farm retail scope
(c) Providing market extension services
(d) Offering advisory and brokerage services
(e) Conducting market research and advising on market policies
(f) Investigating better grading and improved packaging and storage; thus addressing the issue of losses due to post-harvest handling. (A. A. Daw, New GMC, 1993).

IICA

As stated in IICA Annual Report (1992), one section of Programme II Technology Generation Transfers of IICA is the promotion of sustainable agricultural development which incorporates the project Supporting the Development of Tropical Fruit Crops in the Caribbean. In this context, the IICA office in Guyana is collaborating with all the other institutions involved in pineapple cultivation improvement.

Its activities are mainly:

(a) Providing technical assistance and conducting experiments
(b) Organization of seminars and field training
(c) Promotion of crop diversification.

CARDI

CARDI is supporting the strengthening of NARI's actions. It has financed the installation of a misting unit for hardening tissue-cultured plantlets. (Baichoo, 1993).

IFAD

IFAD is working mainly on the rehabilitation of drainage and irrigation systems in Region 3. Various experiments are also carried out on different types of planting material and tissue-cultured plantlets in order to evaluate their agronomic potential.

APPENDIX 6

GENERAL INFORMATION ON PINEAPPLE

1. GENETIC ASPECTS

The genus *Ananas* belongs to the *Bromeliaceae* family; all species originated in the New World (with one exception which originated in Africa). Some genus are epiphytes. The large majority of pineapples cultivated for consumption belongs to the specie *Ananas comosus*, characterized by fruits more than 15 cm in length, seedless, with abundant flesh and a stout peduncle. This species consists mainly of five group of cultivars:

1. Cayenne
2. Spanish
3. Queen
4. Pernambuco
5. Perolera

Ananas comosus is the only species of this genus to be self-sterile. Nevertheless, this self-sterility does not apply between two cultivars and is not compulsory within a single cultivar.

1.1 Morphology

Pineapple is a herbaceous, perennial monocotyledonous plant. The adult plant can measure 1.2 m in height with a diameter of 1.5 m and comprises the following parts:

1. A short axial stem completely concealed by the leaves.
2. Leaves numbering up to 80, are arranged in a spiral around the stem.
3. Adventitious roots and aerial roots.
4. The peduncle, which has bracts and bears the syncarp (compound fruit) with a crown at the top.
5. Shoots which take different forms.

Different types of shoots (g.s = ground sucker; s = sucker; h = hapas; sl = slip; cr = crown)

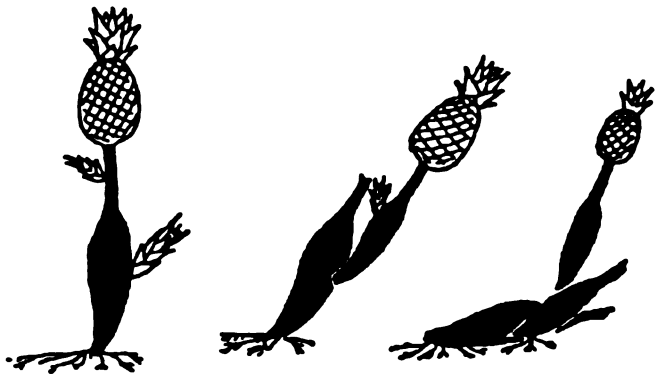


Diagram showing successive vegetative generations in pineapple.

Plant continuity is achieved through the development of axiliary buds after the production of a single compound fruit. The propagation of pineapple is by vegetative means.

2. SOIL-CLIMATIC REQUIREMENTS

2.1. Climate

Ananas comosus is a pan-tropical species. Consequently, the main factor which limits its distribution is temperature. The optimum temperatures vary between 20 °C (minimum) and 30 °C (maximum).

Pineapples can be grown in a large range of rainfall from 600 to 3,500 mm/year. Nevertheless, they do not withstand excessive water which can produce root asphyxia. During the dry season, the plants can sustain a slow growth for several months.

Light intensity affects the plant phenotype. Adequate sunlight is an indispensable factor for satisfactory plant nutrition.

2.2. Soil

The pineapple root system is fragile and sensitive to soil moisture content, therefore suitable soils must be light and must have the ability to eliminate excess water rapidly and renew soil atmosphere.

Optimum pH ranges from 4.5 to 5.5. Below this range, aluminium toxicity and limitation of the development of the roots can appear. Above this range, there is an increasing risk of infestation with *Phytophtora* sp.

For normal growth, pineapples need potassium, nitrogen and to a lesser extent phosphorus. Deficiencies in other elements may be found in extremely poor soils.

3. FLOWERING

Natural flowering occurs when the plant has reached its optimum stage of development; it is conditioned by four factors:

1. Short days and long nights (the pineapple is a nyctiperiodic plant).
2. Low temperatures.
3. Reduction in total radiation.
4. Extremes in water supply (drought or flooding).

One of the main advantages of pineapple production is the possibility of planning the harvesting date and average weight of the fruits using flower induction treatment (FIT). Indeed, floral differentiation is linked with an increase of endogenous ethylene rate. Consequently, applications of ethylene, ethylene generators or ethylene synthetic precursors cause an artificial flowering which can be controlled easily.

4. RIPENESS AND POST-HARVEST PHYSIOLOGY

Different criteria are used in order to judge the ripeness (brix, acid content, firmness, etc.), but the most practical is external colour, which progresses from the base of the fruit upwards in most cases.

Pineapple fruits are sensitive to temperature, which make refrigeration necessary (7–10°C) to keep harvested fruits in prime condition for a limited period of time. Below 24°C titratable acidity increases, due to the respiratory phenomenon, and this can affect the flavour of the fruit. The use of food preserving wax limits this phenomenon by slowing down gaseous exchange.

Refrigeration can also result in alteration of the flesh, e.g. internal browning, if temperatures are below 7°C.

(Source: Py et al., 1987).

APPENDIX 7

METHODOLOGY FOR DETERMINING THE CHARACTERISTICS OF MONTSERRAT FRUITS AND THE EVALUATION OF DISEASE IMPACT.

1. SAMPLING

Different batches of fruit were taken as is shown in the tables. The fruits were harvested at random from the central rows of the plots, in order to eliminate border effects.

2. COLLECTION OF THE DATA

In order to make an evaluation of the impact of the diseases on the fruits, the parameters that appear in the tables were observed.

Region 3 (Canals Polder)
First crop: three batches of unselected fruits
Second crop: two batches of unselected fruits

Purchasing area	No. of fruits (first crop)	No. of fruits (second crop)
Bordeaux	30	36
Uitkomst	30	30
Good Hope	31	30

Region 4 (Kuru-Kururu, Madewini, Swan)
First crop: three batches of unselected fruits
Second crop: three batches of unselected fruits

Purchasing area	No. of fruits (first crop)	No. of fruits (second crop)
Kuru-Kururu	30	36
Madewini	30	30
Swan	31	30

At the same time, data on the external and internal characteristics of the fruits were recorded.

For most of these last parameters, only the fruits from Region 4 were observed, since farmers do not apply any fertilizers or do not practice flower induction treatment which may affect the shape and size of the fruits.

Statistical analyses of the data were made with the help of a computer programme.

PARAMETERS COLLECTED

Date of sampling: **Cultivation cycle:**

Sample number: **Area:**

Fruit number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
External parameters															
Fruit weight															
Fruit size															
Crown weight															
Crown size															
Top diameter															
Bottom diameter															
Shape															
Coloration															
Deformations															
Number of slips															
Sunburns															
Presence of visible rot															
Presence of gum															
Fruit wilted															
Other visible diseases															

Fruit number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Internal parameters															
Heart diameter															
Eye depth															
Coloration															
Translucence															
Maturity															
Presence of seeds															
Presence of black spots															
Presence of leathery pockets															
Presence of soft rot															
Presence of internal fermentation															
Presence of cavities															

APPENDIX 8

CHARACTERISTICS OF THE MONTSERRAT FRUITS

Characteristics of the different types of fruit from the first cycle crop

Type	Shape	Fruit weight (g)	Fruit size (mm)	Crown size (mm)	Crown weight (g)	No. of slips	Heart dia. (mm)	Eyes depth (mm)	Top dia. (mm)	Bottom dia. (mm)
1 (48%)	Conical	1646.0	241.7	223.3	11.6	6	21.2	14.3	71.7	104.6
2 (12%)	Conical	1046.7	210.0	255.0	7.0	4	23.3	15.0	76.7	100.0
3 (16%)	Tends to be cylindrical	865.0	160.0	200.0	6.1	6	18.3	14.5	71.3	90.0
4 (24%)	Tends to be cylindrical	1382.5	205.8	257.5	7.7	8	22.5	15.2	79.2	98.7

Characteristics of the different types of fruit from the second cycle crop

Type	Shape	Fruit weight (g)	Fruit size (mm)	Crown size (mm)	Crown weight (g)	No. of slips	Heart dia. (mm)	Eyes depth (mm)	Top dia. (mm)	Bottom dia. (mm)
1 (38%)	Cylindrical	898.2	153.2	250.4	5.1	4	16.4	11.0	76.4	88.2
2 (17%)	Conical	897.0	177.0	183.0	8.8	6	18.6	14.8	68.0	89.0
3 (45%)	Conical	1122.7	188.4	308.0	6.0	7	19.1	14.0	72.3	93.8

APPENDIX 9

METHODOLOGY FOR THE DETERMINATION OF THE CHEMICAL CHARACTERISTICS OF THE DIFFERENT VARIETIES

1. EXTRACTION OF THE PULP

The analyses were conducted on five fruits for each determination when possible. The flow-sheet of the preparation of the pulp is as follows:

CLEANING
↓
PEELING
↓
CUTTING THE FRUIT VERTICALLY INTO 8 PARTS
↓
CRUSHING
↓
STRAINING
↓
DETERMINATION OF THE BRIX
↓
FREEZING
↓
STORAGE
↓
DETERMINATION OF THE TITRABLE ACIDITY AND ASCORBIC ACID RATE

Flow-sheet for the determination of the chemical characteristics of the fruits

2. DETERMINATION OF THE BRIX

Brix was determined as quickly as possible with a hand refractometer. A correction of the results was made according to the ambient temperature.

3. DETERMINATION OF THE TITRABLE ACIDITY

The standard of analysis AFNOR (Association Francaise de Normalisation), number NF V05-101, was employed. For each determination, three replications were made.

3.1. Chemicals used

Sodium hydroxyde (0.1N)
Phenolphthalein (10g/l ethanol, 95%)

3.2. Equipement

Burettes, pipettes, conical flasks (50 ml).

3.3. Methodology

A sample of 10 ml of pulp is transferred into a conical flask and mixed with five drops of phenophthalein. This mixture is then titrated with sodium hydroxide until the mixture has a permanent pink colour. The formula for calculating the acidity is as follows:

V1 = Volume of the sample (ml)
V2 = Volume of NaOH necessary for the determination (ml)

Acidity = V2/10 * 100/V1 = V1

4. DETERMINATION OF THE ASCORBIC ACID RATE

The method employed is that used by CIRAD-FLHOR in Martinique. As for the above determination, three replications were conducted on each sample.

4.1. Chemicals used

(1) Metaphosphoric acid (20 g)
(2) Trichloro-acetic acid (40 g)
(3) 2-6 dichlorophenol indophenol (125 mg)
(4) Sodium bicarbonate (105 mg)
(5) Ascorbic acid (50 mg)

4.2. Equipment

Burettes, pipettes, conical flasks.

4.3. Methodology

SOLUTION 1: Meta-phosphoric acid and trichloro acetic acid are mixed and made up to 1 litre of water.

REAGENT 1: 2-6 Dichloro-phenol, indophenol and Sodium bicarbonate are mixed and adjusted to 500 ml.

REAGENT 2: Acorbic acid is adjusted to 200 ml with Solution 1.

First, standards of diluted ascorbic acid shown are made in order to determine a standard curve as in the table below (the mixture is adjusted to 15 ml with SOLUTION 1).

Data for the determination of the standard curve

Reagent 2 (ml)	0	1	2	3	4	5
Asorbic acid (mg/l)	0	17	33	50	67	83

The titration is made with reagent 1 until the mixture turns to a permanent pink. After the standard curve is obtained, the titrations are made with 5 ml of pulp adjusted to 15 ml with Solution 1.

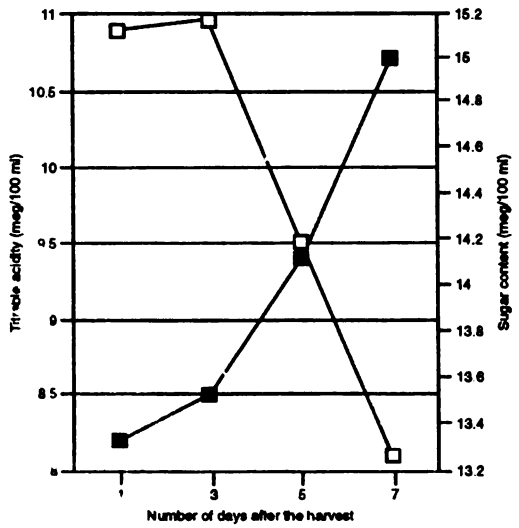
Remarks: For 'English-pine', the samples were diluted five times, since the ascorbic acid rate was too high to fit in the standard curve.

APPENDIX 10

RIPENESS AND POST-HARVESTING BEHAVIOUR OF THE MONTSERRAT VARIETY

The different degrees of ripeness of 'Montserrat' fruits based on a maturity scale developed by the author for this study.

Maturity Stages/Ripeness	External colour	Colour of the flesh	Appearance of the flesh
Maturity 0 (Green fruit)	Full green	White	Opaque
Maturity 1 (Full fruit)	Full green to 1/4 of fruit yellow	Light yellow	Opaque
Maturity 2 (Turning fruit)	1/4 to 1/2 of fruit yellow	Light Yellow	Opaque
Maturity 3 (Ripe fruit)	> 1/2 of fruit yellow	Yellow	Opaque + translucent parts
Maturity 4 (Over-ripe fruit)	Full orange	Yellow	Translucent



Post-harvest evolution of titrable acidity and sugar content.

APPENDIX 11

PARTIAL DESCRIPTION OF THE DIFFERENT LOCAL VARIETIES

Name	Fruit Shape	Leaves	Group	Avg. Fruit weight (kg)	External colour	Flesh	Brix (%)	Sugar content (g/100 ml)
Montserrat	Conical	Spiny	Pernambuco	1.3	Yellow to orange	Light yellow	17	15.3
English-pine (Bakra)	Conical with a bottle-neck	Spiny	Pernambuco ?	1.0	Dark-green to reddish	Yellow, juicy with an unusual taste	15.3	13.7
Cama-head	Conical	Spiny	Pernambuco ?	3	Dark-green	Yellow, juicy but fibrous	14.7	13
Water-pine (Wara-kabra)	Cylindrical	Smooth + 'piping' char.	Perolera	1.5	Green and yellow	White, juicy and fragile	13.7	12.4
Kikichero	Spheric	Spiny	Spanish?	2	Yellow to orange	Yellow and fibrous	13.8	12.6
Sugar-loaf	Cylindrical to spheric	Spiny	Spanish?	1	Dark-green and yellow			
White-pine	Cylindrical	Spiny	Spanish	< 1	Whitish yellow	White and tasteless		
Oshiri	?	Spiny	Spanish ?	?	?	?		
Kabrushi	Cylindrical	Spiny	Spanish ?	1.5	Yellow	?		
Tiger-head	Spheric	Spiny	Spanish ?	3-5	?	?		
Wild pine Moraikobai	Conical	Spiny	Pernambuco ?	> 4	?	?		
Big bones-pine	?	?	?	?	?	?		

APPENDIX 12

METHODOLOGY FOR THE SURVEY OF PINEAPPLE PRODUCTION

The methodology employed are given as follows:

Stages	Purposes
(1) Preliminary training in Martinique (with F. Marie, CIRAD—FLHOR).	— Overview of pineapple cultivation and constraints; visits to canneries.
(2) Library work.	— Learning about the environmental conditions. — Becoming aware of the pineapple industry in Guyana. — Identification of individuals involved in the industry. — Review of the investigations done in the country on the pineapple industry. — Orientation of investigations to be undertaken. — Stratification of producing areas. — Preparation of an initial questionaire.
(3) Discussions with farmers at Stabroek market.	— Evaluation of the ability of farmers to answer the questions. — Evaluation of the main constraints.
(4) Preliminary field investigations.	— Re-definition of the constraints. — First description of the cultivation system. — Meeting with field assistants and agricultural officers. — Modification of the questionaire.
(5) Investigations.	— Collection of data on production and marketing.
(6) Observation of the situation of the fields.	— Evaluation of the reliability of answers. — Collection of complementary data.
(7) Sampling of pineapple fruits	— Collection of data on the Montserrat variety. — Collection of data on the impact of various diseases.
(8) Treatment of all the collected data.	— Diagnosis of the cultivation systems. — Identification and ranking constraints. — Evaluation of the needs for technical assistance and training. — Evaluation of the needs for research and cooperation.

Remarks:

(1) Sampling of the farmers interviewed was at random since investigations were mostly done door-to-door.

(2) A direct questionaire was not welcome; consequently, another with two types of questions was made:
   (a) Direct questions aimed at collecting precise data such as amount of fertilizers used, etc.
   (b) Open questions aimed at obtaining information about the knowledge of the farmers their opinions and aims, etc.

(3) The questionaire was adapted to each situation in order to make the farmers comfortable, consequently obtaining the most precise information.

(4) The data were analysed with a statistical programme called LISA.

APPENDIX 12 (CONTINUED)

A. DESCRIPTION

Name:	Address:	
Area:		A1 ( )
Total acreage:		A2 ( )
Acreage of pineapple	First crop =	A3 ( )
	Second crop =	A4 ( )

B. BACKGROUND

1. How did you get your farm? 1 ( )
   1-( ) did you inherit?
   2-( ) you bought it? How much/acre?
   ( ) at one time?
   ( ) payment of installment?
   5-( ) you rent it? How much/acre?
   6-( ) other? Specify:

2. Before growing pineapple, what did you do? 2 ( )
   1-( ) sugar cane? 2-( ) employed by someone?
   3-( ) others? Specify:

3. Why do you grow this crop? 3 ( )
   1-( ) no other alternative? 2-( ) tradition?
   3-( ) pays the best money? 4-( ) Others? Specify:

4. Do you have any other activities? 4 ( )
   1-No( )
   2-Yes( ) Specify:

C. MEANS OF PRODUCTION

5. What is the principle source of labour? 5 ( )
   1-( ) family? 2-( ) hired full time?
   3-( ) hired part time? 4-( ) exchange with your your neighbours?
   5-( ) others? Specify:

6. In total, how many people are working on the pineapple farm? 6 ( )

7. Do you rent any equipment? 7 ( )
   1-No ( )
   2-Yes( ) Specify:

D. TECHNICAL SYSTEM

D.1. Land preparation

8. How do you prepare the land before planting? 8 ( )

9. About land preparation, observe: 9 ( )
   1-( ) single row? 2-( ) double row?

D.2. Planting

10. What varieties do you grow? 10 ( )
    1-( ) Montserrat? 2-( ) Sugar-loaf?
    3-( ) others?

APPENDIX 12 (CONTINUED)

12. What do you retain for your planting material? 12 ( )
    1-( ) slips? 2-( ) side shoots?
    3-( ) ground suckers? 4-( ) crowns?

13. Do you treat your planting materials before planting? 13 ( )
    1-( ) No
    2-( ) Yes Describe:

14. Do you remove the basal leaves of the planting material? 14 ( )
    1-( ) No 2-( ) Yes

15. Do you grade your planting material? 15 ( )
    1-( ) No 2-( ) Yes

16. How long do you store your planting material? 16 ( )

17. How do you store them? 17 ( )

18. What is the density of plantation? 18 ( )

19. Do you practise any inter-cropping? 19 ( )
    1-( ) No
    2-( ) Yes With what kind of crops?
    — ( ) orchards?
    — ( ) ground provisions?
    — ( ) other?

D.3. Management of the cultivation

20. How many crops do you harvest in one plot? 20 ( )

21. After thoses crops, what do you do with the land? 21 ( )
    1-( ) abandon it? 2-( ) plant other crops?
    3-( ) others? Specify:

22. Do you fertilize? 22 ( )
    1-No ( ) 2-Yes( )

	NPK	Potash	TSP	Urea	Sulphate of ammonia
Qty/plant					
g/plant					

23. What diseases or pests affect your crop? 23 ( )
    1-( ) mealybugs? 2-( ) black spot?
    3-( ) gummosis? 4-( ) others? Specify:

24. Do you use any chemical treatment? 24 ( )
    1-No ( ) 2-Yes( )

	Monocotrophos®	Karate®	Other
Quantity of product			
Quantity of water			
Plants treated			
ppm/plant			

APPENDIX 12 (CONTINUED)

25. Do you treat your plot for weeds? 25 ( )
1-No ( ) 2-Yes( )

	Karmex	Gramoxone	Round up	Other
Quantity of product				
Quantity of water				
No of plants treated				
ppm / plant				

26. Do you weed your plot? 26 ( )
1-No ( ) 2-Yes( )

27. At what stage do you weed the plot? 27 ( )
1-( ) small weeds? 2-( ) well developed?
3-( ) with flowers?

28. With what equipment? 28 ( )

29. Do you do flower-induction? 29 ( )
1-No ( )
2-Yes( ) Describe methods and chemicals used:

30. How many ground suckers do you allow for the following crop? 30 ( )

31. Where do you purchase fertilizers and chemicals? 31 ( )
Do you buy them:
— ( ) alone in small quantity?
— ( ) with other farmers in large quantity?

D.4. Harvesting

32. At what stage do you harvest the pineapple? 32 ( )
1-( ) maturity 1? (<1/4 col.)
2-( ) maturity 2? (1/4<>1/2 col.)
3-( ) maturity 3? (>1/2 col.)

33. What is the average yield per acre? 33 ( )

D.5. Post-harvest handling and transportation

34. Do you store the pineapple at your farm before selling them? 34 ( )
1-No ( ) 2-Yes( )
3-( ) bags? 4-( ) others? Specify:

35. Describe all physical treatmemt you do to the pineapples before selling? 35 ( )

36. In what kind of container do you put them? 36 ( )
1-( ) baskets? 2-( ) boxes?
3-( ) bags? 4-( ) others? Specify:

E. MARKETING OF THE FRESH FRUITS

37. Do you sell your pineapples: 37 ( )
1-( ) at a market? Specify:
2-( ) to an intermediary? For what purpose?
3-( ) to a processing unit?

APPENDIX 12 (CONTINUED)

38. What is your average selling price per dozen? 38 ( )

39. What is the average selling price of a pineapple on the market? 39 ( )

40. How often do you sell the pineapple? 40 ( )
Market?
Intermediary?
Processing unit?

41. How many dozens do you sell each time to: 41 ( )
Market?
The intermediary?
The processing unit?

E.1. Case of market seller

42. Where do you sell the fruits? 42 ( )

43. What transportation do you use? 43 ( )
1-( ) cart? 2-( ) bus?
3-( ) tapir? 4-( ) other?

44. What is the % of loss during transportation? 44 ( )

45. Does transportation take a long time? 45 ( )
1-No ( ) 2-Yes( ) Why?
How long?

E.2. Case of selling the pineapple to an intermediary

46. What are his criteria for selecting the pineapple? 46 ( )

47. Does he pay you: 47 ( )
1-( ) at the same time?
2-( ) payment by installments?

48. How the fruits are conveyed to the packaging shed? 48 ( )

E.3. Case of selling to a processing unit

49. How are the fruits conveyed to the factory 49 ( )
1-( ) baskets? 2-( ) boxes?
3-( ) bags? 4-( ) others? Specify:

F. GENERAL INFORMATION

50. Do you have to pay taxes on your crops? 50 ( )
1-No ( )
2-Yes( ) How much?

51. Are there any farmers' oganizations? 51 ( )
1-No ( )
2-Yes( ) Specify their name and functions:

52. Does anyone advise you? 52 ( )
1-No( )
2-Yes( ) Who?

APPENDIX 12 (CONCLUDED)

53. Do you want to extend your acreage? 53 ( )
    1-No ( )
    2-Yes( ) By how many acres more?

54. What do you think about the future of pineapple production in the country? 54 ( )

G. OBSERVATIONS

1.	HOMOGENEITY:	1-( ) 90%	2-( ) 70%	O11( )
		3-( ) 50%	4-( ) <50	O12( )
2.	DRAINAGE:	1-( ) Good	2-( ) Satisfactory	O21( )
		3-( ) Bad	4-( ) Very bad	O22( )
3.	WILT:	1-( ) <10%	2-( ) 10–20%	O31( )
		3-( ) 20–40%	4-( ) >50%	O32( )
4.	GUMMOSIS	1-( ) <10%	2-( ) 10–20%	O41( )
		3-( ) 20–40%	4-( ) >50%	O42( )
5.	LACK OF POTASSIUM:	1-( ) Low	2-( ) Medium	O51( )
		3-( ) Important	4-( ) Very important	O52( )
6.	ROOTING SYSTEM:	1-( ) Good	2-( ) Satisfactory	O61( )
		3-( ) Partially destroyed	4-( ) Completely destroyed	O62( )
7.	BLOCKS:	1-Width ( )	2-Height ( )	O7 ( )
8.	LODGING:	1-( ) <10%	2-( ) 10–20%	O8 ( )
		3-( ) >20%		

First crop = 1
Second crop = 2

APPENDIX 13

CHARACTERISTICS OF THE MAIN TYPES OF SOIL AT REGION 3

EVERTON SILTY CLAY

Everton silty clay is associated with Tushen and Brickery soils and differs from these soils by having a more developed B horizon and does not contain acid sulphates in the lower horizons.

PROFILE DESCRIPTION:

0–10 cm Dark brown clay with few fine prominent yellowish red and common medium and prominent strong brown mottles; moderate medium subangular blocky structure; slightly sticky and plastic; many fine roots; earthworms present; clear, smooth boundary.

10–30 cm Grey clay with common medium and prominent yellowish red massive structure; firm (moist); slightly sticky and plastic; many fine roots; earthworms present; clear, smooth boundary.

30–72 cm Grey clay with many medium and prominent brownish yellow and strong brown mottles and few fine and prominent yellowish red mottles; massive structure; firm (moist); slightly sticky and plastic; clear, smooth boundary.

BRICKERY CLAY

Brickery clay is developed from fine-textured alluvium over old marine sediments. The soil generally occurs inland of larger river banks, and near the margin of the main swamps of marine origin. The lower subsoil contains pockets of darker material and pieces of partially decomposed plant material.

Brickery clay contains greenish grey or dark-grey clay that contains acid sulphates between 45 and 90 cm.

PROFILE DESCRIPTION

0-13 cm Dark-grey clay with many fine and prominent yellowish red mottles occurring mainly along root channels; massive structure; moderately firm; slightly sticky and plastic; many fine roots; clear, smooth boundary.

13–55 cm Grey clay with many medium and prominent yellowish red and yellowish brown mottles; yellowish red mottles occur mainly around root channels; massive structure; firm (moist); slightly sticky, plastic; few fine roots; some penetration of darker material from the above horizon; clear, smooth boundary.

MARA CLAY

Mara clay is developed from fine-textured fluviomarine sediments of Demerara or Copina age. This soil is characterized by a thin A horizon (not more than 8 cm) and a subsoil that is strongly acidic and usually contains acid sulphates. The soil is associated with Whittaker and Brickery soils.

PROFILE DESCRIPTION

0–15 cm Very dark-grey clay, mixed with some burned peat; medium granular structure, very friable; slightly sticky and plastic; many fine roots, earthworms present; clear, smooth boundary.

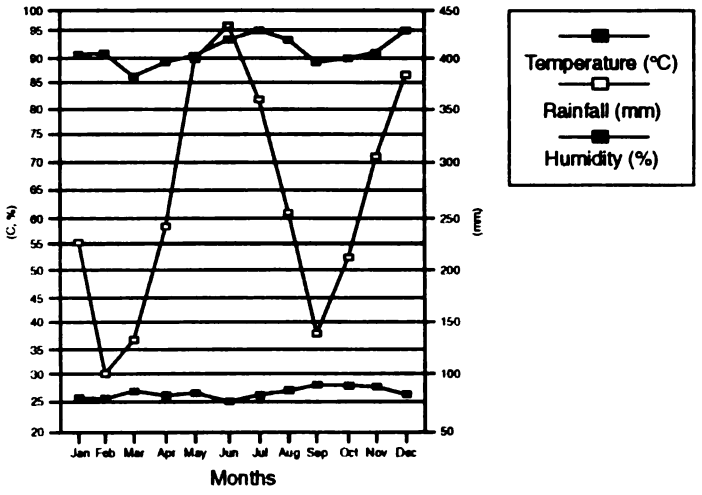
15–46 cm Grey clay with common medium and prominent yellowish red mottles; weak medium subangular blocky structure; firm (moist); slightly sticky and plastic; clear, smooth boundary.

Remarks: The above profile description concerns only the first 50 cm, since ploughing is not done deeper.

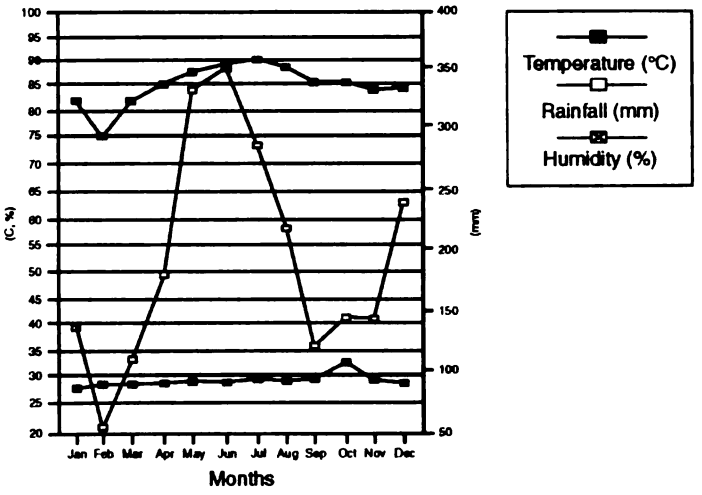
Sources: Khan et al. (1989)

APPENDIX 14

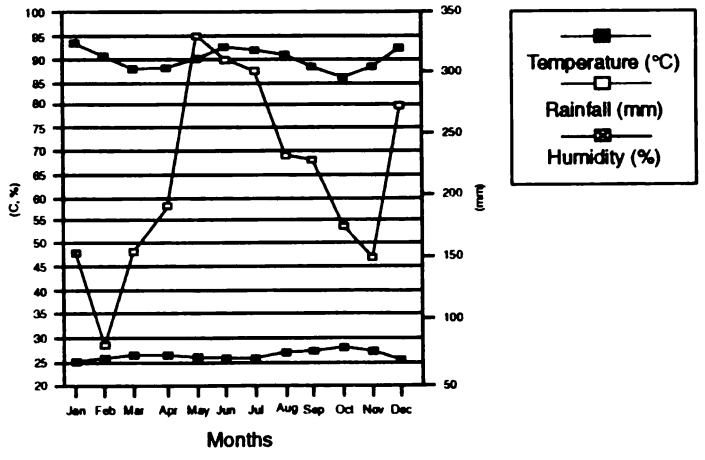
CLIMATIC DATA OF THE MAIN PRODUCING AREAS



Climatic data for Essequibo coast - Region 3 (1970-1980)



Climatic data for West Demerara - Region 3 (1978-1987)



Climatic data for Timehri - Region 4 (1978-1987)

Source: Baichoo (1993)

APPENDIX 15

THE WILT DISEASE

1. MAIN SYMPTOMS

STAGE 1. Firstly, a bronze to red colour appears on leaves of the 3rd or 4th whorl (starting from the heart). Leaf margins curl downwards towards the under-surface of the leaf, but the tips remain erect.

STAGE 2. The colour of the leaves become a bright pink or yellow while the leaves lose turgidity and the tips become brown.

STAGE 3. The youngest leaves are upright but lack turgidity, while the tips of the majority of the other leaves are curled and pale brown in colour. Leaves that remain green are dull with yellowish patches.

Before the appearance of these symptoms, a modification of the root system occurs which is difficult to detect when the plant is uprooted.

If the disease appears in plants that have only differentiated their inflorescence, the inflorescence dries out. If the disease appears later, the eyes of the fruits remain prominent and the flesh is fibrous and sour.

As a result, in the field there are isolated plants or small groups of plants which affects neighbouring plants that are apparently healthy.

2. THE ANT/MEALY-BUG ASSOCIATION

Mealybugs (*Pseudococcus brevipes*) are always found in colonies, between two superimposed leaves at the base of the plant, or under the shelter made by ants in the heart of the plant. The bugs feed by sucking the plant sap while at the same time transmitting the virus in the plant and subsequently from one plant to another.

Ants protect the mealybugs and remove the honey-dew secreted by the latter which they utilize for food. They also help the mealybugs to move from one plant to a neighbouring one when the first plant becomes unsuitable as a source of food for the mealybugs even before the symptoms of wilt occur. With the help of ants, the migration can reach 125 m/month. When there are no ants present, mealybugs move around much more slowly, and the larvae, which are hampered by the honey-dew, can be more or less invaded by different fungi. Ants promote the spreading of the disease and that explains why few mealybugs are found on a wilted plant, they are generally on neighbouring, healthy looking plants.

Pineapple is not the only host for the ant/mealybug symbiosis. For example, they have been reported on a very common local weed, *Solanum straminiifolium*.

3. INFORMATION ON THE VARIOUS FACTORS OF THE DISEASES

3.1. The Virus

Because the direct origin of the agent is a virus, the wilt disease can be transmitted via vegetative reproduction. This is a reason why shoots that are apparently healthy when harvested (but come from a diseased plant) show signs of infection after planting.

When re-infestation does not occur, the virus becomes progressively less virulent and finally disappears.

3.2. The mealy-bug: *Dismicoccus brevipes* (or *Pseudococcus brevipes*)

Dismicoccus brevipes has been reported in Hawaii, West Africa, the Antilles and Malaysia. This species can easily be recognized by the pink colour of the female. The adult female measures 3 mm long and 2 mm across. They are covered with a waxy layer that is secreted by the insect. The wings of the males are tapered. Fertilized females live 90–95 days and engender an average of 250 descendants (males live 35 days).

3.3. The Ant

Two species exist in Guyana: *Solenopsis* sp. and *Araucomyrmex* sp. The former is found within a radius of 3 m of its nest. More than 100 nests of *Solenopsis* and more than 2,000 nests of *Araucomyrmex* have been encountered but the two species have never been found together.

4. CONTROLLING THE WILT DISEASE

4.1 Measures Taken During the Cycle

The residues from the previous crop (which can serve as host for mealybugs) and diseased plants must be destroyed (used to make compost or burnt). Also, slips with excessive amounts of mealybugs must be discarded and destroyed.

4.2. Chemical Approach

The aim is to keep the populations of mealybugs as low as possible to avoid over-infestation by the virus.

(1) After removing the partly dried leaflets, slips and shoots must be dipped vertically into a solution of insecticide, then stored in an upright position for 12 hours, before planting.

(2) Insecticide applications are recommended throughout the cycle (the frequency of required follow-up treatment depends on the evolution of the pest population) but special attention has to be paid to:
   - the beginning of the cycle, since young plants are more sensitive to the disease.
   - the floral dissimilarity, since mealybugs aid in pathogen penetration (such as *Penicillium* sp.).

Two types of products are effective:

(a) Organophosphorus compounds working on contact, partly through inhalation and they also have a very short persistence.

(b) Organophosphorus compounds with partly systemic effects, which have a longer persistence. They are usually in a granulated form and are placed in the axil of the leaves and on the soil at the base of the plant. An easy method of application is to use a plastic bottle with a perforation in the lid so that the correct quantity of product would come out in one shake.

(3) It is equally important to control ants as well as mealybugs. Products with longer persistence are preferable, and their effectiveness is increased by the addition of attractive ingredients, which the ants take back to the nest. It is best to place the baits close to the nests, which are easily located in newly prepared land. The treatment must be repeated during the course of the vegetation. **(Source: Py et al., 1987).**

Other chemicals are available in the country but their effectiveness for the mealybug control is not known. Those include: Padan®, Elsan®, Fastac®, Karate®, Monocotrophos®, Belmark® and Toxaphene®.

For ant control, various effective baits are available locally. Also, chemicals such as Mirex® and Mironex® (active ingredient perchlordecone) may be used at a rate of 3 kg a.i./ha.

Table 14: Various chemicals that can be used for Wilt Control. (Sources: C. Py et al., 1987.)

Commercial	Group	Persistence	Normal concentration of mixture (2,500 to 5,000 l/ha — 4 to 12 applications)
Basudin (Diazinon)	Organophosphorus	Short time	0.03–0.04% a.i.
Fenitrothion	Organophosphorus	Short time	0.03–0.06% a.i.
Dimethoate	Organophosphorus	About 15 days	0.05% a.i.
Malathion	Organophosphorus	Short time	0.10– 0.25% a.i.

APPENDIX 16

NEMATODES

1. MAIN SYMPTOMS

Infested plants exhibit the same symptoms as in nutrient deficiency or water-stress (due to failure of the root system): slow growth, narrow and erect leaves which have a pinkish-yellow to reddish colour. In serious cases, there can even be dehydration of the leaf tips; as a result, the infected plant may bear a small fruit.

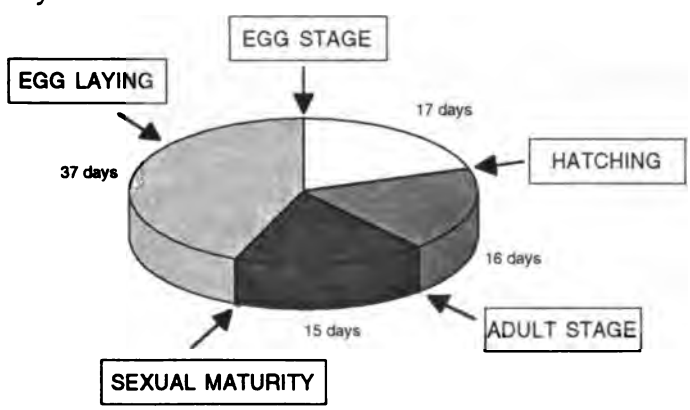
The root system is partially or completely destroyed. However, there are no specific symptoms which are visible to the naked eye except that the parenchyma is easily separated from the central cylinder. Damage to the roots can facilitate the access of secondary pathogenic agents and this accelerates root decomposition.

2. BIOLOGY OF *PRATYLENCHUS BRACHYURUS* (GODFREY) (Previously known as *Tylenchulus brachyurus* or root nematode.

Pratylenchus sp. is a migratory endoparasite which feeds on roots and disturbs the mineral nutrition of the plant. It is typically vermiform in shape, 0.4-0.8 mm long, and has a short strong stylet.

Reproduction is parthogenetic, which is the reason why males are rarely encountered.

Laying continues for 37 days at a rate of one egg per day.



The life cycle of nematodes

Contary to *Meloïdogyne* sp., another type of nematode, *Pratylenchus* sp. can penetrate the roots, especially near the elongation zone, during all stages of development and starts laying eggs shortly after penetration.

It is polyphageous and can survive easily on two cycles of pineapple cultivation, as long as weeds or fragments of living roots are present. If not, survival is reduced to approximately 30 weeks.

The increase in number of nematodes depends on the environmental conditions (climate, soil characteristics). The initial increase is slow, as nematodes are found with a new environment for their activity, but subsequently there is a rapid increase in population. Peak of infestation can be observed between the fifth and eight month after plantation.

3. CONTROL OF NEMATODES

The control of nematodes should start with soil preparation, in order to keep the level of inoculum in the soil as low as possible and at the same time protect the first flush of roots.

Systemic or partially systemic products, which are more suitable, should be incorporated in the bed. As long as their effect persists, there will be no penetration of new parasites and further development of the population already installed in the root system will be terminated. These applications are also efficient in the control of Symphilids.

The result is an improvement in the absorption of nutritive elements and consequently more active growth. Follow-up treatments are of course necessary. To be effective, they should be conducted at the beginning or at the end of the inter-seasons (the first treatment should not be done later than 2 months after planting). Two types of application can be used:

(1) In liquid form by foliar applications. Caution must be taken to protect the heart of the plant and the young leaves against scorching.

(2) In granulated form by placing the product directly at the base of the plant, which reduces the amount used and consequently the risk of phytotoxicity.

Chemicals for nematode control

Commercial brand	Group	Action mode	Persistence	Method of application	
				Before planting	During plant growth
Mocap®	Organophosphorus	Contact and slightly systemic	About 3 months	9–10 kg a.i./ha	About 3 weeks after planting: 9–10 kg a.i./ha of granular formulation, repeated at the beginning of each favourable period.
Vydate L®	Carbamate	Mainly systemic	1-2 months		Foliar spray every month: 0.5-1 kg a.i./ha
Toxaphene®	Organohalide	Contact	Several days		Foliar spray: 3 kg of commercial product/ha

a.i.= active ingredient

APPENDIX 17

SYMPHILIDS

1. MAIN SYMPTOMS

Homogeneous zones of reduced growth are observed, whereas in others there is a heterogeneity between the plants. With a suitable soil humidity, those affected parts are able to recover more or less rapidly as soon as the attacks diminish.

The appearance of the root system depends on the age of the plant and the intensity and frequency of attacks. This pest feeds on the younger parts of the root (tips), causing a typical swelling, followed by growth of secondary roots. The root symptoms can take different forms:

(a) In mild attacks, roots show a characteristic witch's brooms.
(b) If the parasite is still present and virulent, the root tips start to resemble a club.
(c) If massive attacks occur, just as roots are emerging after planting, roots are not able to grow more than a few centimetres. Consequently, numerous very short roots, which do not function satisfactorily, develop around the base of the stem.
(d) Symphilids also feed on root hairs, and can cause lateral lesions in tender roots.

2. BEHAVIOUR AND BIOLOGY OF THE INVOLVED SPECIES

Several species of *Hanseniella* and *Scutigerella* have been reported in different countries.

Adults are white in colour, measure 6–10 mm in length and a few mm across, and have two long feelers on their head. They have 12 pairs of legs and are blind, lucifugous and hygrophilous. Adults can live for several years, and the pest biology depends on environmental conditions. The female lays 10–11 eggs and looks after them with great care.

Symphilids can move only by using natural cracks and tunnels caused by variation of soil moisture, plant roots and underground fauna. Consequently they are more easily found in aerated soils that are rich in organic matter. On clay soils, which are easily compacted, population explosions can occur if a large quantity of vegetation has been buried in an extremely rainy period. They undertake daily and seasonal migrations, and penetrate the deep layers of the soil if the top dries out or if temperatures are too high (the optimum is 28°C).

3. CONTROL OF SYMPHYLIDS

Products used for nematode control are also effective against symphilids. The products have to be incorporated into the soil before planting. Follow-up treatments need to be carried out 5 months after planting when the second flush of roots appears, and at the beginning of the inter-seasons.

Source: Py et al. (1987)

APPENDIX 18

DISEASES CAUSED BY *PENICILLIUM FUNICULOSUM* AND *FUSARIUM MONILIFORME*

1. MAIN SYMPTOMS

1.1. Black Spots

The spots appear in the flesh when the fruit is sliced. They are dark yellow and translucent at an early stage, then become larger and darker. At an advanced stage, black spots spread to a varying degree beyond the tissue of the fruitlets. The number of fruitlets attacked on each fruit varies (up to 50%). Fruitlets are more affected at the base of the fruit and on large fruits.

These symptoms are not visible during fruit development. They appear shortly before maturity and continue to develop after harvesting.

1.2 Leathery Pocket

Suberification gives the walls of the carpellary loci a leathery consistency.

1.3. Interfruitlet Corking

This abnormality consists in the external suberification of fruitlets and fine transverse cracking of the sepals and bracts, which results in misshapen fruits.

2. THE PATHOGEN

Two pathogenic species of fungi, *Penicillium funiculosum* and *Fusarium moniliforme*, are involved in the various forms the disease may take. They penetrate the fruit:

(1) via the nectary ducts,

(2) through cracks in the blossom cup,

(3) with the help of mites (*Steneotarsonemus ananas*) and the mealybugs (*Pseudococcus brevipes*),

(4) via wounds they cause or by simply penetrating the natural openings (in the case of the mite only).

3. METHODS OF CONTROL

Because of the complexity of these diseases, no fungicide treatments are known which can prevent them. Consequently, two types of strategy can be adapted:

3.1. Control of the fauna

This can be done by application of insecticides or miticides just before flower induction, with follow-up applications over a period of at least 4-5 weeks. Fungicides, when added to the latter, improve results.

A more detailed knowledge of the parasites in relation to the climatic factors should allow a reduction in the number (and the cost) of chemical applications by carrying out treatments only after warning signs appear.

3.2. Control of the soil composition

It is known that in the Ivory Coast, application of calcium resulted in a decrease in this disease. On the other hand, application of potassium (which is strongly recommended to increase fruit quality) reduces the impact of black spots. Therefore, a correct fertilization with limestone and potassium should increase the firmness of the fruit and improve the results obtained by controlling the fauna.

(Source: Py et al., 1987)

APPENDIX 19

DISEASES CAUSED BY *CERATOCYSTIS PARADOXA*

1. MAIN SYMPTOMS

1. **On shoots** (suckers, slips, crown and young plants)

The disease takes the form of a soft base rot of the stem; the parenchyma becomes black and disintegrates and there is often a pronounced acetic odour.

2. **On leaves** (white leaf spot)

The pathogen can penetrate through wounds caused by pests or by leaves rubbing against each other. White spots with black margins appear, however the infection generally is not serious.

3. **On fruits** (black rot, water blister)

A soft, watery rot occurs in the fruit flesh, which deteriorates rapidly and is accompanied by a characteristic odour. From the outside, juice can be seen oozing through the skin, which collapses under pressure

Two types of rot are encountered:

(1) the peduncle rot which occurs after harvest and develops from the base to the top of the fruit (in a cone shape)

(2) the rot on a side of the fruit following bruising that has occurred during harvesting.

In both cases, the infection spreads very quickly at ambient temperature.

2. BIOLOGY OF THE PATHOGEN

The pathogenic agent is *Thielavopsis paradoxa* which is the imperfect form of an ascomycete (the perfect form, *Ceratocystis paradoxa*, has never been reported on pineapple).

The fungus grows at a pH that ranges from 3 to 8 and optimum temperatures for its development range from 25 to 28°C. Hot and humid periods and any other factor that increases the sensitivity of the fruit are particularly favourable for the development of the disease.

3. CONTROL

3.1. Shoot Protection

Shoots and slips should be handled carefully to avoid wounds. Healing of wounds, caused when they are separated from the mother plant, is facilitated by simply exposing the base to the sun for a few days.

When the planting material is transported in bulk over long distances, protection can be provided by dipping it into a solution of fungicide.

3.2. Fruit Protection

The sugar content of the flesh provides a favourable environment for the fungus. Thus, it is necessary to avoid bruising through careful handling, and to store the fruits in good conditions (low temperature, clean and airy places).

In the case of fresh fruits for export, the whole fruit must be dipped in a solution of fungicide and the packing shed disinfected with a solution of formaldehyde (3%). Waxes, used to extend the shelf-life of fruits (by slowing down gaseous exchanges) usually also contain a fungicide, otherwise it must be added.

(Source: Py et al. 1987)

APPENDIX 20

THECLA BASILIDES (GEYER) — LEPIDOPTERA

1. MAIN SYMPTOMS

The larvae devour the floral parts and then penetrate the flesh of the developing fruit, creating cavities. The fruit attacked when immature is misshapen and subsequently produces a translucent amber-coloured gum which hardens on contact with the air.

On local pineapple fruits, attacks were mainly situated at the base of the syncarp or directly on the slips. Consequently, deformations caused by larvae activity were not systematic.

2. INFORMATION ABOUT THE PEST AND ITS BIOLOGY

2.1. Description

The female measures 28 mm long and is characterized by ash-coloured wings. The front wings have black borders and fringes of whitish scales, while the back wings have two orange spots with white borders and two pairs of tapering appendages. The male, which is smaller, has a large black patch in the centre of its wings.

2.2. Biology

The female is attracted to the inflorescence as soon as it appears in the rosette of the leaves and usually lays her eggs at the base of the floral bract. Eggs are whitish in colour with a fine reticulation. They are slightly flattened and measure a little over 0.5 mm. The development cycle of this pest depends on the climatic conditions.

Many species of Bromeliaceae in the neighbouring areas and old pineapple fields can serve as hosts for the Lepidoptera. These are the reservoirs and from them the butterflies invade new pineapple fields at flowering time.

3. CONTROL OF THE PEST

The butterfly can be controlled with applications of insecticides at the flower induction stage and throughout the blooming period. Four types of chemicals can be used:

(1) Organophosphorus compounds: the application has to be repeated frequently due to there low persistence.

(2) Organochlorides which are less toxic.

(3) Organohalides.

(4) Carbamates.

The two latter are often preferred, since there is less problem with residual effects.

The organochlorides which can be used to control *Thecla basilides* are for example, Heptachlor®, Chlordecone®, at a rate of 1–3 kg of active ingredient/ha, from floral differentiation at intervals of 10–15 days.

Remark: These two products are forbidden in several countries.

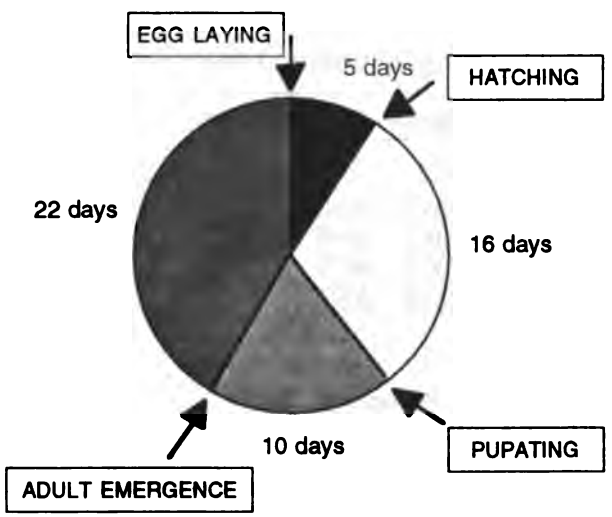
Another chemical, the Toxaphene® can also be used, and is available in Guyana.

Other chemicals are available locally, but their effectiveness in controlling the butterfly is not known. They are : Padan®, Elsan®, Fastac®, and Belmark®.

4. CONTROL OF SPREADING OF THE PEST

It is extremely important to stop the spreading of *Thecla basilides* to other continents. Strict controls have to be done on fresh fruits for export. All cocoons must be removed from the base of the fruit and destroyed.

Generally, neither larvae nor eggs are present on ripe fruits; this facilitates the control for exportation.



The life cycle of *Thecla basilides*

APPENDIX 21

SACCHAROMYCES SP.

MAIN SYMPTOMS

These yeasts may affect fruits which have reached an advanced stage of maturity.

The pathogen enters the fruit and develops rapidly because of the sugar content in the flesh. Initially, there are no external symptoms. Subsequently, a sticky liquid oozes out, indicating the flesh has already been affected by the disease. At this stage, the skin is brownish in colour. In addition to the large spoilage which results from decomposition of tissues during fermentation, bright yellow areas are observed when the fruit is cut cross-sectionally and an odour of fermentation that is more or less alcoholic is given off. At a more advanced stage, only the shell remains, surrounded by a mass of spongy tissues.

The disease is favoured by a hot and humid weather following a dry spell.

CONTROL OF THE YEAST DISEASE

The only method of getting successful results is by controlling the vectors and the water supply.

(Source: Py et al., 1987)

APPENDIX 22

GLOBAL LOSSES DUE TO PESTS AND DISEASES

Hypotheses:

Density of plantation: 15,000 plants/ha

Selling price of good fruits from the first crop: G$800/dozen
Selling price of good fruits from the second crop: G$500/dozen
Reduced selling price of fruits from the first crop: G$400/dozen
Reduced selling price of fruits from the second crop: G$200/dozen

Global losses due to pests and diseases

	Apparently good fruits			Direct losses			Fruits sold at a reduced price				Total	
	(%)	(Nb.F)	(E).	(%)	(Nb.F)	(L.)	(%)	(Nb.F)	(E).	(L.)	(E.)	(M.I.)
CP1	55.2	8280	552.3	34.3	5175	345.2	10.5	1575	52.4	52.4	604.7	397.6
CP2	38.7	5805	242.1	40.8	6120	255.2	20.5	3075	51.4	76.9	293.5	332.1
WS1	30.5	4575	305.2	57.7	8655	577.3	11.9	1785	59.4	59.4	364.6	636.7
WS2	35.5	5327	222.1	57.1	8565	357.2	7.5	1125	18.8	28.1	240.9	385.3

Legend:

CP1 = Canal Polder/first crop.
CP2 = Canal Polder/second crop.
WS1 = White Sand area (Region 4)/first crop.
WS2 = White Sand area (Region 4)/second crop.
Nb. F = Number of fruits
E. = Earning (G$×1,000)
L. = Losses (G$×1,000)
M.I. = Missing income (G$×1,000)

APPENDIX 23

INFORMATION ABOUT THE LOCAL USE OF WEEDICIDES

Characteristics of the main weedicides available locally

Commercial product	Common name	Mode of action	Effectiveness	Method of application	Dosage
Gramoxone®	paraquat	Post-emergence	*Gramineae* and some *Monocotyledoneae*	To be sprayed on the growing foliage of weeds	10–15 kg/ha
Round-up®	glyphosate	Post emergence	Very wide action	To be sprayed on the growing foliage of weeds between the rows (protective device necessary)	2–4 kg/ha
Karmex®	diuron	Strictly pre-emergence	*Dicotyledoneae* and some *Gramineae*	To be sprayed on clean soil before the weeds emerge	2-6 kg/ha
Gesapax® (80% a.i.)	ametryne	Pre-emergence but works as a post-emergence	*Dicotyledoneae* and many *Gramineae*	To be sprayed on young weeds	2–6 kg/ha
Hyvar X® (80% a.i.)	bromacil	Pre-emergence but works as a post-emergence	Very effective against *Cyperaceaes*	To be sprayed on clean soil before weeds emerge or on very young weeds	2 kg/ha
Krovar® (80% a.i.)	bromacil (40%) diuron (60%)	Pre-emergence but works as a post-emergence	*Dicotyledoneae* and *Monocotyledoneae*	To be sprayed on clean soil before the weeds appear or on very young weeds	4 kg/ha

Other chemicals are available as 2.4 D®, Lasso®, Propanyl®, Ally®, Herbadox®, but they are not very common.

APPENDIX 24

EXPERIMENTS WITH FLOWER INDUCTION TREATMENTS (FIT)

OBJECTIVES

Comparison of the effectiveness of three FIT under Guyanese conditions with the Montserrat cultivar.

SITUATION

The experiments were set up in the major producing areas:

(1) Timehri - Region 4 (White Sands)

(2) Canal Polder 1 - Region 3 (Mara clay)

METHODOLOGY:

Plan of Action:	Fisher blocks
Number of Replications:	Timehri: 3 Canal Polder: 4
Plot Size:	30 plants

TREATMENTS:

(1) Calcium carbide in a granulated form (1g/plant)

(2) Solution of calcium carbide (50 ml/plant)

(3) Naphtalene acetic acid (NAA) in tablet form.

Date of treatment

Timehri: 16 July Canal Polder: 27 July,

Time of Treatment

After 5.30 p.m.

Results of treatment

Five weeks after treatment

RESULTS:

The results are given in the Tables below.

COMMENTS

(1) In terms of response, there are no significant differences between the effectiveness of FIT using NAA tablets and FIT using the calcium carbide in a granulated form. The effectiveness is very good; more than 95% success is obtained.

(2) The difference of effectiveness which exists between FIT using the solution of calcium carbide and the other FIT conducted at Timehri, may be explained by the lack of maturity of some plants treated or a too good a nutrient supply which make the plants less sensitive to FIT.

(3) Inducing flowering with NAA costs about G$ 1.7/ plant. A local enterprise purchases calcium carbide from Norway (for its own purposes) for about G$79.2/kg.

Assuming the purchase price tripled, due to the transportation costs and seller's profits, the cost of FIT using calcium carbide would be on average:

— in a granulated form: G$0.24/plant

— in solution: G$0.07/plant.

In order to ensure the effectiveness of the FIT using the solution of calcium carbide, a second application is necessary. In this case, the cost of treatment would be:

— chemical: G$0.07 x 2 = 0.14

— labour : G$0.2

Total = G$0.34

(5) Calcium carbide is known to be neutral with respect to the shape and size of pineapple fruits of any variety in all the producing areas, while NAA may affect the shape and entail a delay in harvesting.

Results of the experiment conducted at Timehri.

Treatment	1st rep.	2nd rep.	3rd rep.	Mean
NAA tablets	88.2	96.9	96.8	94
Calcium carbide granules	93.3	96.7	100	96.7
Solution of calcium carbide	83.3	66.7	76.7	75.6

rep. = replication

Results of the experiment conducted at Canal Polder 1

Treatment	1st rep.	2nd rep.	3rd rep.	4th rep.	Mean
NAA tablets	100	100	96.6	100	99.2
Calcium carbide granules	96.7	96.9	100	96.7	97.6
Solution of calcium carbide	96.7	93.3	90	96.7	94.2

rep. = replication

APPENDIX 25

COST OF PRODUCTION IN REGION 3

Cost of production per ha in Region 3 (Canal Polder, first crop)

Activity	Need	Detailed cost	Total cost
Land preparation			
Ploughing	3 passsages	5,000/passage	15,000
Drainage	10 m.d.	400/m.d.	4,000
Planting	5 × 3 m.d.	400/m.d.	6,000
Lining field	2 taps	500/tap	1,000
Weed control			
Karmex®	3 × 7 kg	1,600/kg	33,600
Weeding	5 × 8 m.d.	400/m.d.	16,000
Pests control			
Karate®	3 × 2 l	3,500/l	21,000
Monocotrophos®	2 × 2 l	3,500/l	14,000
Treatments	3 × 4 m.d.	7,500	400/m.d.
Fertilization			
Urea	2.5 bags (50kg)	3,000/bag	7,500
Ammonia sulphate	10 bags	1,410/bag	14,100
Triple super-phosphate	2.5 bags	2,035/bag	5,088
Application	3 × 8 m.d.	400/m.d.	9,600
FIT			
Tablets	3 tins	9,000/tin	27,000
Treatments	3 × 2 m.d.	400/m.d.	2,400
Harvesting			
Bull-cart rent	5 days	2,000/day	10,000
Harvesting	16 m.d.	400/m.d.	6,400
Collecting slips	2 m.d.	400/m.d.	800
Drainage maintenance	2 × 5 m.d.	400/m.d.	4,000
Land lease	1.5 year	22/year	33
Total Costs			**205,021**
Sales			**604,700**
Profit			**399,679**

m.d.= man-day

Cost of production per ha in Region 3 (Canal Polder, second crop)

Activity	Need	Detailed cost	Total cost
Land preparation	0	0	0
Weed control			
Karmex®	2 × 7 kg	1,600/kg	22,400
Weeding	3 × 8 m.d.	400/m.d.	9,600
Pests control			
Karate®	1 × 2 l	3,500/l	7,000
Treatments	1 × 4 m.d.	400/m.d.	1,600
Fertilization			
Ammonia sulphate	5 bags	1,410/bag	7,050
FIT	0	0	0
Harvesting			
Bull-cart rent	5 days	2,000/day	10,000
Harvesting	16 m.d.	400/m.d.	6,400
Drainage maintenance	1 × 5 m.d.	400/m.d.	2,000
Land lease	1 year	22/year	22
Total Costs			**66,072**
Sales			**293,500**
Profit			**227,428**

m.d.= man-day

APPENDIX 26

COST OF PRODUCTION IN REGION 4

Cost of production per ha in Region 4 (Canal Polder, first crop)

Activity	Need	Detailed cost	Total cost
Land preparation			
Clearing the land	4 × 7 m.d.	400/m.d.	11,200
Burning	2 × 2 m.d.	400/m.d.	1,600
Planting	5 × 3 m.d.	400/m.d.	6,000
Weeding	4 × 8 m.d.	400/m.d.	12,800
Pest control	0	0	0
Fertilization	0	0	0
FIT	0	0	0
Harvesting	16 m.d.	400/m.d.	6,400
Collecting slips	2 m.d.	400/m.d.	800
Drainage maintenance	0	0	0
Land lease	1.5 year	5/year	7.5
Total costs			**38,808**
Sales			**364,600**
Profit			**325,792**

m.d.= man-day

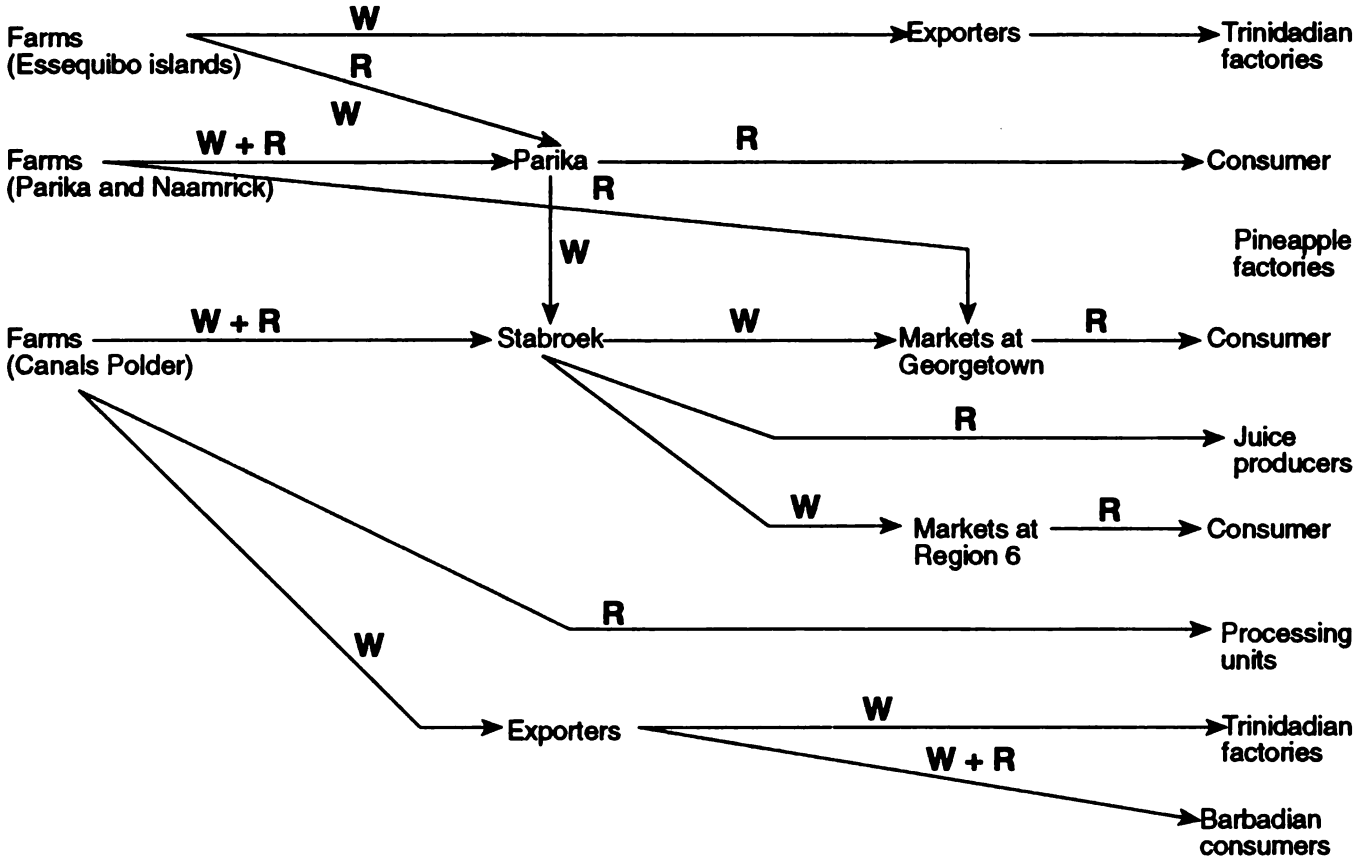
Cost of production per ha in Region 4 (Canal Polder; second crop)

Activity	Need	Detailed cost	Total cost
Land preparation	0	0	0
Weeding	4 × 8 m.d.	400/m.d.	12,800
Pest control	0	0	0
Fertilization	0	0	0
FIT	0	0	0
Harvesting	16 m.d.	400/m.d.	6,400
Drainage maintenance	0	0	0
Land lease	1 year	5/year	5
Total Costs			**19,205**
Sales			**240,900**
Profit			**221,695**

m.d.= man-day

APPENDIX 27

LOCAL MARKETING NETWORK OF FRESH FRUITS



Legend:
Wholesale = W
Retail = R

APPENDIX 28

ECONOMIC DATA ON THE MARKETING OF FRESH FRUITS IN GUYANA

Economic data on the local marketing of fresh fruits.

	PP (G$/kg)	SP (G$/kg)	SR (G$/kg)	Tx/L (G$/kg)	T (G$/kg)	L (%)	Earning (G$/kg)
STABROEK							
Wholesalers	0	49	0	2.0	1.3	5	43.3
Farmers retailing	0	53	0.7	0.5	1.3	15	59.9
Retailers	49	57	0.7	0.5	0	3	5.1
OTHER MARKETS IN GEORGETOWN							
Farmers retailing	0	56	0.7	0.5	1.4	10	47.8
Retailers	49	66	0.7	0.5	1.0	6	10.8
NEW AMSTERDAM							
Retailers	49	61	0.3	0.3	1.5	10	3.9
ROSE-HALL TOWN							
Retailers 1	30	40	0.3	0.3	1.2	5	5.5
Retailers 2	49	58	0.3	0.3	1.5	10	1.2
CORRIVERTON							
Wholesalers	0	30	0	0.5	10	15	15.0
Retailers	30	40	0	0.5	0	5	7.5
NICKERIE							
Wholesalers	0	20	0	0	5	15	12.0

PP = Purchasing Price
SP = Selling Price
SR = Stall Rent
Tx/l = Taxes or lease
T = Transportation
L = Losses

APPENDIX 29

SMALL-SCALE FACTORY PROCESSING IN GUYANA

GUYTRI

SITUATED: Bordeaux, Canal Polder 1, West Coast Demerara, Guyana.

PURCHASING: At the market or directly at the farms for G$25–30/kg according to the size and shape of the fruits.

PRODUCTION: 75 buckets (900 kg)/month on an average, when in season. 100 to 150 dozen pineapples produce 900 kg of canned products. Wastes are evaluated at 45–50% and consist mainly of shells and hearts.

DESTINATION OF THE PRODUCTS: Trinidad

FLOW-SHEET:

Flow-sheet of Guytri's process

APPENDIX 30

SMALL-SCALE FACTORY PROCESSING IN GUYANA
ADVENTURE MANUFACTURING COMPANY LIMITED

SITUATED: Queenstown, West Bank Essequibo, Guyana.

BACKGROUND: This establishment started in 1986 with the processing of jam and jelly. At that time it was situated at Adventure, West Bank Essequibo. The production of chunks began in 1990.

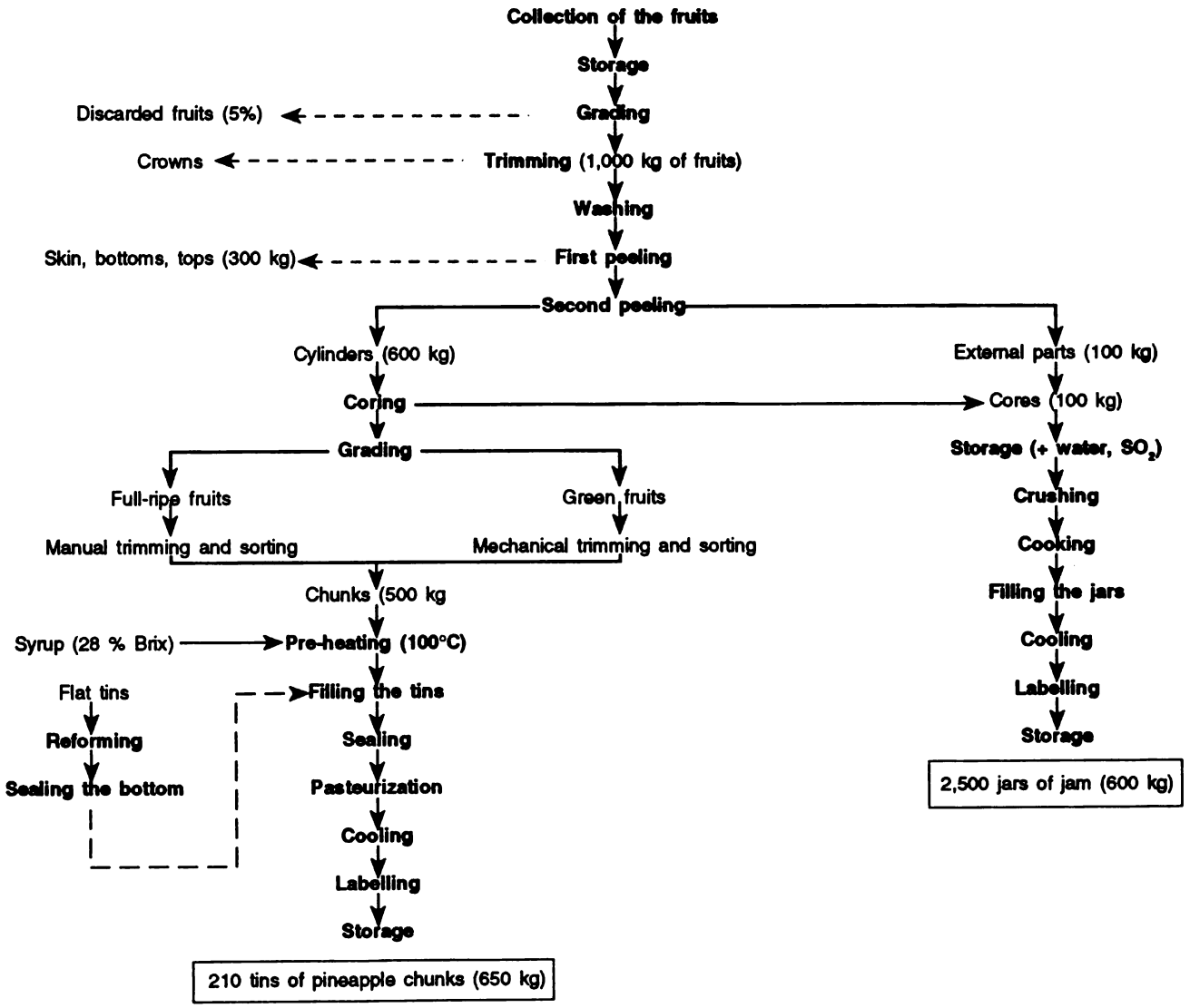
PRODUCTS:
3-kg tins of pineapple chunks
240-g jars of pineapple jam
240-g jars of guava jam and jelly
Guava cheese
Frozen carambola juice

PURCHASING THE RAW MATERIAL:
20% of the fruits are from the company's plantation, which is situated at Naamryick Backdam. The other fruits are purchased from Parika, Naamryick and, to a lesser extent, Canals Polder.

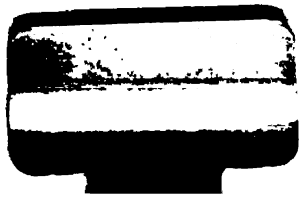
The sugar is bought locally for G$50/kg while the citric acid, sodium benzoate, pectin, etc. are imported from the United Kingdom.

PURCHASING OF THE CONTAINERS:
The containers (flat tins) are purchased from Trinidad for G$125/tin and are reformed in the factory. The jars are purchased from Jamaica for about G$20 each. The carton boxes are bought locally for about G$50 each.

DESTINATION OF THE PRODUCTS:
Pineapple chunks: Trinidad & Tobago;
Pineapple jam: Trinidad & Tobago, Barbados and the local market.



Flow-sheet for processing Pineapple jam and chunks.



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