COUNTRY REPORT ON THE STATE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

TRINIDAD AND TOBAGO

Trinidad and Tobago

Second Country Report on PGRFA

Note by FAO

This Country Report has been prepared by the national authorities in the context of the preparatory process for the Second Report on the State of World's Plant Genetic Resources for Food and Agriculture.

The Report is being made available by the Food and Agriculture Organization of the United Nations (FAO) as requested by the Commission on Genetic Resources for Food and Agriculture. However, the report is solely the responsibility of the national authorities. The information in this report has not been verified by FAO, and the opinions expressed do not necessarily represent the views or policy of FAO.

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned. The views expressed in this information product are those of the author(s) and do not necessarily reflect the views of FAO.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

FOREWORD

At the invitation of the Food and Agriculture Organisation of the United Nations (FAO), the Government of the Republic of Trinidad and Tobago (GORTT) was requested to prepare a Second Report of the State of the World's Plant Genetic Resources for Food and Agriculture. This report, referred to as the Second Country Report is expected to form the basis for updating the rolling Global Plan of Action. Second Country Reports from member countries are expected to be presented at the 12th Session of the Commission on Genetic Resources for Food and Agriculture in 2008.

The Ministry of Agriculture, Land and Marine Resources (MALMR) is the line ministry having been nominated as the Focal Point for the International Treaty on Plant Genetic Resources for Food and Agriculture. The responsibility of preparation of the Second Country Report was delegated to a Core Committee under the chair of the Director Research. This Committee included representatives from other Divisions in the Ministry and began its work in late May 2007.

Valuable contributions were received from several institutions and other governmental bodies including The University of the West Indies, Cocoa Research Unit, Ministry of Public Utilities and the Environment and Tobago House of Assembly.

Information presented in the Second Country Report reflects the early results of the implementation of the Global Plan of Action by Trinidad and Tobago. While the monitoring functions have not been well defined, it is nevertheless recognized that monitoring the conservation of plant genetic resources is of utmost importance and this is evidenced by the development of a five-year project on the conservation and sustainable utilization of plant genetic resources for food and agriculture.

On behalf of the National Focal Point for the International Treaty on Plant Genetic Resources for Food and Agriculture, the Director of Research would like to thank the FAO for the opportunity to contribute to the 2nd Report on the State of the World's Plant Genetic Resources for Food and Agriculture.

INTRODUCTION

SECTION 1

EXECUTIVE SUMMARY

This 2nd Country Report on the state of plant genetic resources for food and agriculture in Trinidad and Tobago provideS both an updated position on important issues relating to the conservation, characterization and sustainable utilization of plant genetic resources for food and agriculture (PGRFA) as well as it provides a strategic direction in the development of appropriate policies and programmes for PGRFA for this small, twin island Republic in the southern Caribbean.

The relatively small land area of Trinidad and Tobago (T&T) results in intensive competition among several sectors (industrial, commercial, housing, mining and agriculture) for limited land resources. This inevitably results in traditional agricultural lands being put into alternative uses. Over the last ten years the pressure for alternative land use has had significant impact on traditional farming and farming communities and institutional *ex situ* crop germplasm collections. Of major concern is the serious threat of genetic erosion to farmers who continue to cultivate these very unique traditional crop landraces.

Trinidad and Tobago enjoys a tropical climate and has an enormous range of crop biodiversity. Many of these crops are early introductions brought in by migrant people from many parts of the world. The historically important agricultural production as well as the establishment of the Imperial College of Tropical Agriculture facilitated the import of a wide range of tropical crop germplasm including, cocoa, coffee, rubber, sugarcane, rice, exotic fruits and vegetable varieties. These introduced crops form the "backbone" of the present agricultural systems.

Cultivated crops include tree species such as cocoa, coconut, coffee, mangoes, citrus, avocadoes and a wide range of exotic fruits. The major cash crops of Trinidad and Tobago include several aroids, many leafy vegetables and some *Solanaceous* crops while plants of medicinal value, herbs and spices, as well as vine crops are considered to be minor crops.

Many of these species have been introduced into Trinidad over one hundred years ago. Farmers have been growing some of these in traditional systems for many years and have made selections which now constitute important crop landraces.

Much of this crop biodiversity is conserved by several well established institutions within Trinidad and Tobago. These include, the University of the West Indies (UWI), Caribbean Agricultural Research Development Institute (CARDI), the Research Division and Agricultural Services Division of the Ministry of Agriculture, Land and Marine Resources (MALMR) and Caroni (1975) Ltd.

In Trinidad and Tobago, there has been a long history of activities relating to the conservation of the wide crop biodiversity which exist in the islands. Many of these efforts have been focused on *ex situ* conservation through working collections, genebanks and museum plots. These efforts, to a large extent, have not been coordinated efficiently and have resulted in significant erosion of crop biodiversity in T&T. However, the International Cocoa Genebank, Trinidad (ICG,T) at the Cocoa Research Unit (CRU) at UWI remains the most active cacao collection in the world . The CRU is regarded as a centre of excellence in research activities relating to *Theobroma cacao*.

The lack of national policy on the important issue of the conservation, documentation and sustainable utilization of crop genetic resources for food and agriculture has hampered, in the past, initiatives aimed at developing comprehensive programmes in the conservation of agricultural crop species. There is ample evidence to establish that over the last ten years, traditional crop varieties are being lost as a result of the general decline of the agricultural sector. The use of imported varieties and the lack of sufficient local seed production has also contributed to the loss of local crop landraces. Efforts to store important crop germplasm as seed material have encountered problems due to the lack of seed banking infrastructure.

Long term funding has been secured to meet obligations to the various treaties and protocols relating to the conservation and sustainable use of crop biodiversity. This funding has now been accessed through the Public Sector Investment Programme (PSIP) and covers the areas of training, *in situ* management, *ex situ* management, inventories and documentation.

The International Treaty on Plant Genetic Resources for Food and Agriculture provides a useful framework for developing programmes and activities to meet national goals and objectives in the area of PGRFA. The Caribbean Crop Genetic Resources Network (CAPGERNET) has an important role to play in directing the human and financial resources of

the region into sustainable activities in the area of crop biodiversity conservation and sustainable utilization. At the most recent CAPGERNET workshop in Trinidad in 2007, the responsibility for the development of regional *ex situ* collections of sweet potato, hot peppers and breadfruit was given to the host country, Trinidad and Tobago.

Characterization, evaluation and pre-breeding activities are progressing slowly, particularly due to the lack of trained persons in the field of plant genetic resources management. Two important national institutions which can lead the way in training activities are the Cocoa Research Unit at UWI and the National Herbarium also located at UWI. CRU has the capacity to conduct morphological and molecular characterization and the National Herbarium has expertise in morphological characterization as well as linkages with centres of excellence in plant genetic resources management.

There are many constraints to the development of a viable seed industry in Trinidad and Tobago, using local cultivars. A programme to develop the seed industry in T&T involving farming communities needs to be explored. One of the strong recommendations of the National Biodiversity Strategy and Action Plan of T&T is to harmonise all international treaties relating to crop biodiversity conservation whereby a common framework will be adopted to develop appropriate national programmes. This has been achieved for the conservation and sustainable utilization of crop genetic resources for food and agriculture.

The implementation of national programmes in plant genetic resources for food and agriculture require the support of training activities in all aspects of plant genetic resources management. Along with this a national public awareness programme is required to educate the public, particularly the farming communities, about the IT-PGRFA and benefits to be gained in terms of benefit sharing to the farming communities of Trinidad and Tobago.

The Government of the Republic of Trinidad and Tobago (GORTT) has enunciated the goal of the country achieving Developed Nation Status by the year 2020. The Agriculture Sub-committee Report for the Vision 2020 exercise indicates that the vision is that the *Agricultural Sector in Trinidad and Tobago by the year 2020 will be competitive and will sustain competitiveness by being resilient, adaptive and market-driven*. The drivers for the 2020 Agriculture Vision were identified as Research, Technology, Development and Extension; Drainage, Irrigation and Water Management; Land Resources; Finance and Credit; Marketing; Access Roads; Policies and Regulations; Fisheries Management and Infrastructure; Building Human Capital; and Information and Communication.

It is within this context that the appropriate management of plant genetic resources, for food and agriculture, is required at the national level in order to achieve the stated goals and objectives for the agricultural sector by the year 2020.

SECTION 2

AN INTRODUCTION TO THE COUNTRY AND ITS AGRICULTURAL SECTOR

1. Physiographic and Climatic Features and Human Population Trends

The twin island Republic of Trinidad and Tobago lies in the Caribbean Sea approximately 11km off the east coast of Venezuela. The island of Trinidad is situated about 10 degrees North of the Equator, between 61 and 62 degrees West longitude in the Southern part of the Caribbean Sea (see Figure 1). It is the second largest of a group of islands comprising the English-speaking West Indies. The larger island is approximately 105km long and 77km broad with an area of 4,828 square km.

The island of Tobago is situated about 11 degrees 9 minutes North of the Equator, 60 degrees 43 minutes West longitude. It lies northeast of Trinidad separated by a channel about 31 km wide. It is approximately 51km long and 18 km broad with an area 300 square kilometer.

The terrain of the islands is a mixture of mountains and plains. In Trinidad there are two extensive areas of flat or gently undulating land, the Caroni Plain in the central part of the island and the Naparima Plain in the south. The highest point in the country is found on the Northern Range at El Cerro del Aripo, which is situated at 940 meters above sea level. Tobago is characterized by a generally rugged elevation with the only extensive lowland being a coral platform at the southwestern end.

Trinidad may be classified as a "continental" island with regard to its South American genesis. A number of endemic plant species is known to exist arising out of the ecology produced by its continental past and recent insular status. The country has considerable ecological diversity. The main ecological types include rain forests, humid forests and savannah. The main ecological zones include coastal regions, rivers valleys, humid regions, hilly slopes and marine and fresh water ecosystems. There are six major soil types in Trinidad and nine in Tobago (see Figure 3).

The tropical humid climate of the country is characterized by a rainy season which extends from June to December and a dry season which extends from January to May. The annual average rainfall is 2,150 mm and the annual minimum temperature is 22°C while the maximum is 32°C.

The population of this twin island republic is relatively small (1.3 Million) with a population density of 215 persons per square kilometer Trinidad and Tobago has recorded a marginal population growth rate over the last decade. Over the period, the national population increased by 1.8% or 23,000 persons to reach 1.3 million in 2006. This modest population growth rate is expected to continue.

FIGURE 1
Location of Trinidad and Tobago within the Caribbean Region

2. Food Security Issues

Agriculture is an economically small but socially important sector. It contributed 0.6% to GDP in 2006. In that year, primary agriculture contributed US$112.0 million to the GDP of Trinidad and Tobago. This comprised of sugar which contributed US$32.3 million, other export agriculture (cocoa, coffee and citrus) which contributed US$2.9 million and domestic agriculture which contributed US$76.8 million. The most significant contributor to domestic agriculture was vegetable and root crops, which amounted to US$14.1 million.

The contribution of the agricultural sector to GDP has been declining over the last decade. It declined from 2.1% in 1997 to 0.6% in 2006. The production of sugar fell by 70.2% from 236.8 thousand tonnes in 1997 to 70.5 thousand tonnes in 2006. Cocoa production also declined, with output reducing by 67.3 % from 1,740.2 tonnes in 1997 to 569.2 tonnes in 2006. Rice (paddy) production also fell from 6.8 thousand tonnes in 1997 to 2.3 thousand tones in 2006.

Trinidad and Tobago is an overall net food importer. Additionally, the extent to which food imports has exceeded food exports increased over the last decade. In 1996, food imports exceeded exports by 41.66%. The comparable figure for 2005 was 64.10%.

In 2005, food imports from all sources were US$432.35 million, while food exports were US$155.20 million. The greatest value of imports was for fruits and vegetables (US$91.95 million), while the greatest value of exports was for cereal and preparations (US$44.81 million).

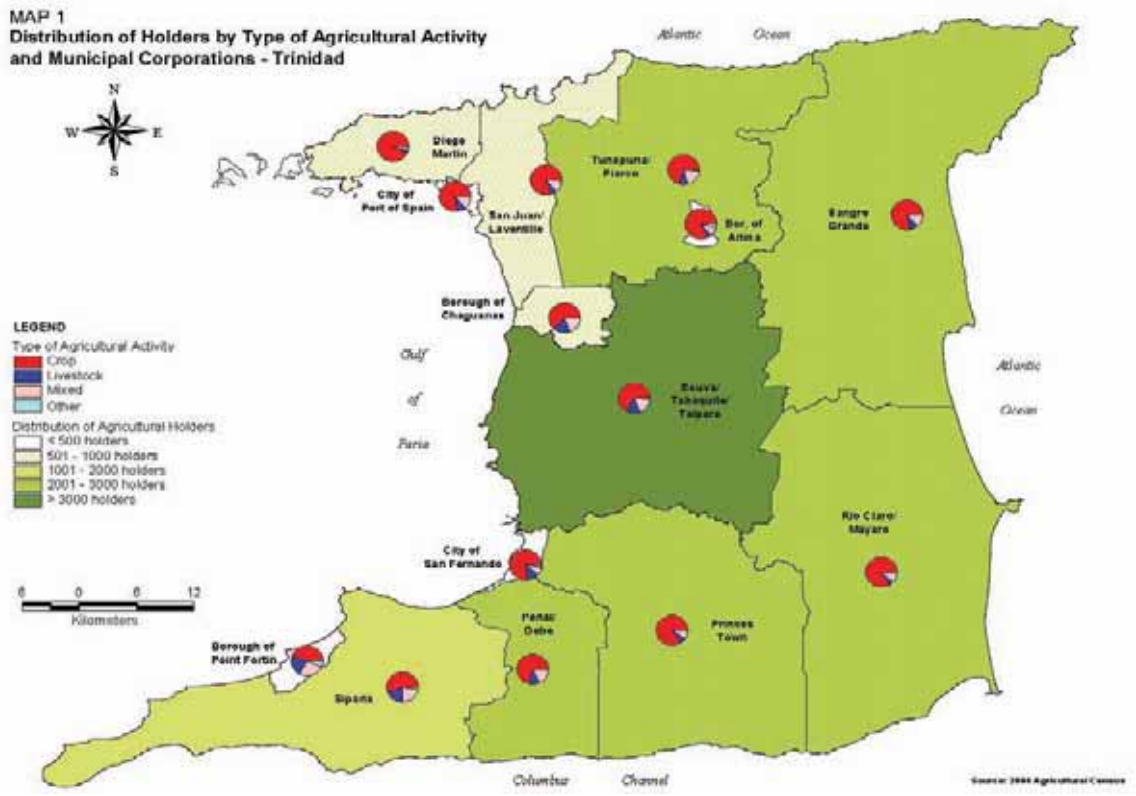
In Trinidad and Tobago domestic consumption outstrips domestic production and only a few staple commodities are produced in any significant quantity. In effect, adequate food availability depends on an adequate supply of foreign exchange. However it has been reported that 11 % of the population was undernourished in 2001-2003, which was a decline from 13% in 1990-1992 (FAO, The State of Food Insecurity in the World, 2006).

The relative importance of crop and crop products for domestic use in Trinidad and Tobago can be seen in terms of consumption, food security and self-sufficiency. For exports its importance can be illustrated in terms of income and building international relationships through enhancing the country's negotiating capability, understanding how existing agreements and conventions impact agricultural trade. It also enhances the international competitiveness, including

increasing the capacity of domestic products to meet international standards and developing niche markets.

The constraints that make it difficult to produce food in quantities sufficient to meet national demands are land constraint and un-competitiveness in the production of staple food items.

FIGURE 2
Map of Trinidad showing Distribution of Holders by Agricultural Activity



3. Profile of the Agricultural Sector

The results of the 2004 Agricultural Census revealed that the total number of agricultural holders in Trinidad and Tobago was 19,143 of which 18,169 or 94.9% were recorded in Trinidad and 974 or 5.1% in Tobago. This represents a decline of 11,423 holders or approximately 37.4% when compared to the total number of holders, 30,566 recorded in the previous Agricultural Census which was conducted in 1982.

The total number of holdings in Trinidad and Tobago in 2004 was 18,968. The majority of holdings were less than 10 hectares in area. The break down is as follows:

- Under 0.5 ha - 22 %
- 0.5 to < 1 ha - 12.8 %
- 1 to < 2 ha - 18.2 %
- 2 to <5 ha - 34.1 %
- 5 to < 10 ha - 8.9 %
- 10 to < 50 ha - 3.7 %
- Over 50 ha - 0.3 %

The vast majority of holders (89.4%) were concentrated within six regions (see Figure 2.) The region of Couva/ Tabaquite/Talparo recorded the highest number with 3,078 holders. There were 2,812 holders enumerated in the region of Princes' Town, 2,099 in Mayaro/Rio Claro, 2,460 in Sangre Grande, 2,227 in Penal/Debe, 2,221 in Tunapuna/Piarco and 1,342 holders were found in the region of Siparia.

Private holders accounted for 19,055 or approximately 99.5% of which 18,505 were classified as "Individual/Household/ Sole Proprietor" and 550 as "Joint Partnership". The remaining 0.5% of holdings were primarily Private Companies and

Government Institutions. In 1982 the total number of Private Holders was 30,422 or 99.5%.

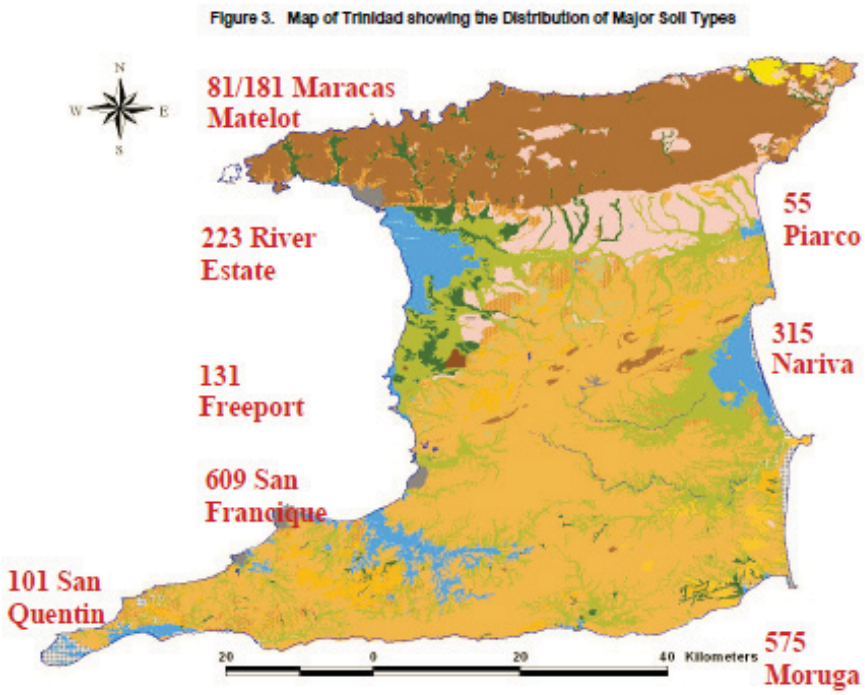
In Trinidad and Tobago the main cropping systems are; the monoculture systems, mixed cropping systems, intercropping systems and tree cropping systems. The main crops are cocoa, citrus, coffee, coconut, rice and vegetables. The major animal products are poultry and pork.

The data for Trinidad and Tobago revealed that the majority of agricultural holders were engaged in crop activity (Figure 2). There were 13,874 or 72.4% holders engaged in crop production while the remaining holders were engaged in mixed, livestock and other activities. The number of holders involved in mixed activities was 3,077 or 16.1%, while livestock activities recorded 2,046 holders or 10.7%. Only 146 or 0.8% of holders were engaged in other activities such as apiculture, aquaculture and horticulture.

Employment in the crop sector is very important since the age profile of farmers in Trinidad and Tobago has increased as a result of the inability of the agricultural sector to attract young persons. To facilitate the sustainability of the agricultural sector it is critical that this trend is reversed. The percentage of the labour force employed in primary agricultural production is decreasing over time. Agriculture's contribution to the nation's GDP is also on the decline. In 2004 primary agriculture provided a little over 1 percent of the country's GDP and employed 5 percent of the labour force. However, agro-industries accounted for 3.1 percent of the GDP and 45 percent of the manufacturing GDP.

FIGURE 3

Map of Trinidad showing the Distribution of Major Soil Types



4. Driving Forces and Limiting Factors for Agricultural Development

The Government of the Republic of Trinidad and Tobago (GORTT) has enunciated the goal of the country achieving Developed Nation Status by the year 2020. The Agriculture Sub-committee Report for the Vision 2020 exercise indicates that the vision is that the *Agricultural Sector in Trinidad and Tobago by the year 2020 will be competitive and will sustain competitiveness by being resilient, adaptive and market-driven*. The drivers for the 2020 Agriculture Vision identified were Research, Technology, Development and Extension; Drainage, Irrigation and Water Management; Land Resources; Finance and Credit; Marketing; Access Roads; Policies and Regulations; Fisheries Management and Infrastructure; Building Human Capital; and Information and Communication.

The Agricultural Census (2004) indicates the major production problems from the perspective of the farmer. Praedial larceny was reported as a problem by 30.8% of farmers, flooding by 29.6%, destruction by disease by 27.3%, destruction

by animals by 23.8%, poor/no access roads by 22.6%, financial problems by 18.2%, marketing problems by 14.8%, inadequate water supply by 14.0%, difficulties obtaining labour by 13.4%, low labour productivity by 16.4%, security of tenure by 4.5%, credit difficulties by 4.1%.

MAIN PART

CHAPTER 1

THE STATE OF DIVERSITY

1.1 The State of Diversity and Relative Importance of all Major crops for Food Security

The major agricultural crops of Trinidad and Tobago are listed in Table 1, which also shows the relative importance and its state of diversity. These crops are also included in **Annex 1 of the International Treaty on PGRFA.** However, it must be noted that for most of these crops, such as sweet potato, cassava and breadfruit, there is a significant dependence on imported primary product and/or processed products.

TABLE 1

List of the Major Crops of Trinidad and Tobago, the Number of Accessions, Products, Relative Importance and State of Diversity.

	Major Crops	Genus	No. of Accession	Products	Relative importance		State of Diversity			
					Food Security	Economic	I	D	RS	UN
1	Pigeon peas	*Cajanus*	3	Frozen & processed	H	H			*	
2	Citrus	*Citrus*	156	Juices & animal feed	H	H	*			
3	Coconut	*Cocos*	3	Coconut water & coconut milk	H	H		*		
4	Major Aroids	*Colocasia, Xanthosoma*	4	-	H	H			*	
5	Sweet potato	*Ipomoea*	85	-	H	H			*	
6	Cassava	*Manihot*	66	-	H	H			*	
7	Rice	*Oryza*	5	-	H	L		*		
8	Eggplant	*Solanum*	1	-	H	L	*			
9	Cowpea	*Vigna*	5	-	L	L			*	
10	Maize	*Zea*	3	Cornmeal	M	L			*	
11	BreadfruitX	*Artocarpus*	2	-	H	L			*	
12	YamsX	*Dioscorea*	41	-	M	L			*	

XMinor crops to Trinidad and Tobago that are listed in Annex 1

H-High
I-Increasing
D-Decreasing
RS-Remaining the Same
UN-Unknown
M-Medium
L-Low

1.2 The State of Diversity and Relative Importance of all Minor Crops and Underutilized Species for Food Security

Tables 2 and 3 provide a list of Minor Crops and Underutilized Species that contribute to food security and the agricultural sector in Trinidad and Tobago. Some of these crops (cocoa, hot peppers and pumpkins), although of low priority for food security, have excellent export potential.

TABLE 2

List of the Minor Crops of Trinidad and Tobago, the Number of Accessions, Products, Relative Importance and State of Diversity

	Major crops	Genus	No. of Accession	Products	Relative importance		State of Diversity			
					Food Security	Economic	I	D	RS	UN
1	Paw Paw	*Papaya*		-	H	H			*	
2	Pineapple	*Ananas comosus*		-	H	H			*	
3	Pumpkin	*Cucurbita moschata*	3	Ketchup	H	H		*		
4	Hot pepper	*Capsicum annuum*	8	Pepper sauce	H	H			*	
5	Mango	*Mangifera indica*	63	Preserved, jams, fresh cut & frozen	H	M			*	
6	Cocoa	*Theobroma cacao*	125	Chocolate & powders	H	H	*			
7	Sugarcane	*Saccharum officinarum*	15	-	L	L		*		
8	GingerX	*Zingiber officinale*	1	-	L	M			*	
9	SorrelX	*Hibiscus sabdariffa*	1	Dried & drinks	L	L			*	
10	SeimX	*Lablab niger*	4	-	L	L			*	
11	Bitter gourdX	*Momordica charantia*	2	-	L	M			*	

XMinor crops to Trinidad and Tobago

H-High UN-Unknown

I-Increasing M-Medium

D-Decreasing L-Low

RS-Remaining the Same

TABLE 3

List of Forages that are of importance to Trinidad and Tobago

		No. of Accessions	Relative Importance		State of diversity			
			Food Security	Economic	I	D	RS	UN
Legumes								
1	*Desmodium ovalifolium*	1	L					*
2	*Zornia latifolia*	1	L					*
3	*Arachis*	1	L					*
4	*Leucaena leucocephala*	1	H		*			
5	*Gliricidia sepium*	1	H			*		
6	*Centrosema pubescens*	1	L				*	

		No. of Accessions	Relative Importance		State of diversity			
			Food Security	Economic				
Grasses								
7	*Andropogon*©	1	L					*
8	*Tripsacum laxum*©	1	M				*	
9	*Brachiaria* spp.	4	H		*			
10	*Digitaria decumbens*	1	L				*	
11	*Pennisetum* spp. (hybrid)	3	H		*			
12	*Enchinochloa* spp.	-	L				*	

© Crops covered under Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture

1.3 The State of Diversity of Wild Plants Harvested for Food Production

Traditionally, the plants of the forests have not been a source of food for the early migrant workers and subsequently the mainstream population. Most of the edible plants, except for aroids, hot peppers and pineapple, have been introduced into Trinidad through early migrant populations. Most of the traditional uses of forest species are for building materials, handicraft and medicinal uses. The harvesting of forest plants for food is restricted to "cabbage" palms and wild yams that are used for domestic consumption.

1.4 The State of Diversity of Crop Varieties (Modern Varieties and Landrace/Farmers' Varieties)

There is an ever-increasing threat of crop genetic vulnerability to the range of crop diversity in Trinidad and Tobago. Several important factors contribute to this genetic vulnerability, such as:

- Increased pressure for alternative land usage for housing and industry
- Use of modern imported cultivars/varieties
- Delayed implementation of governmental policy with regards to PGR (Plant Genetic Resources)

The diversity of *Modern Varieties* has been decreasing, in the areas of vegetables and fruit crop production, due to the increased use of imported hybrid seeds by farmers. Hybrid seeds produce higher predictable yields as well as being tolerant to specific pests and diseases.

The diversity of *Landraces/Farmers' Varieties* has been decreasing, mainly because of the increasing use of modern hybrid seeds and the lack of public awareness of the need to conserve important crop landraces.

1.5 Factors Influencing the State of Plant Genetic Diversity in Trinidad and Tobago

The relative importance of various crops has changed significantly over the past ten (10) years, especially for traditional plantation crops such as sugarcane, coffee, coconut and cocoa. Factors affecting these changes include:

- Lack of clear policy direction for the agricultural sector
- Decline in the availability of labour for agriculture
- High minimum wage in the agricultural sector

At the present time there is no formal structure to monitor the loss of crop biodiversity. There is no documentation or assessment on genetic erosion, however, it is known that considerable genetic erosion of crop genetic resources is taking place due to the following factors:

- Variety replacement
- Policy and Legislative changes
- Overexploitation-overgrazing; land clearing and deforestation
- Urbanization and human population growth

- Environmental effects-invasive alien species - pest and diseases such as the:
  - *Hibiscus* mealy-bug
  - Giant African snail
  - Fire ants
  - Black *sigatoka*
  - Black *citrus* aphid
  - *Citrus tristeza* virus (CTV)
- Flooding

1.6 Future Needs and Priorities

National priorities for improving the understanding of the state of diversity of plant genetic resources include:

- National policies on PGR (Plant Genetic Resources) have to be established
- Detailed inventories to be conducted on crop biodiversity
- The natural flora of Trinidad and Tobago needs to be updated, including indigenous crop biodiversity

Capacity building needs to enhance assessments of the state of diversity of plant genetic resources, including ways to better assess genetic erosion and understanding of the causes of erosion are:

- Financial resources
- Staffing
- Training
- Dedicated unit for handling PGR activities
  - Documentation (legal and computerization of records)
  - Treaties (harmonization of national focal points)
- Improved technology
  - GPS
  - Internationally recognized databases (PC-GRIN, SINGER)

Trinidad and Tobago's major priorities to better understand the role and value of the diversity of plant genetic resources for food and agriculture are:

- Ensuring food security
- Economic benefits
- Environmental benefits

At present government policy is being formulated to improve monitoring of genetic erosion and improve the response to observable genetic erosion.

Other strategies relevant to improving understanding of the state of diversity of plant genetic resources and maintaining this diversity at the national, regional and global levels include:

- Revival of CAPGENET (Caribbean Plant Genetic Resources Network).
- Providing funding and training for PGRFA
- National policies on PGR need to be implemented

1.7 State of the Art

At the present time an appropriate methodology to analyze and assess plant genetic resources, genetic diversity, erosion and vulnerability have not been employed. However this issue is currently being addressed.

Obstacles to Trinidad and Tobago obtaining and using available methods for analyzing and assessing genetic diversity, erosion and vulnerability include:

- Plant Genetic Resources for Food and Agriculture (PGRFA) not collected and inventoried
- Inadequate staff
- Insufficient training and skills of staff
- Insufficient farmers' involvement
- Insufficient financial support

CHAPTER 2

THE STATE OF *IN SITU* MANAGEMENT

2.1 Plant Genetic Resources Inventories and Surveys

Within Trinidad and Tobago are found unique crop landraces which date back to introductions into the country made by the early immigrant people. These crops cover a range of *Solanaceous*, Curcubits, Cereals, Leafy vegetables, Fruits and Exotic plants. A list of these crop landraces is provided in Appendix 1.

Recent surveys indicate that there is significant contraction in the cultivation of these unique landraces. Over the last ten years it is estimated that there is a general trend in reduction in the cultivation of local landraces for sale in the market place (Table 4). In many agricultural districts of Trinidad, these landraces are grown mainly for home consumption. Some of the important crop landraces in Trinidad are shown in Table 4.

A concerted effort is being made by the Research Division, MALMR to shift from crop surveys to a national inventory of crop genetic resources. This data will be used to establish a farmer's database which will provide up to date information on important crop landraces under cultivation. Information for the database will be collected at the level of the farmer. The data base will be used to cross reference with a National Forest Inventory to capture important wild species used for food, which are harvested from the forest.

The greatest constraint to improved inventorying is perhaps, the absence of trained personnel in crop genetic resources management. Inventories will be undertaken by frontline extension officers with limited knowledge of the subject. Efforts will be made to provide training in basic plant genetic resources management before an inventory is undertaken.

The priority activity for inventorying crop genetic resources is to determine where local landraces are being cultivated or exist in order to immediately implement a programme of rescuing these land races by identifying farmers who still engage in the cultivation of local landraces. It is proposed to conserve as many of these landraces, where appropriate, in a national seed banking facility.

2.2 Conservation of Wild Plant Genetic Resources for Food and Agriculture in Protected Areas

The major action taken to encourage and support *in situ* conservation of crop biodiversity is to bring this aspect of conservation into a formal, structured framework of a national programme. This has been achieved by receiving funding for a Public Sector Investment Project (PSIP) titled "Implementing a Comprehensive Crop Biodiversity Programme for Trinidad and Tobago". In this programme farmers are viewed as a major stakeholder in the conservation of crop genetic resources. A significant aspect of this programme is to carry out an up-to-date inventory of important crop genetic resources conserved by farmers. A second aspect of this programme is the development of a national database in which this information is stored, and finally, to implement an out-reach programme to educate farmers about crop genetic resources and provide support to farmers to achieve this objective.

Some activities are planned for the characterization and conservation of wild relatives of indigenous crop species. These plans include forming appropriate partnerships with centres of excellence for a particular wild relative eg the characterization of wild forms of *Dioscorea trifida* with CIRAD in Guadeloupe.

TABLE 4
Current Status of Important Crop Landraces in Trinidad and Tobago

Crop	Number of districts cultivated	Status of cultivation over ten year period
Curcubitaecae		
Lauki –Bottle gourd (*Lagenaria spp).*	41	Reduced
Jinghi –Angled loofah (*Acutangula* spp.*)*	40	Reduced
Saputiya – Angled loofah (*Luffa* spp.)	37	Reduced
Caraaili – Bitter gourd (*Momordica charantia)*	50	Expanded
Seim – Hyacinth bean (*Lablab niger)*	53	Reduced
Christophine (*Sechium edule)*	27	Expanded
Bhagi (leafy vegetable)		
Chowrai (*Amaranthus* spp.)	52	Reduced
Poi (*Basella* spp.)	36	Reduced
Gooma (*Solanum americanum*)	36	Reduced
Dasheen (*Colocasia esculenta*)	47	Reduced
Sarhachee (*Alternathera* spp.)	30	Reduced
Karmee	35	Reduced
Katchu (*Caladium* spp.)	33	Reduced
Root crops		
Cassava (*Manihot esculenta*)	56	Expanded
Yams (*Dioscorea* spp.)	50	Reduced
Sweet potato (*Ipomoea batatas*)	52	Expanded
Cush Cush (*D. trifida*)	27	Reduced
Vegetables		
Local tomatoes (Choka) (*Solanum* spp.)	56	Reduced
Local hot peppers (*Capsicum* spp.)	58	Expanded
Local Melongene (*S. melongena*)	44	Reduced
Local ochro (*Hibiscus* spp.)	32	Reduced
Crapaudback pumpkin (*Cucurbita* spp.)	47	Reduced
Pimento (*Capsicum* spp.)	57	Expanded
Tree crops		
Cocoa (*Theobroma cacao*)	42	Expanded
Coffee (*Coffea* spp.)	32	Reduced
Tonka bean (*Dipteryx odorata*)	21	Reduced significantly
Breadfruit (*Artocarpus* spp.)	53	Expanded
Chataigne (*Artocarpus* spp.)	36	Reduced
Beans/Peas		
Local pigeon peas (Cajanus spp.)	53	Reduced
Long bodi – Lagoon bodi (Vigna unguiculata)	45	Reduced
Sesame seed – Black bean (*Sesamum indicum*)	40	Reduced
Mung bean – Urdi (*Phaseolus aureus*)	27	Reduced

2.3 Ecosystem Management for Conservation of Plant Genetic Resources for Food and Agriculture and Crop-associated Biodiversity Outside Protected Areas

The Environmental Management Authority (EMA) is the National Focal Point for all biodiversity in Trinidad and Tobago. The EMA has a critical role in protecting agricultural biodiversity through the instrument of a certificate of environmental clearance which is required before a site is disturbed for construction, farming or other use. However, the EMA does not have the in-house expertise to adequately monitor these threats to agricultural crop biodiversity.

2.4 On-farm Management and Improvement of Plant Genetic Resources for Food and Agriculture

It is recognized that some of the local landraces cultivated by farmers over several generations represent valuable genepools. This fact has been documented in previous reports on agricultural biodiversity. However, there has not been any formal programmes to address the valuable contribution made by farmers in the conservation of these crops. Efforts to safeguard these materials are aimed primarily at *ex situ* methods of conservation such as seed banking and *ex situ* collections.

The major limitations to on-farm management and improvement of PGRFA in the country, include the following:

- Inadequate incentives provided to farmers to cultivate traditional varieties
- Insufficient number of appropriately trained staff in PGR
- Insufficient financial support from public and private sectors

Funding has recently been secured to implement a formal programme in which farmers will be provided with an incentive to continue growing these landraces. This programme will firstly establish a national database of farmers who are involved in *in situ* conservation and through stakeholder meetings the best way to assist these farmers in their continued participation in the management of these on-farm genetic resources will be determined.

This structured programme will include the following activities:

- Establishment of pilot sites in high risk areas
- The characterization and evaluation of local varieties
- Seed multiplication and distribution of bred varieties

The recent designation of a National Focal Point for the IT-PGRFA has resulted in a rapid change in the integration of formal projects in crop biodiversity conservation at the national level. Along with this, a high level of priority is being afforded to funding biodiversity conservation at the national level.

It is hoped that the changed level of priority will stimulate activity in the following:

- Participatory cultivar selection
- Market development
- Strengthening local seed production and supply

The Government is also pursuing the possibility of the establishment of a regional seed banking facility to be developed under the CAPGERNET regional network, primarily to rescue material that is under significant threat of genetic erosion.

It is fully recognized that local land races are very valuable plant genetic resources and contain valuable genetic characteristics, particularly, local adaptability and resistance to local diseases. It is envisaged that the new "Crop Biodiversity PSIP" will recognize the role of farmers in PGRFA conservation and will involve, in a structured way, on-farm participation in selection and breeding activities.

2.5 Assisting Farmers in Disaster Situation to Restore Agricultural Systems

There is no formal system to facilitate the restoration of agricultural systems after catastrophic natural disasters such as hurricane, earthquake or volcanic activity. At this time financial relief is provided to farmers where crops are destroyed by flooding or fire.

A regional seed bank has been proposed with the primary responsibility of safeguarding the unique plant genetic resources of the Caribbean. This facility would provide adequate safety for landraces and indigenous materials, particularly from small island states.

The major constraint to a plant genetic resources disaster response is the priority level to which it is assigned. In the case of a natural disaster the priority is to safeguard human life and property. In the case of agricultural activity, livestock would receive some priority and finally crops.

CHAPTER 3

THE STATE OF *EX SITU* MANAGEMENT

3.1 The State of Collections

Plant germplasm collections range from international repositories (International Cocoa Genebank, Trinidad – ICG,T), regional collection (hot peppers), working collections of crop germplasm for evaluation by researchers (sweet potatoes, cassava), museum plots which are aimed at conserving the genetic diversity in a particular crop and nursery gardens which provide vegetative material for propagation for the farming communities.

Efforts to sustain and expand *ex situ* conservation of crop genetic resources are undertaken by several institutions. These institutions include the Ministry of Agriculture, Land and Marine Resources (MALMR), the Food Production Department of the University of the West Indies (UWI), St. Augustine, the Cocoa Research Unit (CRU) of UWI, The Caribbean Agricultural Research and Development Institute (CARDI) and the Sugar Cane Research Station, Caroni (1975) Ltd.

Crop genetic resources are conserved by two Divisions of the MALMR, the Agricultural Services Division and the Research Division. The former division houses mainly varieties/cultivars required for propagation for the farming communities. Crop genetic resources are held at Chaguaramas Agricultural Development Project (CADP), which includes mainly root crops and vegetables, Marper Farms (MF), which holds mainly fruit trees and cocoa, La Reunion Propagation Station (LRPS) which houses a range of fruit tree germplasm and cocoa seed gardens and the St. Augustine Nursery (SAN), which has mainly citrus, mangoes and avocadoes.

The number of accessions housed in germplasm collections at various institutions in T&T is summarized in Tables 5 and 6.

TABLE 5
Major Crops Housed by Various Institutions in Trinidad & Tobago

Crop	Name of Institution	Scientific Name	No. of accessions
Sweet potato	UWI	*Ipomoea batatas*	I
	CADP - MALMR		51
	CES - MALMR		31
Cassava	UWI	*Manihot esculenta*	40
	CADP - MALMR		38
	CES - MALMR		20
Yams	UWI	*Dioscorea* spp.	30
	CADP - MALMR		34
	CES - MALMR		7
Capsicum – Hot peppers	UWI	*Capsicum annum*	
	CADP - MALMR		6
Cucurbits - Pumpkin	CADP - MALMR	*Cucurbita moschata*	2
Cocoa	CRU	*Theobroma cacao*	
	LRCR - MALMR		112
Coconut	CES - MALMR	*Cocos nucifera*	1
	MF		1

Crop	Name of Institution	Scientific Name	No. of accessions
Citrus	CES - MALMR	*Citrus* spp.	1
	LRPP		20
	MF		13
	SAN		22
Fruit species	UWI		14
	CES - MALMR		52
	LRPP		11
	MF		37
	SAN		59

TABLE 6
Number of accessions of Minor Crops Housed at Various Institutions in Trinidad & Tobago

Crop	Name of Institution	Scientific Name	No. of accessions
Medicinal	CES		21
	LRPP		18
	MF		41
	SAN		39
Herbs/Spices	CADP		49
Pigeon peas	UWI	*Cajanus cajan*	
	CADP		2
Bananas/Plantains	UWI	*Musa* spp	17
	CES		1
Breadfruit	UWI	*Artocarpus altilis*	
	CES		1
	MF		2
	SAN		1
Sugar cane	CARONI	*Saccharum officinarum*	15

3.2 Collecting

Working collections have been expanded with germplasm from International Centre such as CIP, CIAT, IRRI, and INIBAP. (Bananas, rice, pigeon peas).

Efforts to collect indigenous germplasm are confined to herbs/ spices and plants with medicinal properties (shadon beni).

A rapid survey was conducted by the Research Division in 2007, aimed at finding out areas of cultivation of local landraces, historical crops and medicinal plants. There are plans to carry out a detailed inventory throughout Trinidad and Tobago to determine sites of these crops.

It has been recognized that some major gaps exist in the present collections of crop genetic resources. Most of the previous collections can be considered to be working collections, in which significant erosion took place. These gaps include missing known local cultivars/landraces and missing historical cultivars. These gaps have been identified from historical documentation. Again, there is a specified Programme for the recollection/rescue of these important crop genetic resources of minor crops and underutilized species. The overall strategy is to conserve as much of the local crop biodiversity as possible.

The greatest constraint to undertaking collection missions is the absence of accurate inventories of *ex situ* collections, landraces housed by farmers and wild/indigenous crop germplasm. Along with this, there is the lack of trained staff, dedicated toPGR, to carry out this activity. The priority for recollection will be unique landraces and historical plantation crops.

Local crop landraces are considered to be an important crop genepool particularly with regard to adaptability for abiotic and biotic factors. Their uniqueness is found in aromas, textures and tastes. Local landraces have the potential

to be developed into a source of planting materials for farmers using modern biotechnologies. Again, the new Crop Biodiversity PSIP proposes that cutting-edge biotechnology can be employed under appropriate partnerships with leading international institutions.

3.3 Types of Collections (Major and Minor Crops)

Crop germplasm collections can be divided into two categories of major crops and minor crops of economic importance to the agricultural sector of Trinidad and Tobago.

TABLE 7
List of Major and Minor Crop Germplasm Housed in Trinidad and Tobago

Major crops	Minor crops
Sweet potato	Medicinal
Yam	Herbs/ Species
Cassava	Pigeon peas
Capsicum	Bananas
Cucurbits	Breadfruit
Citrus	
Coconuts	
Cocoa	
Fruit species	

The University of the West Indies has seven collections. The cocoa germplasm collection is an international collection, hot peppers is considered to be a regional collection, while yams, sweet potatoes, bananas, cassava and breadfruit are considered to be national collections.

The CRU houses the International Cocoa Genebank, Trinidad (ICG,T) which contains approximately two thousand cocoa accessions from several areas of diversity (Table 8). Most of the cocoa accessions are wild and semi-wild materials. It is the only freely accessible cocoa germplasm collection in the world. The contents of the ICG,T according to the area of origin is summarized in Table 5 and the complete range of cocoa accessions is listed in Appendix 3.

TABLE 8
List of Accessions of *Theobroma cacao* Housed at the ICG,T

Code	Name	Origin Where Known	Population Type
AC.T	Accession Trinidad	Trinidad	Trinitario
ALMEIDA	Almeida	Brazil	"Para"
AM	Amalia	Ecuador	Refractario
AMAZ	Amazon	Ecuador	Forastero
AS	Aimela Station	Ecuador	Refractario
AX		Trinidad	Hybrid
B	Bolivar	Ecuador	Refractario
BH			
C		Ghana/Ivory Coast, West Africa or Nicaragua	Hybrid
CATONGO	Catongo	Brazil	Comun
CC	Cocoa centre	Costa Rica	Hybrid
CJ		Ecuador	Refractario
CL	Clementina	Ecuador	Refractario
CLEM	Clementina	Ecuador	Refractario
CLM	Clementina	Ecuador	Refractario
COL. HUILA	Huila	Colombia	Hybrid

Code	Name	Origin Where Known	Population Type
CRU	Cocoa Research Unit	Unkown	Various
CRUZ	Cruzeiro Sol Open Pollinated	Brazil	Forastero
D		Venezuela	Hybrid
DE	Double embryo	Trinidad	Hybrid
DOPOL	Double Pollination	Trinidad	Hybrid
DOS HERMANOS			
DR	Djati Roenggo	Java	Hybrid
E	Ecudaro	Ecuador	Hybrid
EBC	Expedition Botanica Caqueta	Colombia	Forastero
ECGB			
ECNR	Ecuador Cacao Nacional Refractario		
EEG	Estacao Experimental Goitacazes	Brazil	Forastero
EET	Estacion Experimental Tropical	Ecuador	Hybrid
EQX	Ecuado Crosses	Ecuador	Forastero
G	Getas	Java	Criollo
GA	Grande Anse	Haiti	
GCT	Genetic Accession Trinidad	Various	Hybrid
H. CLEM	Hacienda Clementina	Ecuador	Refractario
HOR			
ICS	Imperial College Selections	Trinidad	Trinitario
IMC	Iquitos Mixed Calabacillo	Peru	Forastero
INUS	Inus Bougainville	PNG	Amelonado
JA	Javilla	Ecuador	Refractario
L. COCHA	Limon Cocha		
LAFI	Lafi	Samoa	Trinitario
LCT-EEN	London cocoa Trade-Ecuador	Ecuador	Forastero
LH			
LP	La Paz	Ecuador	Refractario
LV		Ecuador	Refractario
LX	Limoncillo	Ecuador	Refractario
LZ	Limoncillo	Ecuador	Refractario
M		Suriname	Hybrid
MACAS	Macas		
MAN	Manaus Open Pollinated	Brazil	Forastero
MATINA	Matina	Costa Rica	Amelonado
MO	Morona	Peru	Forastero
MOCO	Mocorongo Open Pollinated	Brazil	Forastero
MOQ	Moquique	Ecuador	Forastero
MOTOLO	Motolo		
MX			
MXC	Mexican Chiapas Criollo	Mexico	Pentagona
NA	Nanay	Peru	Forastero
NAPO	Rio Napo	Ecuador	Forastero
NG		New Guinea	Trinitario
P	Pound (peru)	Peru	Forastero
PA	Parinari	Peru	Forastero
PLAYA ALTA	Playa Alta	Venezuela	Forastero
POR	Porcelana	Venezeula	Criollo
RB	Rio Branco	Ecuador	Forastero
RED	Red Amelonado		Amelonado
RT			

Code	Name	Origin Where Known	Population Type
RUY	Brazil	Forastero	
SC	Santa Cruz/Seleccion Palmira	Venezuela	
SCA	Scavina		
SD	SSD	Trinidad	
SJ	San Juan	Ecuador	
SLA+SLC	Santa Lucia	Ecuador	
SM	Rio San Miguel	Ecuador	
SNK	Selection N'Koemvone	Cameroun	
SP	Spieringshoek	Trinidad	
SPEC	Specimen	Colombia	
SSD			
STAHEL	Stahel	Suriname	
TAP	Rio Tapiche	Ecuador	
THY	Three Way Cross	Trinidad	
TSH	Trinidad Selected Hybrid	Trinidad	
UCA	Rio Ucayali	Peru	
UF	United Fruit Company	Costa Rica	
VEN	Venezuela	Venezuela	

The Agricultural Services Division maintains several germplasm collections at various sites throughout T&T. These sites include the Chaguaramas Agricultural Development Project (CADP) that stores samples of vegetable seeds, root crops, herbs and spices (Table 9).

TABLE 9
Summary of Crop Germplasm Collections at CADP, Chaguaramas

Category of germplasm	Number of varieties	Source of germplasm	Type of collection
Vegetables	16	Local	Working collection Source of planting material
Root crops	129	Local selections and introductions	Working collection
Herbs/spices	44	Local selections and introductions	Museum plots

The germplasm collections housed at the St. Augustine Nursery (SAN), La Reunion Propagation Station (LRS) and Marper Farm (MF) houses mainly commercial fruit species (particularly citrus, mango, avocado) and exotic species including tropical fruits, ornamentals, herbs and spices, and medicinal plants. At the Marper Farm, in east Trinidad, is housed the original Pound's collection, which is perhaps one of the most diverse collections of primary cocoa germplasm in the world. Along with this, there is a collection of commercial cocoa clones (TSH). A summary of the main collections at these locations are summarized in Table 10.

TABLE 10
Summary of Crop Germplasm Collections at LRPS, SAN and MF

Category of germplasm	Number of varieties	Source of germplasm	Type of collection
Commercial fruits	16	Local	Working collection Source of planting material
Exotic fruits	129	Local selections and introductions	Working collection
Cocoa (Marper farm only)	44	Local selections and introductions	Museum plots
Marper farm Pound's collection	700	Primary cocoa germplasm	International collection

The Research Division at the Central Experiment Station, Centeno houses crop germplasm, mainly as working collections for characterization and evaluation by researchers. There are collections of root crops, fruit crops, medicinal plants and cocoa. The number of cultivars/varieties of various crop categories is summarized in Table 11.

TABLE 11
Summary of Crop Germplasm Collections at the Central Experiment Station, Centeno

Category of germplasm	Number of varieties	Source of germplasm	Type of collection
Fruit crop species (*Citrus*, mango, avocado, breadfruit, chataigne)		Introduced	Working Source of planting material
Exotic fruit species	52	Mainly introduced	Germplasm collection
Root crops	58	Local selections and introductions	Working collection
Cocoa			Working collection and germplasm collection
Medicinal/Herbs	12	Local selections and introductions	Museum plots

The University of the West Indies also houses important crop germplasm. The major collections include root crops, breadfruit and hot peppers. The pepper collection is stored as seed from pure lines (Table 12).

TABLE 12
Summary of Crop Germplasm Collections at the University of the West Indies, St. Augustine

Category of germplasm	Number of varieties	Source of germplasm	Type of collection
Cassava	40	Local, regional	National
Sweet potato		Local, regional, international	Regional
Yams	34	Local. Regional	National
Capsicum – Hot peppers		Local. Regional	Regional
Fruit species	14	Local, regional, international	National
Breadfruit		International	Regional
Bananas	17	Local, regional, international	Museum
Pigeon peas		Local, regional	National

3.4 Storage Facilities

It is proposed also, that a regional seed bank be established in Trinidad, to primarily save the unique landraces of the region, in the face of serious threats, such as, natural disasters (hurricanes, earthquakes and volcanic activity), replacement of traditional landraces by modern hybrid cultivars and changing patterns of land use.

It is expected that the appropriate use of biotechnology will assist in the conservation of some of these threatened species by employing *in vitro* conservation. This technique will be used mainly for germplasm that is regenerated by vegetative means. A tissue culture laboratory has been "operationalized" at the Research Division, MALMR for this purpose.

3.5 Security of Stored Material

Seed material is stored by MALMR and UWI. At the present time, storage facilities for seed banking are very basic. There is no provision for the long term storage of seed material. It is envisaged that under the new PSIP project, the conservation of crop biodiversity, action will be taken in order to develop a seed banking unit with improved infrastructure and trained personnel.

There are plans to expand tissue culturing activities at the Research Division to include the *in vitro* storage of crop germplasm. This programme is expected to begin in 2008

3.6 Documentation and Characterization

Germplasm characterization commenced a number of years ago and has been an ongoing activity with the inclusion of a wide range of crops. About 20% of all germplasm have been characterized (Table 13). Evaluation, however, is proceeding at a slower pace. Efforts to accelerate the documentation of crop genetic resources will require significant human resource development. Training has been earmarked at Centres of excellence for conservation of plant genetic resources such as, Kew Gardens, London and the University of Wageningen, Netherlands.

3.7 Germplasm Movement

There is a very wide range of diversity of crop plants in Trinidad and Tobago. This diversity can be considered to be an assembled or introduced plant diversity due to early migrants who introduced traditional crops from their respective homelands.

Added to this, was the establishment of the Imperial College of Tropical Agriculture (ICTA) in the 1930's which carried out research on a wide range of plantation crops (cocoa, coffee, sugarcane, citrus, cotton, coconut and rubber). Hence, there were early introductions of these crops from all areas of the former British colonies primarily for evaluation and enhancement.

The Cocoa Research Unit has collected and established an international germplasm collection of *Theobroma* from primary and secondary centres of diversity beginning in the 1930's.

The Central Experiment Station has also played a significant role in the assembly of crop genetic resources into Trinidad. The main emphasis has been fruits, cereals, vegetables and root crops. These crops have formed the basis of unique landraces and local selections.

3.8 Roles of Botanical Gardens

At the present time there is one National Botanical Garden whose official mandate is to preserve the early introductions of exotic tree species into the gardens. These introductions are mainly tropical tree species from Africa, India and Australia. There is some representation of indigenous trees of Trinidad and Tobago. The Botanical Garden does not house agricultural crop species at this time. There are plans, however to establish a crop biodiversity centre which will replicate and store at a safe site all the crop genetic resources for food and agriculture present in Trinidad and Tobago.

TABLE 13
Status of Germplasm Characterization and Evaluation

Institution/ Name of crop	Status of germplasm characterization/ evaluation					
	No. of accessions	Morphological trait %	Molecular Marker %	Agronomic traits %	Abiotic stresses %	Biotic stresses %
UWI						
Cocoa	2,300	50	60	50	Not attempted	42% Black Pod 26%Witches Broom Phytophtora
Hot pepper	350	80	50	10	Not Attempted	Viral Diseases
Yam	30					
Sweet potato	77					
Cassava	42					
Banana	16					
Breadfruit						
Grapefruit						
CARDI						
Hot pepper	99	<10 Elite selections	0	≈ 10	0	0
MALMR						
Cocoa	≈100	<10	0	0	0	0
Cassava	20	100	0	100	0	0
Sweet Potato	32	60	0	20	0	0
Yam	10	60	0	60	0	0
Dasheen	1	0	0	0	0	0
Topi Tambu	6	0	0	0	0	0
Pineapple	5	60	0	0	0	0
Sapodilla	15	50	0	0	0	0
Mango	25	50	0	5	0	0
Citrus	80	0	0	0	0	0

3.9. An Assessment of Major *ex situ* Needs

The priority needs for conservation in Trinidad and Tobago include:

- Filling the gaps in collections
- Complete safety duplication
- Rationalizing collections through regional and international collaboration and sharing facilities
- Improved germplasm management

The strategic direction for the future conservation and utilization of crop genetic resources is provided in a Public Sector Investment Project (PSIP) titled "Implementing a Comprehensive Crop Biodiversity Conservation Programme for Trinidad and Tobago". This sets out, primarily, the National agenda for crop germplasm conservation.

Caribbean regional initiatives are being guided by the Caribbean Plant Genetic Resources (CAPGERNET) under the coordination of CARDI. Under this initiative Trinidad will be designated a regional centre for the conservation of sweet potato, breadfruit and hot peppers.

There are many constraints to be addressed in sustaining *ex situ* collections of crop genetic resources over the next ten years. The major constraint in the past has been the lack of a focused National Policy on crop genetic resources. However, with the coming into being of the IT-PGRFA the country has been working towards developing a National Policy for crop genetic resources. Along with this funding has been identified for the long term security of crop genetic resources over the next seven to ten years.

The other constraints to sustaining crop genetic resources include insufficient staff and lack of training opportunities:

- Lack of focused approach
- Insufficient staff
- Lack of training

At the national level a PSIP has been developed by the Research Division, MALMR to provide funding for sustaining and expanding *ex situ* conservation of crop genetic resources, developing a structured *in situ* conservation programme and to develop the human resources to effectively undertake the major thrust of this project.

The expansion of crop genetic resources will take place under a programme of "assembling working collections of specified crops". This programme of assembly will be harmonized with the Annex 1 crops listed under the IT-PGRFA. However there will be constraints faced in this programme. Such as:

- Issues of pest and diseases (phyto-sanitary measures)
- Insufficient trained staff

The priorities for expanding *ex situ* conservation are based on a list of priority crop commodities identified by MALMR. These include root crops, pumpkins, hot peppers, and coconuts. Another priority area is to secure all local crop landraces. Further to this, efforts to conserve wild or native species will be undertaken.

The stakeholder institutions, such as, UWI, CARDI and MALMR have agreed to come together to cooperate in a significant way, on matters relating to crop genetic resources. The first issue to be addressed will be the safe duplication of unique accessions. The major constraint to this effort is to update the documentation of living collections or to update the crop germplasm inventories. As soon as this is carried out the safe duplication of unique accessions can be implemented.

Most of the crop germplasm collections can be considered to be traditional working collection assembled for evaluation studies or to provide planting material to farmers (mangoes, citrus, avocado and fruit species). The University of the West Indies (Faculty of Agriculture), founder of the Tropical Root Crops Society began collecting germplasm in the 1970's. Also, breadfruit is conserved and held in trust for other countries.

It is proposed that a regional seed bank be established in Trinidad to save the unique landraces of the region in the face of serious threats, such as, hurricanes, replacement by modern hybrid cultivars and land use issues.

Under a global initiative, cocoa germplasm is being collected in order to maintain traditional characteristics and flavour profiles. Under this initiative over seventy selections have been made from twelve regions in Trinidad and Tobago.

CHAPTER 4

THE STATE OF USE

4.1 The Importance of Utilization

Over the last decade, there has been a fundamental shift in global policy to encompass a wider strategy of achieving food security, protecting the environment and conserving the earth's biodiversity by the collective actions of farmers, forest dwellers, pastoralist, scientists and policy makers.

Trinidad and Tobago shares considerable biodiversity and important crop genetic resources such as maize, *Amaranthus* spp., *Phaseolus*, *Ipomoea*, *Manihot*, cotton, *Capsicum*, vanilla, *Solanaceae* tomato, cucurbits, pineapple, papaya, avocado, guava, and a number of region-specific medicinal plants. However, according to the National Biodiversity Strategy and Action Plan (NBSAP) there is considerable threat to these unique crop gene pools and further, the Ministry of Agriculture, Land and Marine Resources (MALMR) did not previously have an appropriate programme or structure to collect, conserve, characterize and utilize sustainably these important renewable, natural resources. A new thrust of the MALMR is to use the unique traits of local landraces to generate comparative advantage in both local and foreign niche markets.

4.2 Utilization of Conserved Plant Genetic Resources and Major Constraints to Their Use

The Agricultural Services Division of the MALMR is mandated to provide good quality planting material to the farming community. Most of the genetic material used for propagation is derived from early selections. The Division has maintained nursery stocks of a wide range of fruit and tree crops (Table 14) at several locations in Trinidad (Marper Farm, La Reunion Plant Propagation Station and St. Augustine Nurseries).

The Agricultural Services Division of the MALMR is charged with the responsibility of distribution of seed and plant material to farmers and the general public. The Division is sub-divided into four (4) units through which different types of plant genetic material is propagated, conserved and distributed.

1. **La Reunion Plant Propagation Station (LRPPS), Centeno**
   Activities at LRPPS involve the production of high quality planting material- mainly cocoa and breadfruit for sale to farmers.
2. **Marper Farm, Manzanilla**
   The major activities at Marper involve the maintenance of cocoa germplasm fields, mango and other fruits. Scion, budwood, and rootstock material are supplied to LRPPS, SAN, and researchers. In order to increase diversity, new varieties are added as they become available.
3. **Chaguaramas Agricultural Development Project (CADP)**
   CADP is responsible for the production and distribution of cereal, legume and vegetable seeds, and root crops e.g. sweet potato, cassava etc. to farmers and the general public.
4. **St. Augustine Nurseries**
   Activities at SAN involves a production of high quality planting material mainly mango, avocado and citrus for sale to farmers.

TABLE 14
Fruit Plants Produced for the Farming Public

Common name	Scientific name
Akee	*Blighia sapida*
Abiu	*Pouteria caimito*
Black Sapote	*Diospyros digyna*
Bilimbi	*Averrhoa bilimbi*
Chennet	*Melicocca bijuga*
Cashew (Red Fruited)	*Anacardium occidentale*
Fat pork	*Chrysobalanus icaco*
Governor Plum	*Flacourtia ramontchi*
Guava	*Psidium guajava*
Jaboticaba	*Myrciara cauliflora*
Passion Fruit	*Passiflora edulis*
Wax Apple	*Syzygium samarangense*
White Sapate	*Casimiroa edulis*
West Indian Cherry	*Malpighia glabra*

4.3 Utilization Activities (Characterization, Evaluation, Pre-breeding and Genetic Enhancement)

At CADP evaluation of several important maize lines from CIMMYT for adaptability to local conditions and have been conducted and two selections made (CIMMYT 7728 and 8136). CIMMYT 7728 has made significant contribution and impact on the production of corn in Trinidad and Tobago.

The Research Division has played an important role in the testing, evaluation and breeding crop plants for the benefit of the farmers. The genetic improvement and selection programme includes the selection of appropriate root crop varieties for the farming community, the selection of coconut cultivars for the water nut trade, breeding and selection of a highly uniform pumpkin variety for export, evaluation of four hot pepper and the breeding/selection of new commercial cocoa cultivars.

The CRU of UWI is responsible for maintaining the International Cocoa Genebank, Trinidad (ICG, T). At the CRU significant pre-breeding work is carried out on cocoa. This includes evaluation for disease tolerance (Witches' broom and *Phytophthora*) and evaluation for flavour profiles, cocoa butter fat content and productivity characteristics.

The characterization and evaluation of *Capsicum* is being undertaken by a joint UWI/CARDI initiative, which will provide varieties for T&T and the wider Caribbean region.

Both the MALMR and UWI participate in regional and international cocoa breeding programmes. Trinidad and Tobago participates in a (Regional Variety Trial) RVT to evaluate cocoa crosses developed in Peru, Costa Rica, Brazil, Ecuador, and Venezuela. These crosses, that possess resistance to diseases such as Witches' Broom, Black Pod and Monilia and superior traits for yield potential, represent superior selections from these countries.

The Research Division of the MALMR is also involved in the conservation of cocoa genetic material of the Trinidad Selected Hybrid (TSH) parent varieties which are currently maintained in a field genebank. These varieties are used to develop crosses some of which are commercialized. Extensive research initiatives and collaborative effort with the UWI have produced seven commercial varieties. These are TSH 919, TSH 1076, TSH 1095, TSH 1102, TSH 1104, TSH 1188, and TSH 1220. All of these varieties favorable characteristics such as resistance to Witches' Broom and Black Pod disease in cocoa and positive flavour attributes.

Links have been established with local cocoa farmers who are able to purchase planting material from the La Reunion Plant Propagation Station at Centeno. Cocoa farmers benefit from useful on-farm demonstrations arranged by the Cocoa Research Section of MALMR. The new varieties soon to be released are the TSH 1300's. The MALMR is in the process of performing flavour assessments and establishing seed gardens. A major constraint to releasing the varieties is the length of time for the evaluation of agronomic characteristics and yield parameters. The maintenance of a high flavour attribute is a critical consideration in the breeding programmes employed at the MALMR.

CARDI has attempted to integrate plant genetic resources, plant breeding and seed systems in its current research initiatives for Trinidad and Tobago which involve hot peppers and pumpkin. The hot pepper project aims to purify and

stabilize local landraces of economic value and to supply farmers with high quality seeds. The project was implemented by CARDI in collaboration with stakeholders such as UWI, National Agricultural Marketing and Development Corporation (NAMDEVCO), MALMR, Inter American Institute for Coorporation in Agriculture (IICA) and some chemical companies. Stabilization work in pumpkin is ongoing. Superior landraces are being selected and purified.

At Goldsborough, Tobago, CARDI's activities revolve around the development of viable crop production systems and the undertaking of the research required to advise local farmers on the best production practices. On-farm demonstrations are offered for the production of bodi-bean (*Vigna ungiculata* (L.) Walp.), cabbage (*Brassica oleracea* var *Capitata* L.), corn (*Zea mays* L.), cucumber (*Cucumis sativus*), hot pepper (*Capsicum chinensis*), squash (*Cucurbita moschata*), string bean (*Phaseolus vulgaris* L.) and sweet pepper (*Capsicum annuum* L.).

The Chaguaramas Agricultural Development Project (CADP) a sub-division of the Agricultural Services Division, MALMR is the major seed producing establishment in the country. This seed centre is engaged in the production, storage, processing, sale and distribution of seeds and seed pieces to be used by home gardeners and farmers both local and regional.

Seeds produced at CADP (Table 15) are open pollinated varieties and include corn (7728), bodi (Los Banos), bodi (UW resist), hot pepper (Yellow), hot pepper (Red) egg plant (Long Purple), ochro (Clemson spineless), ochro (Lucky Five), pigeon pea (Tobago), pumpkin (Local), pumpkin (Musa) and sorrel (Early Red). Seeds are sold to farmers and the general public through distribution outlets located throughout the country.

TABLE 15
Seed Production (kg) at CADP over the period 2003 to 2006

Crop Type	Year			Total	Impact on Production
	'03 - ‹04	'04 - ‹05	'05 – '06		(hectares)
Corn	4,230	4,475	7,800	16,505	743.8
Pigeon Pea	1,899	0	1,070	4,384	394.9
Hot pepper	18	1,415	15	33	1 591.9
Bodi	271	303	1,106	1,680	83.3
Melongene	25	17	28	70	580.3
Pumpkin	116	82	21	219	86.1
Sorrel	127	0	280	407	366.2
Okra	123	176	22	321	1,587.1
Cucumber	2	0	0	2	1.2
Carilla	0	0	10	10	4.8
Total	**6,811**	**6,468**	**10,352**	**23,631**	**5,430**

Source (CADP)

The private sector also plays a significant role in the seed supply system with the importation of hybrid vegetable seeds. Imported vegetable seeds totaled 11,273 kg for the year 2006, *(CSO 2007)*. These were distributed through retail outlets, seed gardens and directly to farmers.

UWI also produces a small quantity (approx. 200 kg/yr) which is sold to farmers and CADP. They include sweet corn, ICTA Field corn, cowpea and pigeon pea. Along with this, small quantities of seed are produced by farmers for sale to the farming community.

In order to enhance seed production and distribution CADP has embarked on projects to refurbish its cold storage facility and to construct a seed treatment facility. Other minor equipment such as new mechanical planters, harvesters and boom sprayers have been introduced to improve mechanization, and seed dryers have been purchased to facilitate the processing of larger quantities of seeds.

Activities at CADP involve the multiplication of seed material and the production of root crops, specifically cassava, sweet potato, eddoes yam, tannia, and topi tambu. A major constraint to making new varieties of seeds available in the market place is the lack of a well-defined seed policy. Legislation is required to regulate seed production and seed quality standards for Trinidad and Tobago. There is also a lack of integration between researchers, seed producers and farmers, resulting in significant gaps in the seed production and distribution programme in Trinidad and Tobago. Further research is needed to generate new varieties of seeded crops which should then be injected into a clearly-defined and structured seed production system.

TABLE 16
Post-harvest Studies Conducted on some Underutilized Crops at UWI and the Research Division, MALMR

Crop Type	Present Use	Potential/Alternative Use
Papaya (Paw Paw)	Fresh Fruit (Local, Export) Fruit Salad Paw Paw Balls (candy)	Fruit Juices, Fruit Leathers Papain Extraction
Breadfruit	Fresh Fruit	Fresh Frozen, Roasted Frozen Flour-single or as part of a composite
Mango	Fresh Fruit Juices Fruit Salad	Leather Mango filling for cake and pastries
Christophene	Vegetable	Flavoured pie-filling
Barbardine/Guava	Drinks Ice- Cream	Flavoured pie filling Processed Pulp – for ice cream, drinks etc.

4.4 Assessment of Needs to Improve Utilization

Many under exploited or underutilized crops are nutritionally rich and are adapted to low input agriculture. The erosion of these species can have immediate consequences on the nutritional status and food security of the poor of the country. Studies are being conducted by CARDI on sweet potato (*Ipomoea batatas* L.) for the production of convenience foods. Research areas covered to date include processing and market development. At the Research Division (MALMR), extensive effort has been placed on the development and commercialization of cassava (*Manihot esculanta*) as a major contributor to food security. Post-harvest research on alternative uses for a number of commodities such as papaya, mango and breadfruit (Table 16) is also being conducted at UWI. Other underutilized minor crop and fruit species, such as plums and cherries that can provide income and/ or nutritional supplement, are promoted through direct links between the small farmer and agro-processors. These links are facilitated by the National Agricultural Marketing and Development Corporation (NAMDEVCO).

A significant opportunity exists for a direct linkage to be forged between NAMDEVCO and the national school feeding programme in order to increase the component of local crops in school meals. This will have the effect of stimulating the production of local landrace varieties.

CARDI'S extensive research on hot peppers has led to the collection and characterization of hot pepper germplasm. Cacao accessions at the ICG, T are being characterized for morphological traits using a modified version of a descriptor list sanctioned by Biodiversity International (formerly IPGRI). Molecular characterization for genetic diversity studies and clone verification is also conducted at the Cocoa Research Unit (UWI). Characterization efforts at MALMR began within the last ten (10) years and have been directed to cocoa and a range of root crops and fruits. The availability of characterization information on germplasm collections is limited. This lack of information limits the use of the conserved material hence, restricting its value. In order that these accessions might play a significant role in sustainable production, it is essential that morphological and agronomic traits as well as biotic and abiotic stresses be assessed.

Over the last twenty-five years there have been significant losses in crop germplasm at the Central Experiment Station, at Centeno. Many crop germplasm introductions of the Research Division have been discarded or lost due to fires, pest and disease or mixing of the plant identities.

The major contributing factors to this situation are:

- Lack of adequate funding
- Lack of a dedicated programme for crop biodiversity conservation
- Lack of trained personnel in crop genetic resource management
- Insufficient capacity for plant breeding
- The long term nature of pre-breeding activities required to broaden the base of breeding materials
- Lack of core collections or access to samples from them (Core collections are present for cocoa and hot peppers)
- Weak policy development

- Lack of integration between conservation and utilization programmes
- Lack of coordination among researchers, breeders, genebank managers and farmers.

Main constraints to achieving diversification of crop production and broadening diversity in crops:

- Policy/Legal
- Marketing/commercial
- Limited financial and Human Resources
- Research (collection, characterization, conservation, evaluation, and utilization) is time consuming
- Preference (of farmers) - the growth habits, the resistance to pest and diseases and the labour input required.

Trinidad and Tobago has not employed strategies to address genetic vulnerability in farming systems. There are few germplasm collections (*in situ* and *ex situ*). Conservation of *in situ* plant genetic resources needs to be improved since genetic erosion of particular varieties have accelerated due to crosses with other varieties of the same crop species. Future needs and priorities to reduce genetic vulnerability are as follows:

- Training in crop genetic resources management
- Documenting crop genetic resources
- *Ex situ* conservation of crop biodiversity
- *In situ* conservation of crop biodiversity
- Education and public awareness about crop biodiversity

Basic, formal sector crop improvement programme, germplasm identification, and evaluation programmes are employed in Trinidad and Tobago. Table 17 lists some crops that have benefited from these programmes. Genetic improvement in particular varieties of crops (Table 17) have the potential to ensure food security in Trinidad and Tobago. Breeding programmes have been developed to increase crop resistance to pests and diseases (Table 18). Achievements include: cow pea varieties which displays resistance to Saline Blight, Cowpea Severe Mosaic Virus, and *Cercospora* Leaf Spot**,** tomatoes – Gemini Virus, Bacterial Species and Bacterial Blight, cocoa – Black Pod Disease and Witches Broom Disease, hot peppers – Tobacco Etch Virus and *Phytophthora* Blight.

TABLE 17

Crops that have Benefited from Improvement Programmes

Name of programme/ project/activity	Name of crop	Areas of research
CFC/ICCO/IPGRI Cocoa productivity and quality improvement	Cocoa	Resistance to Black Pod disease and Witches' Broom disease
CFC/ICCO/INIAP Flavour project	Cocoa	Establish physical, chemical and organoleptic parameters to differentiate between bulk and fine cocoa.
Caricom Regional Transformation Programme	Hot pepper	Genetical purification and stabilization of land races
Root and tuber crop programme MALMR	Cassava	Agronomic, pest and post harvest problems Germplasm conservation and morphological description
CTV Training Programme	*Citrus*	*Citrus Tristeza* Virus testing
Food crop programme- vegetables UWI	UW7 Sweet Corn variety, UW10 Pigeon pea variety, Cowpea UW resist	Agronomic traits

TABLE 18
Post-harvest Management as part of Crop Improvement

Crop Type	Target	Priority in Country	Post-harvest Management as part of Crop Improvement	Post-Harvest Processing
Papaya	Local and Imported Varieties	Low-Medium	Some activities ongoing Some activities completed as "Easy tips on papaya pre and post harvest management booklet and fact sheet on papaya picking pole.	(Shell life extension of Papaya fresh cut pieces) Some on-going activities
Tomato	Imported	Medium	Some on-going activities. Some activities planned but not initiated.	
Melongene	Imported	Low	Some on-going activities	
Breadfruit	Local	Low	No activity planned	No activity planned
Mango	Local	Low-Medium	Some on-going activities	Shell life extension of fresh cut pieces

Significant changes in the use of plant genetic resources in Trinidad and Tobago are expected in the next ten years. CARDI hopes to extend its breeding programme and make improvements to the management of plant genetic resources for crops such as hot peppers, sweet potatoes and pumpkin (Table 19).

TABLE 19
Major Crops in Plant Biodiversity Conservation Programmes at MALMR

Crop/ Commodity	Activities
Citrus	Propagation, production and establishment of Citrus Tristeza Virus (CTV) tolerant rootstock trees and disease free budwood to provide seed for future use.
Tropical fruits	Propagation available tropical fruits with market potential
Herbs and Spices	Development and maintenance of a germplasm bank of herbs and spices
Vegetables	Germplasm conservation of vegetable crops (pumpkin, ochro, hot pepper, eggplant, tomato and bodi)
Root Crops	Germplasm acquisition, maintenance and morphological description Maintenance of existing germplasm *Ex situ* conservation of plant species; development and management of a plant biodiversity database, and biogeographic mapping

4.5 State of the Art Methods for Utilization of Plant Genetic Resources

Exploiting Hybrid Vigour

This method is used at both the MALMR and the UWI to produce varieties of cocoa that are highly tolerant to Witches' Broom and Black Pod Diseases. Manual pollinations are first conducted on particular varieties of cocoa, the progeny of which is then tested for resistance to witches' broom and black pod diseases.

Genetic Engineering

At the present time UWI is the only institution in Trinidad and Tobago with the capacity to carry out genetic modification. This has been applied to anthurium (*Anthurium andraeanum*). It is hoped that genetic modification can be used in traditional crops.

Marker Assisted Selection Programme (cocoa)

There are plans to replace the traditional breeding and selection programmes of cocoa with modern marker assisted selection. This programme will significantly improve the efficiency of breeding and selection programmes. Marker assisted selection is an ideal technique for identifying the unique genes of local landraces for incorporation into high yielding varieties.

4.6 Strategic Directions Relevant to Improving the State of use of Plant Genetic Resources including Minor and Major Crops and Underutilized Species at the National, Regional and Global Levels

- Conserve local crop diversity in a sustainable manner
- Build capacity for the conservation of crop genetic resources
- Use crop genetic resources in a sustainable way for the benefit of the farming community
- Promote education and public awareness about local crop diversity
- Encourage farmers' participation in local crop diversity conservation (*in situ* conservation)
- Conserve crop germplasm by *in vitro* method
- Increase public awareness about plant biodiversity and the environment
- Training in all areas of local plant genetic resource conservation
- Establishing a national crop diversity database
- Engaging farmers in *in situ* conservation of plants
- Collecting and conserving historically important local crop plants as well as medicinal plants and local traditional varieties
- Participating in plant genetic resources exchanges with regional, and International Genetic Resources Centres for the improved management and sustainable use of local crop genetic resources
- Establishing Crop Diversity Centre for the long conservation of crop biodiversity
- Raising public awareness about plant biodiversity and the environment

CHAPTER 5

THE STATE OF NATIONAL PROGRAMMES, TRAINING AND LEGISLATION

5.1 National Programmes for Plant Genetic Resources

The Cabinet of the Government of the Republic of Trinidad and Tobago (GORTT) has recently approved, on June 22, 2006, a Public Sector Investment Project for the implementation of a Comprehensive Crop Biodiversity Conservation Programme for Trinidad and Tobago. Further, it was agreed that the Minister of Planning and Development give consideration to the inclusion of the above-mentioned project in the 2007 Public Sector Investment Programme. This project has received funding in the 2008 National Budget of T&T.

The aim of this crop biodiversity conservation project is to implement recommendations made in the National Biodiversity Strategy and Action Plan which is to develop a structured and focused National Programme for Crop Genetic Resources in Trinidad and Tobago. In addition to this, the project is designed to fulfill obligations to the Global Strategy for Plant Conservation (GSPC) and the International Treaty on Plant Genetic Resources for Food and Agriculture (IT-PGRFA). The objectives of the project are set out below:

(a) General Objectives

The general objective of this project is to develop the institutional capacity and capability in order to adopt recommendations of the National Biodiversity Strategy and Action Plan (NBSAP) for Trinidad and Tobago. The NBSAP focuses on the conservation and sustainable utilization of the country's crop biodiversity resources and identifies national goals and targets for the country.

At the same time, the national goals and targets of the NBSAP are harmonized with the obligations of the GORTT to (a) the Convention on International Trade of Endangered Species of Wild Flora and Fauna (CITES, 1973), (b) the Global Strategy for Plant Conservation (GSPC). The GSPC was adopted in Decision VI/9 of the Conference of Parties (COP) to the Convention on Biological Diversity, on 19 April, 2002 and (c) the International Treaty on Plant genetic Resources for Food and Agriculture (PGRFA) which links this treaty to the FAO and the Convention on Biological Diversity.

(b) Specific Objectives

The specific objectives include:

1. Conserving local crop biodiversity in a sustainable way
2. Building capacity for the conservation of crop genetic resources
3. Using crop genetic resources in a sustainable for the benefit of farming communities
4. Promoting education and public awareness about local crop biodiversity
5. Encouraging farmers to participate in local crop diversity conservation (*in situ* conservation)
6. Conserving crop germplasm by *in vitro* methods
7. Increasing public awareness about plant biodiversity and the environment

National stakeholders, which includes the public sector, private sector, local communities, educational and research institutions will be engaged in the conservation, characterization and utilization of crop genetic resources through a significant National public awareness programme.

The new national programme for the conservation of crop genetic resources is harmonized with all major treaties relating to the environment and plant genetic resources conservation. GORTT is a signatory to the Convention on

Biological Diversity of which the GSPC protocol has been adopted. GORTT is also a party to the IT-PGRFA. These treaties have provided the foundation for developing a National programme. The national programme is fully integrated into the national policy areas of environmental protection, biodiversity conservation and food security.

5.2 Training

The training needs required to effect an enhanced national PGR programme include:

- Increasing the number of trained personnel and posts in plant breeding, agronomic evaluation, taxonomy, statistical sampling, biotechnology, public awareness and education. Such trained personnel should be the primary motivators in a national PGR conservation and management programme. There are limited in-country training opportunities for either local or regional personnel. In this regard attachments and exchanges to relevant germplasm conservation institutions abroad are necessary.
- Expansion of opportunities at the UWI/ Faculty of Agriculture and Eastern Caribbean Institute of Agriculture and Forestry (ECIAF) to address basic training needs in PGR conservation and management. Provision of scholarships to nationals in identified primary areas will enhance the national PGRM effort. Provision of incentives to retain trained nationals in the national PGR programme is noted as a corollary requisite.
- Our national *ex situ* PGR conservation effort, though limited, encompasses a wide range of crop germplasm and genetic resources and is capable of serving as a complementary tool for such training and education, including a capacity to accommodate international needs through personnel and germplasm exchange.
- In respect of the lattermost, the UWI and ECIAF are expected to reorient their training programmes to incorporate resource management, environmental assessment, management and protection and other areas related to safeguarding our natural resource base
- Opportunities for education and training are actively pursued by the MALMR in collaboration with centres of excellence in PGR management. These are usually MSc. Programmes at the Royal Botanic Gardens at Kew and the University of Wageninen, Holland. Several persons have been trained at these institutions in Plant Genetic Resources Management. Training opportunities are also accessed through Technical Cooperation Projects (TCP) with participating countries (Brazil, Cuba and Mexico).

5.3 National Legislation

The MALMR has taken the initiative, through statutory requirements, to ensure the conservation and exploitation of its plant biodiversity. However there is a great need to update and revise the national legislation in order to effectively operate within the framework of the IT-PGRFA and the GSPC protocol and to gain benefits from these treaties.

Important Legislation Enacted to Deal with Issues of Plant Biodiversity and the Environment include:

- Plant Protection - The Plant Protection Ordinance 1940 Chapter 23:17 and the Plant Protection Regulations, 1953
- Regulation of forests and forest products- Forests Act Chapter 66:01.
- Regulation of sawmills- Sawmills Act Chapter 66:02
- Provision of improved security of tenure for farmers- Agricultural
- Botanic Gardens Act Chapter 41:03
- Queen's Park Savannah Act Chapter 42:06
- Environmental Management Act No.3 of 1995
- National Trust of Trinidad and Tobago Act of 1991.

In the context of Intellectual Property Rights (IPR), enabling legislation to activate the terms and conditions of the 1978 International Convention for the Protection of New Varieties of Plants (UPOV), which this country has accepted, was completed by the end of 1995. The 1978 convention has been adopted given the benefits, which would accrue to both farmers and breeders and the facilitation of trade, which would arise there from.

5.4 Public Awareness

It is clear that there is a limited level of awareness of the roles and values of crop genetic resources in Trinidad and Tobago. A major component of the new national programme on PGRFA is to raise public awareness about the importance of conserving plant diversity including crop biodiversity. It is planned that this can be achieved through the following:

- workshops and seminars in primary and secondary schools
- Meetings with farmers' groups
- Field days at crop germplasm conservation sites
- Articles and documentaries in print media and broadcast media

5.5 Assessment of Major Needs for National Programme Development, Training and Legislation

Support for the conservation on agricultural biodiversity has been gaining ground over the last ten years. The conservation of crop biodiversity is now a priority activity within MALMR and other institutions of T&T. There is considerably more information sharing and networking in order to achieve national goals. There is now a structured national programme with dedicated funding over the next six years to effect new goals and targets in crop biodiversity conservation.

GORTT has identified in its Medium Term Policy Framework 1994-1996 as well as its Vision 20/20 policy document its commitment to the development of the agricultural sector as a primary source of economic activity. In this context the mission of the MALMR has been defined as a facilitator in the sustainable development of agriculture, forestry and fisheries while conserving and enhancing (safeguarding) the environment and strengthening the capabilities of our clients.

The MALMR Strategic Plan 1993-1995 has recognized the Agricultural Services Division, the Forestry Division and the Research Division as its primary operational arms with responsibility for PGR conservation and management. Other collaborators include the UWI, Caroni (1975) Ltd., The Cocoa Research Unit, CARDI and private farmers and organizations. This position has been reiterated in the more recent vision 20/20 policy document.

The responsibilities associated with the programmes include the identification, selection, adaptation and development of appropriate technology to enhance crop production; the acquisition and conservation of germplasm to expand and preserve genetic potential; the conservation of indigenous plant material and the introduction of plant species and cultivars to promote the development of the horticultural.

The new national programme for the conservation of crop genetic resources has secured dedicated funding for the next six years (2008/14). Initially funding to the extent of 15.23 M$TT will be available to carry out all the comprehensive activities of a national programme. It is hoped that international support can be attracted to assist with the implementation of this programme.

The major challenge to be faced with the implementation of a national programme on PGRFA is the lack of trained personnel in the area of plant genetic resources management. One of the first activities planned in the national programme is to train officers in several areas of plant genetic resources management. Eventually it is hoped that expertise in all aspects of plant genetic resources management can be developed.

Another major challenge will be to accelerate the rate of documentation of collections. This will be considered a priority area for the crop genetic resources programme. The unnecessary duplication of work will have to be eliminated through closer collaboration of research institutions and other stakeholders.

CHAPTER 6

THE STATE OF REGIONAL AND INTERNATIONAL COLLABORATION

6.1 Regional and Sub-regional Networks for Maintaining *ex situ* Collections

At the regional level, significant networking occurs through Ministries of Agriculture (MsoA), the UWI and CARDI. Major benefits which have resulted from these interactions include cost effective multiple-site research and development PGRFA, ease of access to regional and international crop germplasm, easy access and exchange of information and the strengthening of inter and intra sectoral linkages in the conservation and utilization of PGRFA. Regionally, networking in PGRFA occurs through the Ministries of Agriculture of several island states, the three University campuses of UWI located in Barbados, Jamaica and Trinidad and Tobago and CARDI, which is represented in many of the smaller islands of the Caribbean Community (CARICOM).

The Caribbean Genetic Resources Network (CAPGERNET) was established in 1999 under the umbrella body of PROCICARIBE with the mandate to coordinate activities of a Caribbean regional network. It was funded by IICA and CARDI and implemented by CARDI. CAPGERNET provides a mechanism to foster collaborative efforts for the acquisition, improvement, conservation, evaluation and utilisation of crop genetic resources for the benefit of the region's farmers using environmentally sound principles and policies.

Trinidad and Tobago has also been involved in other regional networks under PROCICARIBE which includes Caribbean Post Harvest Technology Network (CAPHNET), Caribbean Fruit Network (CARIFRUIT), Caribbean Biosystematics Network (CARINET), Caribbean Vegetable Network (CARIVEG) Caribbean Roots and Tubers Network (CAROT) Caribbean Integrated Pest Management Network (CIPMNET) and Caribbean Rice Industry Development Network (CRIDNET). The main benefit gained by these network has been exchange of crop germplasm, however, this exchange has been limited due to inadequate national policy in the area of PGRFA. Other constraints include lack of financial and human resources. Added to this, direct benefits to participating countries were not clear since there was a lack of consensus with regard to benefit sharing among potential partners.

Development of a national and regional policy on the conservation and sustainable utilization of crop genetic resources would greatly assist networking capabilities in the region. There is also need for training at the tertiary level and support for infrastructural development.

In the area of information exchange a number of information systems have been used in Trinidad and Tobago. The CSEGRIN programme was developed by the FAO in 1994. CSEGRIN is a powerful and user-friendly electronic environment designed to improve germplasm and variety exchange, to facilitate management of plant genetic resources, enhance communication among breeders, seed technologists and agricultural extensionists, facilitate standardized information access to users and reduce redundancy of research efforts. This network was developed to serve the CARICOM region. The major limitation of this programme involved the use of Foxpro for MS DOS Ver 2.6a, a software programme which was not supported in the new windows environment.

An attempt was made by CARDI in 1999 to update the databases using pc-GRIN. This programme was limited because it was subject to modification by different users and therefore not standardized throughout the region. The new comprehensive crop biodiversity project aims to be totally compatible with the USDA based pc-GRIN database and the European based SINGER database.

6.2 International Programmes

At the global level, the FAO has been the prime facilitator of national crop germplasm conservation and improvement activities through the provision of training opportunities, the hosting of conferences and workshops, information and documentation support, commodity research and development, and to limited extent, *ex situ* conservation.

The FAO has a regional office in Santiago, a sub-regional office in Barbados and local representation in T&T. Through these offices FAO has facilitated a regionally networked root crop research and development programme, a vegetable and fruit crop seed programme and the exchange of relevant scientific expertise. The executing agencies of such programmes include the International Plant Genetic Resources Institute (IPGRI), the Asian Vegetable Research and Development Centre (AVDRC), CIAT, IITA, IICA, CIP, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT). Major linkages are described below.

IPGRI has hosted regional courses in respect of plant biodiversity, information and documentation support in respect to cowpea, coconut and mango and sponsored slow growth experiments at the MALMR's Tissue Culture Laboratory. The AVDRC has been responsible for supplying tomato germplasm material for national research and development. CIAT has provided cassava, rice and bean germplasm from which agronomic studies have resulted in cultivars being released to farmers. Cassava storage has been developed to international standards and the formulation of a cassava/ molasses livestock feed has been shown to be of potential.

IITA's supply of cowpea has facilitated cowpea breeding studies at the UWI. Cultivars of white potato from CIP have been evaluated whilst ICRISAT has been instumental in assisting with national pigeon pea breeding efforts. CIMMYT's contribution to corn breeding efforts for increased yields have resulted in the selection of improved lines, developed at CIMMYT, for commercial production in Trinidad and Tobago.

6.3 International Agreements

The GORTT is fully committed to supporting all international treaties and agreements which support the preservation and sustainability of biological resources. To this end several international agreements have been aceeded to which include, the Convention on Biological Diversity (CBD), the Global Strategy for Plant Conservation (GSPC), the International Treaty on Plant Genetic Resources for Food and Agriculture (IT-PGRFA), Convention on the International Trade in Endangeered Species (CITES), The International Union for the Protection of New Varieties of Plants (UPOV) along with other protocols.

The 1992 Convention on Biological Diversity **(CBD)** addresses biological diversity, including agrobiodiversity. This convention was ratified by GORTT on 1st August 1996. Since this treaty came into effect, there has been considerable effort to implement an international thrust through the Global Strategy for Plant Conservation (GSPC).

Trinidad and Tobago became a party to the **IT-PGRFA** on the 27 October 2004. It is envisaged that this Treaty would assist in facilitating easier access to crop germplasm stocks, as well as ensure fair and equitable sharing of benefits to farmers.

The International Union for the Protection of New Varieties of Plants **(UPOV)** protects the rights of breeders. The 1991 Act of the UPOV convention was acceded to on the 31st December 1997. The 1991 Act allows participating countries to protect plant varieties through Plant Breeder's Rights or patents. T&T must develop mechanisms of overcoming the exclusive rights granted to breeders by making provisions in their national legislation.

The **WTO/TRIPS** Agreement requires WTO member states to establish patent rights and other intellectual property rights.

The GSPC and IT-PGRFA treaties have been the driving forces for the developing a national policy framework for crop genetic resources in T&T. Further to this, these legislative agreements will be assessed by the Biodiversity Unit in the Ministry of Agriculture to determine the relevance and usefullness of these treaties to the national agenda.

6.4 Assessment of Major Needs to Improve International Collaboration

To improve international collaboration in the area of crop genetic resources in Trinidad and Tobago would require:

- The drafting of appropriate legislation to provide the framework for meeting obligations to international treaties on PGRFA.
- The drafting of appropriate legislation to facilitate and control the movement of crop genetic resources, in line with the commitments to the IT-PGRFA.

- Developing a comprehensive national policy for the conservation, characterization and sustainable utilization of PGRFA.
- Strengthen the linkages between the respective national focal points for the various treaties.
- Develop the capacity and capabaility to form the appropriate linkages/partnerships with appropriate institutions to develop programmes in the conservation and sustainable utilization of PGRFA.
- Developing a standardized information management and early warning system for plant genetic resources.
- Strengthen ties with regional networks to develop a coordinated approach to *ex situ* conservation of crop species.
- Participating in training programmes in all aspects of crop genetic resources management.

CHAPTER 7

ACCESS TO PLANT GENETIC RESOURCES, SHARING OF BENEFITS ARISING OUT OF THEIR USE AND FARMERS' RIGHTS

7.1 Access to Plant Genetic Resource (PGR)

Trinidad and Tobago is a party to the International Treaty for Plant Genetic Resources for Food and Agriculture, and thereby pledged its commitment to the conservation and sustainable utilization of plant genetic resources for food and agriculture, and to the fair and equitable sharing of the benefits derived from the use of these resources. At present, there are no specific co-operation agreements with regional crop networks or international organizations for conserving accessions from our local germplasm collection, making the country extremely vulnerable to genetic erosion especially in the event of natural disaster. However opportunities to strengthen networks with regional and international organizations, including CIAT, AVDRC IITA, IPGRI, IRRI, CIP, INRA, CAPGENET could include cooperation arrangements for conserving plant germplasm from Trinidad and Tobago in regional or international collections. This requirement for international cooperation between countries, which are fundamentally interdependent with respect to PGR, is critical to effectively and efficiently secure the safely of genetic material already collected and provide for its regeneration and duplication. Additionally there is a need to institutionalize the responsibility for implementation of GPA priority areas.

Over the past 10 years there have been no policy, legal or regulatory changes impacting on the conservation, sustainable use of PGR resources within the country and sharing of benefits arising out of their use. However, efforts are being made to implement a Comprehensive Crop Biodiversity Programme for T&T. This programme has received funding from GORTT. In addition there has been some effort by MALMR to collect and establish museum plots of under-utilized medicinal herbs and spices including aloe, fever-grass, aniseed, bay leaf, clove, curry leaf, henna, mauby, nutmeg, shadow-beni, thyme and turmeric. However there is still a need to develop national strategies to encourage and support the sustainable use and marketing of under-utilized species. Collaboration between CARDI, UWI, and the Sugarcane Feed Centre (SFC) has also resulted in the implementation of a project to purify, stabilize and maintain local elite lines of hot pepper *Capsicum chinensis* and to develop hybrid seeds from these improved lines.

A national Agribusiness Development agency (TTABA) has been mandated to develop the agribusiness opportunities for a range of local commodities including papaya, dwarf pommecythere, sweet potato and hot pepper. Interest in the development of organic production systems for vegetable crops and cocoa could also promote niche markets for local varieties. The School Nutrition Company Limited which has responsibility for the provision of breakfasts and lunches in public schools could play a role in the increased utilization of local varieties and "diversity – rich" products for local consumption.

No management action has been taken over the past 10 years to maintain or enhance access to plant genetic resources located outside Trinidad and Tobago. Indeed the closure of a regional plant quarantine facility in Barbados which facilitated the entry of rice, root crop and cocoa germplasm into Trinidad has constrained access to PGR. This not withstanding, some agencies have obtained PGR from resources located outside of Trinidad and Tobago.

There are no agreements in place for rapid acquisition of PGRFA from international, regional or national sources following natural disasters. Farmers are afforded some monetary compensation for damages incurred by flooding or other natural disaster but there is no assistance specifically for restoration of agricultural systems following these natural catastrophes. T&T restricts access to its locally-bred Trinidad Select Hybrids of cacao as these hybrids are not protected by Plant Breeders Rights.

7.2 Benefits Arising out of the Utilization of Plant Genetic Resources for Food and Agriculture

Quantitative data is not available to describe the benefits arising from the use of PGR in Trinidad and Tobago but beneficiaries would include governmental, non-governmental and academic institutions as well as local farming communities.

At present there are no established mechanisms for sharing benefits arising out of the use of PGR and assistance to put such mechanisms in place would be beneficial to T&T. For example, a hot pepper improvement project which utilized farmers' landraces and may eventually be used in the development of hybrid seeds must take account of how the benefits arising would be shared between farmers', breeders and entrepreneurs. The absence of clearly defined mechanisms could result in unfair sharing and disadvantage to one or more of the parties concerned.

Identification of the obstacles to achieving and enhancing fair and equitable benefit sharing would be key to establishing a mechanism for sharing of benefits in Trinidad and Tobago. The need for capacity building to effectively implement the provisions of the IT-PGRFA, ensuring the involvement of all stakeholders, and having regard to incentives, accountability, verification means and dispute settlement within a transparent framework, is critical to fair and equitable sharing of benefits. Both legal mechanisms and focused programs and projects would be required to promote fair and equitable benefit-sharing.

7.3 Implementation of Farmers' Rights

Being a signatory to the IT-PGRFA , Trinidad & Tobago recognizes and supports the call for farmers and their communities to participate fully in the benefits derived from the use of PGR. However, this country has not subscribed to any international agreements relevant to the implementation of Farmers' Rights, nor has any national legislation or policies been developed or modified to achieve or enhance the implementation of Farmers Right. As with fair and equitable sharing of benefits, identification of the obstacles to achieving or enhancing the implementation of Farmers' Rights is yet to be addressed in Trinidad & Tobago.

CHAPTER 8

THE CONTRIBUTION OF PGRFA MANAGEMENT TO FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

8.1 Overview on Contribution of PGRFA To Food Security

There is a wide diversity of crop genetic resources in Trinidad and Tobago. These plant genetic resources for food and agriculture have been underutilized and there is considerable threat to this unique crop genepool in the country. It is, however, recognized that genetic improvement in particular varieties of crops (such as cassava, pigeon peas and sweet corn) has the potential to contribute to the enhancement of the status of food security.

The reality is that in Trinidad and Tobago, domestic food consumption outstrips domestic production. The country is a net food importer and the extent to which food imports exceeded food exports has increased over the last decade. In effect, adequate food availability depends on a favourably supply of foreign exchange.

The trend toward globalization, trade liberalization and the emergence of the CARICOM Single Market Economy (CSME) make food security increasingly a policy objective that is to be viewed from the perspective of interdependence and complimentarily in demands and supplies.

At the sectoral policy level, the Vision 2020 Agriculture Sub-Committee Report emphasizes the need for cost-effective agricultural and food policies in order to achieve food security objectives. The national food strategy proposed is expected to achieve: sustained growth in domestic food production, improved income distribution, satisfactory nutritional status for the population, adequate food security overtime to ensure against poor harvests, national disasters and uncertain world food supplies; and disaster preparedness.

8.2 National Agricultural Development Programme

A National Agribusiness Development Programme (NADP) has, therefore, been formulated which aims to develop an Agribusiness Sector that is private sector driven, competitive and adds value to primary production. Specifically, in terms of scale of production, it is not the intention of the Government to promote large farms at the expense of small farms. What is envisaged is a new mix in the farming community of large and small farms.

The potential areas targeted for private sector investment in agriculture include:

- **Establishment of Large Commercial Farms**
  Under the NADP, the Government will be creating 16 large scale farms of a minimum of 100 acres each, all utilizing modern techniques and management for the large scale production of food. These estates will be operated along commercial lines and will involve participation by the private sector, including established international companies in the field of agriculture.
  In addition, Government will operate two additional farms in collaboration with the Government of Cuba. These farms will serve as a catalyst in driving food production and will become the new "food baskets" of the country. Crops that will be produced include: sweet potato, cassava, yam, dasheen, tomato, ochro, cucumber, egg plant, pumpkin, eddoes, cabbage, lettuce, green pigeon peas, carrots and string beans.

- **Commodity Development**
  The Trinidad and Tobago Agribusiness Association (TTABA) is managing some critical components in the NADP. Under these components, commodities have been identified for development based on their potential to grow

into major industries and a range of value added products for selected local and export niches. These commodities include hot pepper, paw-paw, sweet potato, cassava, pumpkin, rabbit, dwarf pommecythere, green coconut and culinary medicinal herbs. Private sector investments are being encouraged in the production of these commodities and in the establishment of multi-purpose processing facilities that can process the commodities.

ABBREVIATIONS

ADB	Agricultural Development Bank
AGRIS	International Information Systems for Agricultural Sciences and Technology
AGRIN	International Information Network for Agricultural Sciences and Technology
AVDRC	Asian Vegetable Research and Development Centre
BIONET	International Network to Support Regional and National Biosystematic Services
CABI	Commonwealth Agricultural Bureau International
CADP	Chaguaramas Agricultural Development Project
CARDI	Caribbean Agricultural Research and Development Institute
CARIRI	Caribbean Industrial Research Institute
CARICOM	Caribbean Community
CATIE	Centro Agronomico de Investigacion y Ensenanza
CDS/ISIS	Computerized Documentation System/Integrated Set of Information Systems
CES	Central Experiment Station
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIDA	Canadian International Development Agency
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CIP	Centro Internacional de la Papa
CITES	Convention for International Trade in Endangered Species
CRIN	Caribbean Rice Information Network
CRS	Caribbean Research Station
CRU	Cocoa Research Unit
CSEGRIN	Caribbean Seed Improvement Germplasm Resource Information Network
CSO	Central Statistical Office (Trinidad and Tobago)
CTV	Citrus Tristeza Virus
ECIAF	Eastern Caribbean Institute for Agriculture and Forestry
FAO	Food and Agriculture Organization of the United Nations
GORTT	Government of the Republic of Trinidad and Tobago
GRIN	Germplasm Resource Information Network
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICTA	Imperial College of Tropical Agriculture
ICS	Imperial College Selections
IIBC	International Institute for Biological Control
IICA	Inter-American Institute for Cooperation in Agriculture
IITA	International Institute of Tropical Agriculture
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated Pest Management
IPR	Intellectual Property Rights
ISNAR	International Service for National Agricultural Research
MALMR	Ministry of Agriculture, Land and Marine Resources

MsoA	Ministries of Agriculture
NAMDEVCO	National Agricultural Marketing Development Company
NGOs	Non-Governmental Organizations
NIHERST	National Institute for Higher Education (Research, Science and Technology)
PGR	Plant Genetic Resources
PGRM	Plant Genetic Resources Management
SFC	Sugarcane Feeds Centre
SOE	State Owned Enterprises
TFAP	Tropical Forestry Action Plan
TSH	Trinidad Selection Hybrids
T&T	Trinidad and Tobago
UN/ECLAC	United Nations/Economic Commission for Latin America and the Caribbean
UPOV	International Convention for the Protection of New Varieties of Plants
UWI	The University of the West Indies
VAT	Value Added Tax

BIBLIOGRAPHY

Adams, Herman. Turkeyen, Guyana: FAO/CARDI, 1993. Unpublished. Ahmed, B. and Collins, P. Forage seed production and establishment of improved pastures in the region. St. Augustine: CARDI, 1987.

Ainsworth, A.M. and Hawksworth, D.L., eds. Biodiversity in the Caribbean: report and abstracts of an International Workshop on Diagnostic Services for Agriculture and the Environment. Port of Spain, Trinidad and Tobago, 25-27 May 1992.Oxon, UK: CABI, 1992.

Annual Report of the Research Division, MALMR.MALMR, CES, Centeno 2006.

Bacon, Peter R. and Cooper St., G.C.The Natural Resources of Trinidad and Tobago.London: Edward Arnold, 1981.

Bacon, Peter R.Flora and fauna of the Caribbean: an introduction to the ecology of the West Indies.Port of Spain: Key Caribbean Publication, 1978.

Barrow, Ronald M. and Mohamed, Musa El S.An inventory of germplasm material researched at Central Experiment Station.Centeno: MALMR, June 1985. Unpublished.

Beard, J.S.The Natural Vegetation of Trinidad.Oxford: Clarendon, 1946.

Belcher, Brian and Hawtin, Geofrey.A patent on life ownership of plant and animal research.Ottawa: IDRC, 1991.

Capote, Maricela.Composicion actual de las especies fruticolas existente en la Estacion Nacional de Frutales.La Habana: Estacion Nacioanl de Frutales, September 1994.

Chalmers, W.S. and Faizool, S.Trinidad & Tobago National Forestry Action Programme: report of the Country Mission Team.Port of Spain: FAO/CARICOM Tropical Forestry Action Programme, March 1992.

Cocoa Research Unit.International Workshop on Conservation, Characterization and Utilization of Cocoa Genetic Resources in the 21st Century Port of Spain, Trinidad, 13-17th September, 1992. Proceedings.St. Augustine: CRU, 1993.

Comeau, Paul L. Report on Conservation of Tropical Forest and Ecosystems, Biological Diversity and Herbaria. Tropical Forestry Action Programme GCP/RLA/098/UR.St. James: Forestry Division, 1991.

Dardine, S."Sustainable development as it relates to Biodiversity and Ecotourism." Extension Newsletter 25 (1) March/ April, 1994.

Germplasm Accessions Lists: Version 1.Tacarigua: IICA,March 1994.

Global Strategy for Plant Conservation.The Secreteriat for the Convention on Biological Diversity. World Trade Centre, Montreal, Quebec, Canada, 2006.

Hewitt, S.Fruit Trees of the Caribbean.Macmillan Education, 2005.

Intellectual property rights: the debate. Geneflow 1992: pp. 10-13.Special UNCED edition: Biodiversity and Plant Genetic Resources.

International Code of Conduct for Plant Germplasm Collecting and Transfer.
Rome: FAO, 1994.

Kapoor-Vijay, Pormila and White, James.Conservation Biology: A training manual for Biological Diversity and Genetic Resources.London: Commonwealth Secretariat, 1992.

Luego, A.E. and Bayle Bruce.Wetlands management in the Caribbean and the role of forestry and wetlands in the economy.Proceedings of the fifth meeting of the Caribbean Foresters at Trinidad.Rio Piedras, Puerto Rico: USDA Forest Service, 1992.

Magnus, Ken.Pollution and Management of Waste. Regional Technical Meeting for the Atlantic/Caribbean/ Mediterranean Preparatory to the Global Conference on the Sustainable Development of Small Island Developing States [Report].Doc No. CCS/UNECLAC/ACM/TRM 1/9.Port of Spain: UNECLAC, July 1993.

Mahabir, Kumar.Medicinal and Edible Plants used by East Indians of Trinidad and Tobago.Chakra Publishing House, 1991.

Marshall, R.C.Trees of Trinidad and Tobago.Port of Spain: Government Printery, 1934.

Mooleedhar, V.Proposal for Technical Cooperation between the Government of the Republic of Trinidad and Tobago and the Government of Brazil.MALMR, CES, Centeno, 2006.

Mujeeb-Kazi, A. and Sitch, L.A. tech. Eds.Review of Advances in Plant Protection of New Varieties of Plants: General Information: p. 5-11.Geneva: UPOV, 1986.

Nakasone, H.Y. and Paull, R.E.Tropical Fruits.CAB International, UK, 1998.

Partners in conservation: Plant Genetic Resources at the CGIAR System.2nd ed. Washington D. C.: CGIAR, 1993.

Perez Porras, Emilio.Delegation of the European Commission/Cooperation between the European Union and the Caribbean Region, Annual Report 1993 (VIII/269/94 – EN).Port of Spain: European Commission, 1994.

Rao, Ramanatha; and Riley, Kenneth W."The use of biotechnology for conservation and utilization of plant genetic resources" PGR Newsletter 97 1994: pp. 3-16.

Recent advances in the conservation and utilization of Genetic Resources: proceedings of the Global Maize Germplasm Workshop.Mexico: CIMMYT, 6-12 March, 1988.

Report of the meeting of the Project Coordinating Committee for ProjectGCP/RLA/108/ITA (Phase II), Port of Spain, Trinidad and Tobago, 30-31 March, 1995.St. Augustine: CARDI, 1995.

"Research in Progress."Cocoa Research Unit Newsletter, pp. 1-2.May 1994.

Rodriguez, A. and Feininez, R.Inventario sobre colecciones de frutales en la Republica Dominica. (FDA/ISA-14-91/13). Santiago, RD: Fundacion de Desarrollo Agrofecuaria, 1994.

Roher, Jens, G.Tropical Plants of the World.Sterling Publishing Co., Inc. New York, 2002.

Seaforth, C.E., Adams, C.D. and Sylvester, Y.A Guide to the Medicinal Plants of Trinidad and Tobago.London: Commonwealth Secretariat, 1983.

Sustainable Agricultural Systems 22.Iowa: Soil and Water Conservation Society, 1991.

"The Case for Crop Networks"Geneflow June 19889: pp. 6-9.Rome: IBPGR, 1989.

The Ecology and Potential Utilization of a Rainforest Tree SpeciesPenny piece (Pouteria multifora).Trinidad Expedition Report, 1992.Team members: Kerry Cooper, Amanda Ferguson, Nicola Cilvary, Wendy Rooke, Amy Summer and Byron Wood.Open Chemistry Department of Biology.

Walton Hall, Milton Keynes, MK.The Probe: Official Newsletter of the Caribbean Society of Biotechnology.March 1995.

Torres Ojito Miguel *et al*.Recursos geneticos de mango (Mangifera indica Lin) en Cuba del sol.La Habana: Estacion Nacional de Frutales.

Trinidad and Tobago, Central Statistical Office.Annual Statistics Report (1994).Port of Spain: Government Printery. 1994.

Trinidad and Tobago.Biodiversity Strategy and Action PlanEnvironmental Authority, St. Clair, Port of Spain.

Trinidad and Tobago. Laws of Trinidad and Tobago; House Bill No. 3 of 1991: National Trust of Trinidad and Tobago Act, 1991.

Trinidad and Tobago.Laws of Trinidad and Tobago; Act No. 3 of 1995: Environmental Management

Trinidad and Tobago. Review of the Economy 1993.

Trinidad and Tobago National Resource Management Project: Identification Follow up Mission: Project Brief.Port of Spain: FAO, 16 August 1994.Report No. 102/94 CP-TR16PBTWPS [Unpublished]

University of the West Indies. Faculty of Agriculture.Annual Report 1982-1985.St. Augustine: UWI, August 1986.

Van Wijk, Jeroen, *et al*.Intellectual Property Rights for Agricultural Biotechnology: Options and Implication for Developing Countries.The Hague: ISNAR, 1993.(ISNAR Research Report; 3).

Wilkes, Garrison.Strategies for sustaining crop germplasm preservation, enhancement and use.Washington, DC:CGIAR, 1992.(Issues in agriculture No. 5).

Williams, R.O.The Useful and Ornamental Plants in Trinidad and Tobago.Port of Spain: Government Printery, 1949.

"Women and plant genetic resources."Geneflow 1991: pp. 8-16.Rome: IBPGR, 1991.

World Resources 1994-1995.A report by the World Resources Institute in Collaboration with the United Nations Environment Programme and the United nations Development Programmed.New York, Oxford: OUP, 1994.

APPENDIX 1

LIST OF IMPORTANT AGRICULTURAL LANDRACES IN TRINIDAD AND TOBAGO

Crop	Status of cultivation over ten year period
Lauki –Bottle gourd	Reduced
Jinghi –Angled loofah	Reduced
Saputiya – Angled loofah	Reduced
Caraaili – Bitter gourd	Expanded
Seim – Hyacinth bean	Reduced
Christophine	Expanded
Chowrai	Reduced
Poi	Reduced
Gooma	Reduced
Dasheen	Reduced
Sarhachee	Reduced
Karmee	Reduced
Katchu	Reduced
Cassava	Expanded
Yams	Reduced
Sweet potato	Expanded
Cush Cush	Reduced
Local tomatoes (Choka)	Reduced
Local hot peppers	Expanded
Local melongene	Reduced
Local ochro	Reduced
Crapaudback pumpkin	Reduced
Pimento	Expanded
Cocoa	Expanded
Coffee	Reduced
Tonka bean	Reduced significantly
Breadfruit	Expanded
Chataigne	
Local pigeon peas	Reduced
Long bodi – Lagoon bodi	Reduced
Sesame seed – Black bean	Reduced
Mung bean - Urdi	Reduced

APPENDIX 2

LIST OF GROUPS OF COCOA ACCESSIONS BY CODE HOUSED AT ICG,T

Cocoa germplasm code	No. of accessions
ACT (TTO)	19
AGU (CHA)	5
AM (POU)	99
AMAZ (CHA)	10
AMEL (MAY)	1
WAA	2
AMELONADO	1
AS (ECU)	3
AX	9
B (POU)	125
B 6 R (BLZ)	1
BE	2
BH	1
BLZ 5	1
BOB 8 (CHA)	1
C (TRI)	7
CAS 1	1
CATIE 1000	1
CATONGO	1
CC	14
CERRO AZUL 10	1
CL	140
CLEM	4
CLM	17
COCA	7
CRIOLLO	2
CRU	214
CRUZ	3
DE (TTO)	8
DOM	25
DOPOL	13
DOS HERMANOS	3
DR 2	1
E (ECU)	2
E (ICT)	1
ABC	1
EBC	2
ECNR	1
EEG 8	1
EET (ECU)	16
ELP	29
EQX	4

Cocoa germplasm code	No. of accessions
FSC	2
G 8 (GET)	1
GA 11 (HAI)	1
GC T	11
GDL	4
GF 32	1
GNV 22	1
GS	13
GU	29
HERRANIA	8
ICA 70 (COL)	1
ICS	93
IMC	66
JA (POU)	198
LAF17	1
LCT EEN	111
LEGON VERDE	1
LH	2
LP (POU)	133
LX	25
LZ	11
M	4
MACAS	1
MAN (BRA)	2
MAR	13
MARPER	43
MATINA	2
MO	27
MOCO	1
MOQ	129
MOTOLO 5665	1
MX (TTO)	6
MXC 67	1
NA	232
NAPO (CHA)	3
NG 3	1
OC 61 (VEN)	1
P 19 (MEX)	1
PA (PER)	125
PENTAGONA	2
PH	10
PLAYA ALTA 2 (VEN)	1
POR 1 (TTO)	1
POUND (POU)	30
RB (BRA)	5
REDAMEL	3
RIM (MEX)	23
SAN JUAN WSC	1
SAN MIGUEL (CHA)	13
SC (COL)	16
SCA	15
SD	1

Cocoa germplasm code	No. of accessions
SI	54
SIAL	2
SIC 5	1
SILECIA 8 (ECU)	1
SJ (POU)	47
SLA	29
SLC	11
SM (POU)	9
SNK 12	1
SP1 (VEN)	1
SPA (COL)	11
SPEC	40
STAHEL	1
TAP (CHA)	3
Theobroma speciosa	1
THY	5
TRD	68
UF	19
VEN (ICT)	4
VENC 4-4 (FRA)	1
YAL	3

APPENDIX 3

CASSAVA GERMPLASM COLLECTION – UWI

Varieties	No of plants
M Col 22	10
CMC 40	10
Maracas Black Stick	10
M Trin 1	10
Unknown	10
Bluestick	10
M Guy 4	10
M Trin 4	10
M Guy 2	10
M Trin 2	10
Butterstick	10
M Guy 3	10
To 3/72	10
T 16/72	10
M Guy 6	10
Valencia	10
Vo 4/72	10
Vo 6/72	10
M Guy 2	10
Yuca Var. Negra A	10
To 10/72	10
Vo 5/72	10
Vo 7/72	10
To 12/72	10
To 4/72	10
Unknown 1	10
Yuca Var Flor De Lis	10
Whitestick	10
Yuca Var 4200	10
M Guy 6	10
Llanera	10
Yuca Var Negra B	10
Yuca Var. 32	10
T 15/72	10
M Mex 59	To be established
T 17/72	10
Unknown 2	10
CIAT Hybrid	10
T 9/72	10
Redstick	10
M Col 22	200
Maracas Black Stick	200

APPENDIX 4

SWEET POTATO GERMPLASM COLLECTION – UWI

Varieties	No of plants	Varieties	No of plants
Chicken Foot	36	82-BM-31	36
Ornamental Yellow	36	TIS 82/02/30	18
C 99	36	TIS 4400-4	36
Ninety Nine	36	TIS 82-02-35	36
TIB 8-21-1	54	TIS 8504 (60)	18
02/59	36	TIS 2534	18
TIS 82-06-41	54	TIS 8504 (2)	18
A 64	18	Major Choiseui	36
Magarita	36	TIS 8200-70	36
TIS 8250	72	TIS 3194	36
TIS 2033-3	36	TIS 82/02/70 (10)	18
TIS 9191	36	Carrot Potato	36
34/59	18	03/58	18
Bugs Bunny	36	03/58/11	18
G-R1-9	36	86-BM-15	36
TIB 11-21-1	18	05/06	18
TIS 21-54	36	Jewel	36
R 268	36	05/57	18
049	54	03/58/16	18
A 28/7	36	Hydry	18
R 551	18	3030-1-3	54
C 104	18	Nina	36
TIB 11/5/2	18	Certain	36
503/72	18	Mauve	18
TIS 82/02/70 (22)	18	Purple Ornamental	18
TIS 82/02/70 (33)	18	Ornamental Varigated	18
2532/1/2	18	TIS 8504	18
566	36	Never Mix	36
Sugar Root	36	2532-10-1	18
S 128	54	Tomato Vine	18
Maggie	36	3030-21-3	36
TIB 313	36	Sumor	18
3053/2/2	18	CM 1489/89	36
TIS 70995	18	Never Miss	36
John	36	45/57	36
TIB-9	36	F2	18
03/58/25	18	77	18

APPENDIX 5

YAM GERMPLASM COLLECTION – UWI

Varieties	No of plants
Affou	48
Bottle Neck Libson	96
Sweet	144
Ebboe	48
Unknown	48
Moonshine	16
Seedling Yam	48
Belep	48
Barbados Oriental	96
R6	48
St. Vincent Red	48
Lucie	96
Chinese	96
Aerial Flat Small	48
Ashmore	96
Harper	96
Aerial Large Round	48
Muapoi (off white)	48
Local Oriental Selection	48
Murapoi (white)	48
Kinny Bayo	48
Coconut Libson	48
Pana	48
Smooth Statia	48
White Libson	48
Yellow Yam	48
Seal Top	48
Negro	48

APPENDIX 6

BANANA GERMPLASM COLLECTION – UWI

Variety	No. of Stools
3405-1	8
168-12	8
GROS MICHEL	8
DWARF CAVENDISH	8
GIANT CAVENDISH	8
ROBUSTA	8
VALERY	8
LACATAN	8
RED MATABURO	8
WHITE MATABURO	8
SUCRIER	8
SILK	8
MYSORE	8
SABA	8
PELIPITA	8
UNKNOWN	8
PLANTAIN	16

APPENDIX 7

LIST OF ANNEX 1 CROPS HOUSED AT THE MINISTRY, OF AGRICULTURE, LAND AND MARINE RESOURCES

	Crop	Genus	No. of acc'ns	Origin
1.	Banana / Plantain	*Musa*	17	Malaysia, Malay Archipelago, Australia
2.	Brassica complex	*Brassica et al.*	-	Western Europe, Mediterranean, Asia
3.	Breadfruit	*Artocarpus*	2	Polynesia
4.	Cassava	*Manihot*	66	Paraguay, Mexico, Guatemala, Brazil
5.	Citrus	*Citrus*	156	India, China, Australia, New Caledonia
6.	Coconut	*Cocos*	3	Asia, South America
7.	Cowpea *et al.*	*Vigna*	5	T. Africa
8.	Eggplant	*Solanum*	1	India, Sri Lanka
9.	Maize	*Zea*	3	Mexico
10.	Major aroids	*Colocasia, Xanthosoma*	4	China, Japan, West Indies
11.	Pigeon Pea	*Cajanus*	3	Africa
12.	Rice	*Oryza*	5	S.E. Asia, Africa
13.	Sweet Potato	*Ipomoea*	85	Mexico, West Indies, Central and South America
14.	Yams	*Dioscorea*	41	Asia, Africa

APPENDIX 8

LIST OF NON-ANNEX 1 CROPS HOUSED AT THE MINISTRY OF AGRICULTURE, LAND AND MARINE RESOURCES

	Crop	Genus	No. of acc'ns	Origin
15.	Arrowroot	*Maranta arundinacea*	2	Caribbean (The Lesser Antilles)
16.	Bitter gourd	*Momordica charantia*	2	Tropics
17.	Cucumber	*Cucumis sativus*	2	India
18.	Ginger	*Zingiber officinale*	1	India/China
19.	Hot pepper	*Capsicum annuum*	8	Peru
20.	Jack bean	*Canavalia ensiformis*	2	Central America, West Indies
21.	Mung bean	*Phaseolus* sp	2	India
22.	Ochro	*Hibiscus esculentus*	4	West Africa
23.	Pumpkin	*Cucurbita moschata*	3	Central America and Mexico
24.	Seim	*Lablab niger*	4	India
25.	Sorrel	*Hibiscus sabdariffa*	1	West Africa
26.	Topi tambo	*Calathea allouia*	1	Caribbean
27.	Winged bean	*Psophocarpus tetragonolobus*	1	Madagascar or Mauritius
28.	Mango	*Mangifera indica*	63	Indo- Burma
29.	Cocoa	*Theobroma cacao*	125	Andes in the Amazon, from Mexico to the soutern Costa Rican border
30.	Abiu	*Pouteria caimito*	1	
31.	Akee	*Blighia sapida*	1	West Africa in Cameroon Gabon, Sao tome etc.
32.	Avocado	*Persea armericana*	4	Mexico to Peru
33.	Balata	*Manilkara bidentata*	2	South America, Trinidad
34.	Bael	*Aegle marmelos*	1	India
35.	Barahar	*Artocarpus lakoocha*	1	
36.	Baya		1	
37.	Bilimbi	*Averrhoa bilimbi*	1	Malaya
38.	Biriba	*Rollinia mucosa*	1	
39.	Black Sapote	*Diospyros digyna*	1	Mexico, Central America South to Columbia
40.	Calabash	*Crescentia cujete*	1	Tropical America, West Indies
41.	Camaite	*Chrysophyllum cainito*	1	Central America, West Indies
42.	Camu Camu	*Myrciaria dubia*	1	Peru, Brazil
43.	Canistel	*Pouteria campechiana*	1	Mexico to Brazil
44.	Carambola	*Averrhoa carambola*	1	Indonesia
45.	Chaitaigne	*Artocarpus altilis*	1	Polynesia
46.	Chalta	*Dillenia indica*	1	

	Crop	Genus	No. of acc'ns	Origin
47.	Chapotte		1	
48.	Cashew	*Anacardium occidentale*	1	Brazil, Mexico to Peru, West Indies
49.	Cashima		1	
50.	Chennette	*Melicoccus bijugatus*	1	Central America, Colombia, Venezuela, Suriname, Caribbean
51.	Chilli Plum	*Spondias purpurea*	1	Tropical America
52.	Chinese Tamarind	*Vaugueria edulis*	1	
53.	Custard Apple	*Annona reticulata*	1	West Indies, South America
54.	Date Palm	*Phoenix dactylifera*	1	Dessert oases of Africa
55.	Dunks	*Zizyphus mauritiana*	1	Africa, Asia
56.	Fat Pork	*Chrysobalanus icaco*	1	
57.	Guava	*Psidum guajava*	1	Mexico, Caribbean, Central and South America
58.	Govenor Plum	*Flacourtia indica*	1	
59.	Grumichama	*Eugenia brasiliensis*	1	Brazil
60.	Jaboticaba	*Myrciaria cauliflora*	1	Brazil
61.	Jackfruit	*Artocarpus heterophyllus*	1	India
62.	Jamaica Plum	*Spondias purpurea*	1	Tropical America
63.	Lue Gina Gong		1	
64.	Lychee	*Litchi chinensis*	1	China
65.	Mangosteen	*Garcinia mangostana*	1	Malaysia
66.	Mammey Apple	*Mamme americana*	1	Tropical America, West Indies
67.	Marbolo	*Diospyros blancoi*	1	
68.	Mini Mango		1	
69.	Miracle Fruit	*Synsepalum dulcificum*	1	West Africa
70.	Mustapha		1	
71.	Number 11		1	
72.	Paradise Nut	*Lecythis ollaria*	1	Guiana, Brazil
73.	Peewah	*Bactris gasipaes*	1	Tropical America
74.	Pennypiece	*Pouteria multiflora*	1	
75.	Pitomba	*Eugenia luschnathiana*	1	
76.	Pommecythere	*Spondias cytherea*	1	Polynesia
77.	Pommerac	*Syzgium malaccense*	2	Malaysia
78.	Poix Doux	*Inga laurina*	3	Central America, West Indies
79.	Pommerose	*Syzgium jambos*	1	
80.	Primrose	*Primula vulgaris*	1	Western and Southern Europe
81.	Rambajan		1	
82.	Rambutan	*Nephelium lappaceum*	1	Malaysia
83.	Sapo› La Round		1	
84.	Sapodilla	*Manilkara zapota*	2	Central America, Mexico
85.	Sha		1	
86.	Sour Cherry	*Phyllanthus acidus*	1	Madagascar, India
87.	Soursop	*Annona muricata*	1	From Brazil north to West Indies
88.	Sugar Apple	*Annona squamosa*	1	South America, West Indies

	Crop	Genus	No. of acc'ns	Origin
89.	Suriname Cherry	*Eugenia uniflora*	1	Brazil
90.	Tamarind	*Tamarindus indica*	2	Africa
91.	Tonka Bean	*Dipteryx odorata*	1	Northern South America (Guyana, Orinoco region)
92.	Vikun		1	
93.	Wompi Nut		1	
94.	WI Cherry	*Malpighia glabra*	1	West Indies, Northern South America
95.	Aloe	*Aloe vera*	1	Northern Africa
96.	Basil	*Ocimum* sp	1	India and other tropical regions of Asia
97.	Bay Leaf	*Pimenta racemosa*	5	West Indies (Windward Islands)
98.	Black Pepper	*Piper nigrum*	1	India
99.	Cake Bush		1	
100.	Cat's Claw	*Unicaria tomentosa*	1	
101.	Chive	*Allium schoenoprasum*	1	Europe, Asia, North America
102.	Cinnamon	*Cinnamon zeylanicum*	1	Sri Lanka, India
103.	Congolala	*Eclipta alla*	3	
104.	Curry Leaf	*Murraya koenigii*	1	India
105.	Datura	*Datura innoxia*	1	China
106.	Day ta Payee		3	
107.	Dill	*Anethum graveolens*	1	Eurasia
108.	Fennel	*Foeniculum vulgare*	1	Mediterranean (from Morocco and Portugal east to Pakistan
109.	Gully Root	*Petiveria alliacea*	1	
110.	Jigger Bush		1	
111.	Lemon Balm	*Melissa officinalis*	1	Southern Europe, Mediterranean
112.	Lemon Grass	*Cymbopogon citratus*	1	Malaysia, Sri Lanka
113.	Lucky Seed	*Thevetia nereifolia*	1	
114.	Malomay	*Euphorbia hirta*	1	
115.	Mint	*Mentha* sp	1	
116.	Noni	*Morindad* sp. *citrifolia*	2	
117.	Olive Bush	*Olea europaea*	1	Eastern Mediterranean
118.	Paan	*Piper betle*	1	Malaysia
119.	Plantea		1	
120.	Pomegranate	*Punica granatum*	1	Iran to the Himalayas in Northern India
121.	Rachet	*Opuntia* spp.	1	
122.	Rosemary	*Rosmarinus officinalis*	1	Mediterranean
123	Roucou	*Bixa orellana*	1	
124.	Tumeric	*Curcuma longa*	1	India
125.	Sage	*Salvia officinalis*	1	Mediterranean
126.	Shadow Beni	*Eryngium foetidum*	1	Mexico, South America
127.	Shallot	*Allium ascalonicum*	1	West Africa
128.	Shandilay	*Leonotis nepetifolia*	1	Africa, Southern India
129.	St. John›s Bush	*Justicia secunda*	1	

	Crop	Genus	No. of acc'ns	Origin
130.	Tref	*Aristolochia trilobata*	1	
131.	Thyme	*Thymus* sp	1	Europe, North Africa, Asia
132.	Vervain	*Verbena officinalis*	3	From Canada south to Southern Chile
133.	Vicks		1	
134.	Wonder of the World	*Bryophyllum pinnatum*	1	
135.	Worm Grass	*Speigelia marilandica*	1	
136.	Zebapique	*Neurolaena lobata*	1	