Root Crops Production and Research in the Caribbean

Proceedings of a Regional Workshop held in Guadeloupe, 9-10 July, 1985

Centro Internacional de la Papa (CIP)
International Institute of Tropical Agriculture (IITA)
United Nations Economic Commission for Latin America and the Caribbean (UNECLAC)
Centro Internacional de Agricultura Tropical (CIAT)

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CIAT Centro Internacional de Agricultura Tropical

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Contents

The Cultivation of Root and Tuber Crops in the Caribbean Countries: Report on the 1985 Workshop of the Caribbean Collaborative Agricultural Research Network

*Theodore U. Ferguson**

Introduction

The workshop was attended by representatives from the Bahamas, Barbados, Belize, Dominica, the Dominican Republic, Grenada, Guadeloupe, Martinique, Guyana, Haiti, Montserrat, St. Kitts-Nevis, St. Vincent and the Grenadines, Trinidad and Tobago, the Netherlands Antilles, and the United States Virgin Islands. Two regional research organizations: the Caribbean Agricultural Research and Development Institute (CARDI) and the University of the West Indies (UWI) were also represented. Representatives were present from the sponsoring institutions: Centro Internacional de Agricultura Tropical (CIAT), Centro Internacional de la Papa (CIP), International Institute of Tropical Agriculture (IITA), and the United Nations Economic Commission for Latin America and the Caribbean (UNECLAC). Other institutions represented at the Workshop were the Caribbean Community (CARICOM) Secretariat, Food and Agriculture Organization of the United Nations (FAO), Canadian International Development Research Centre (IDRC), European Economic Community (EEC), and Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) (see Directory).

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Background

At the meeting of directors of agricultural research of the Caribbean Development and Cooperative Committee (CDCC) countries held in Jamaica in December 1984, it was agreed that a Caribbean Cooperative Agricultural Research Network be established. The directors further agreed that root crops be selected as one of the commodity groups to be included in the proposal for the Caribbean Cooperative Agricultural Research Network.

The directors of agricultural research requested the cooperation and assistance of the three international agricultural research centers involved in root crop research (CIAT, CIP, and IITA) in the development of this commodity network. The international centers agreed and sponsored the workshop in association with UNECLAC.

Objectives

The major objectives of the workshop were:

The identification and definition of common regional problems limiting the further development of root crops in the region;

Evaluation of the potential for further development of root crops in the Caribbean region; and

The development of a program for regional network activities including research exchange, training, and technology transfer.

Organization of the Workshop

CIAT organized the workshop on behalf of the other sponsoring institutions. Dr. Theodore Ferguson served as consultant to the workshop, advised on the preparation of country papers, and prepared a regional background paper. UNECLAC assisted in the funding of some country representatives. Local arrangements in Guadeloupe were made with the Institut National de Recherches Agronomiques (INRA).

Workshop Activities

The opening session of the workshop was addressed by Dr. Lucien Degras, representative of INRA, who welcomed the participants to Guadeloupe. Dr. James Cock spoke on behalf of the three sponsoring international centers—CIAT, CIP, and IITA—and outlined the objectives of the

workshop. He indicated the commitment of the centers in assisting with the development of root crops in the Caribbean. He also thanked Dr. Degras and INRA for holding the workshop in Guadeloupe and for the excellent local arrangements. Dr. Carle Walter, in his capacity as representative of UNECLAC, reviewed the development of the Caribbean Cooperative Agricultural Research Network and helped place in perspective the objectives of the workshop.

Following the opening session country reports were presented by all participating countries except the Netherlands Antilles. On the second day of the workshop CARDI and the UWI presented reports on their research and training activities in tropical root crops. The consultant then presented a summary paper which gave a comparative analysis of national root crop production and research needs of the Caribbean.

The workshop generated much discussion among workshop participants and led to the identification of many areas of common needs in research, training and information exchange. Country representatives were asked to indicate their countries' interest in a list of possible project activities. Their responses are given in Table 1 and indicate that a majority of countries were interested in project activities involving cultivar evaluation, improved postharvest systems, yam propagation, and training. The general meeting was, however, unable to arrive at an acceptable summary position and agreed to appoint a committee to develop more fully the ideas discussed into broad work-areas for possible network activities. The committee consisted of representatives from: Barbados; Dominica; Guyana; St. Vincent and the Grenadines; the Caribbean Community (CARICOM) Secretariat; UNECLAC; and the workshop consultant.

The committee met on 10 July 1985, and agreed to the following work areas:

Improving the marketability of root crops by introducing and/or developing cultivars with improved storage and handling characteristics, improving storage handling and packaging techniques, and developing processed products;

Improving the propagation and production technologies for root crops and, in particular, for yams and potato;

Reducing the incidence of pests and diseases of root crops;

Training research scientists and production personnel;

Increasing the exchange of information on root crops between participating countries; and

Holding workshops and exchanging scientists.

The project activities identified by the workshop will be developed by the consultant into a proposal for the establishment of a regional network on tropical root crops. This proposal will be presented to the sponsoring institutions for their consideration.

Table 1. **Countries' interest in specific project activities.**

Proposed project activity	Countries indicating interest (no.)
Collection and maintenance of elite germplasm	4
Development of improved systems of yam *(Dioscorea* spp.) propagation	7
Seed potato production	4
Yam cultivar evaluation	10
Sweet potato *(Ipomoea batatas)* cultivar evaluation	10
Cassava *(Manihot* spp.) cultivar evaluation	8
Potato *(Solanum tuberosum)* germplasm evaluation	6
Control of sweet potato borer *(Euscepes postfasciatus)*	2
Control of sweet potato weevil *(Cylas formicarius)*	6
Control of nematodes *(Meloidogyne* spp.) in yams	6
Control of anthracnose *(Glomerella cingulata)* in yams	6
Studies on the characterization and control of yam viruses	2
Control of tannia burning disease	3
Integrated pest and disease control in potato	5
The development of improved cultural methods for root crop production	8
Evaluation of storage methods of root crops	6
Handling and packaging techniques for root crops	7
Root crop processing	9
Training of research scientists	9
Training of production personnel	9
Information dissemination and exchange	5

Spanish Summary

Reunión de Trabajo sobre Producción e Investigación de Cultivos de Raíces en el Caribe

Representantes de dieciseis países y dependencias de la región del Caribe

asistieron a una reunión de trabajo en Guadalupe los días 9 y 10 de Julio de 1985. También estuvieron presentes representantes de dos organizaciones de investigación regionales, de otros institutos y de las instituciones que patrocinaron el evento, a saber, CIAT, CIP, IITA y UNECLAC.

Esta reunión se organizó a raíz de otra reunión llevada a cabo en Jamaica, En Diciembre de 1984, en la cual los directores de investigación agrícola de los países del Caribbean Development and Cooperation Committee (CDCC) se pusieron de acuerdo en la necesidad de establecer una red colaborativa de investigación agrícola en el Caribe.

Los objetivos principales de esta reunión de trabajo consistieron en la definición de los problemas regionales para un futuro desarrollo de los cultivos de raíces en el Caribe; la evaluación del potencial de desarrollo de aquéllos; y el planteamiento de un programa para las actividades de la red regional que incluyen investigación, intercambio, capacitación y transferencia de tecnología.

Root and Tuber Crops in the Bahamas

*Leon S. Smith, Ghaly Swann, and Kenneth Richardson**

Introduction

Tropical root and tuber crops have always played an important role in the Bahamian diet although maize has traditionally been the main carbohydrate source. A change in eating patterns over the years has resulted in a decreased consumption of tropical root crops as Bahamians use more rice, pasta, wheat flour, and white potato (*Solanum tuberosum*) for their carbohydrate sources.

A national effort to cut the food import bill, pegged at Bah$150[1] million per annum, has led to the initiation of programs to stimulate the local agricultural economy. The government has set goals for self-sufficiency in basic food crops that can be grown economically. Certain priorities have been established. One of the major government objectives in its agricultural development plan is to "direct our research efforts towards improving production of grain legumes, and root and tuber crops."

Socioeconomic Patterns

Most Bahamian farmers have received primary school education. Recently, there have been more professional people becoming involved with food production as a second career. In addition, many of the farmers are equipped with other vocational skills such as construction and mechanics. Moreover, special skills were acquired by a few of the farmers by working on large farms in the United States on contract. The more successful farmers earn from Bah$10,000 to Bah$50,000 per annum. Under the existing methods of practiced cultivation, farmers can earn approximately Bah$5000/ha.

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1. Exchange rate: Bah$1.00 = US$1.00 (1984).

Root and Tuber Crop Production and Constraints

Cassava (*Manihot esculenta*) and sweet potato (*Ipomoea batatas*) are the most popular of all root crops cultivated, but land areas for any given crop rarely exceed 0.4 hectares. Cassava is usually found growing in association with pigeon pea while sweet potato is usually grown in monoculture. Of the aroids the *Xanthosoma* spp., locally referred to as eddoe **[sic]**, are the most widely cultivated. The *Colocasia* spp. are not popular with Bahamians. One of the limiting factors in the production of good quality root crops is the lack of consideration given by the farmers to the crops' nutritional and phytosanitary needs. Root crops are, for the most part, planted on marginal lands but even when planted on more organized plots they are still left unattended. Many farmers consider it a waste of funds to invest in these crops. Root crops tie up valuable land for long periods when compared to vegetable crops such as tomatoes, cabbage, and sweet peppers.

In cropping systems where roots and tubers are important components intercropping and multiple cropping systems are generally practiced. Sweet potato is usually grown in monoculture because of its viny nature.

The most important areas of production for root and tuber crops are the southeastern Bahama islands. Among them there are some 28.8 ha planted with root and tuber crops. The island of Eleuthera is located east of the centrally located capital, New Providence, and accounts for a significant proportion of root and tubers produced.

In the southeastern islands, where fertile black and red loamy soils have developed and most of the 'pothole' farming is done, root and tuber crops have been productive. However, no research has been conducted on these islands for documentation. On the more northern pine islands unfertilized cassava, for example, shows little growth indicating the very low level of fertility of newly-cleared land. Six cultivars of high-yielding cassava were introduced from the Centro Internacional de Agricultura Tropical (CIAT) in Colombia and tested under Bahamian soil and climatic conditions. Results of the trials are shown in Table 1.

The islands of Exuma and Andros account for 97.9% of all white potato; Eleuthera, Cat Island, and North Andros account for 85.3% of sweet potato grown; and Eleuthera, Long Island, and New Providence are responsible for 92.8% of the cassava produced.

The northern pine islands of the Bahamas, being flat and of softer rock material with large reserves of fresh water, are suitable for mechanical

Table 1. **Yields of six cassava cultivars introduced from Colombia and tested under Bahamian conditions.**

Cultivar	Plant type	Edible roots (avg. no. per plant)	Type	Root yield based on small plot trial (t ha)
M Mex 59	Large	12.0	Sweet	34.3
M Col 638	Medium	8.0	Sweet	11.3
M Col 1684	Small	7.6	Bitter	20.7
M Ven 218	Small	10.6	Sweet	20.9
SMI 150	Large	8.3	Sweet	27.2
M Col 1468	Large	7.8	Sweet	24.3

preparation. Therefore, these islands hold the greatest potential for agricultural growth. There are some 96,319 ha of arable land that can be used to expand agricultural production.

The average farm size ranges from 0.8 to 2.0 ha. There are approximately 4446 farm holdings (1978 Census of Agriculture). There are no reliable data, however, on the number of farms producing roots and tubers.

Mixed farming is widely practiced among crop and livestock farmers. It is common to find farms where the main emphasis is on growing fruit tree crops, corn and pulses, viny vegetables, roots and tubers, and winter vegetable production. In addition, there are some farms actively engaged in both crop and livestock farming covering a wide range of agricultural products.

Statistics for 1984 from the principal marketing outlet—the Government Produce Exchange—show that some 171 tons (t) of root and tuber crops were produced locally. This figure represents approximately 70% of the total production. Tables 2 and 3 show the approximate volume of production and percent distribution of local production.

The following factors constraining the expansion of production are:

Crop competition—because cash returns from vegetable crops are so much quicker, farmers tend to use their limited land for vegetables;

Available markets—until recently the fresh market was the only market for tuber crops. However, recent efforts by the Department of Agriculture in the areas of promotion, animal feeds research, and food processing have considerably increased the available markets for roots and tubers;

Table 2. **Total quantity (kg) and value (Bah$)[a] of root and tuber crops purchased by the Government Produce Exchange, Bahamas, 1982-1984.**

Crop	1982		1983		1984	
	Quantity	Value	Quantity	Value	Quantity	Value
Cassava	10,009	2,207	12,896	2,275	28,624	5,048
Sweet potato	79,307	40,130	102,178	45,947	66,752	27,961
Yams (white)	2,722	1,200	3,940	1,737	1,565	862
Eddoe	6,713	2,960	19,981	6,608	16,658	5,508
White potato	—[b]	—	13,812	7,308	58,106	35,868

a. Exchange rate: Bah$1.00 = US$1.00 (1984).
b. No data available.

Table 3. **Regional distribution of local root crop production in the Bahamas, 1984.**

Island	Total crop production (%)				
	Cassava	Sweet potato	White yams	Eddoe	White potato
Eleuthera	60.0	60.3	55.0	65.0	0.7
Long Island	13.6	1.3	5.0	3.0	0
Abaco	0.6	6.4	10.0	10.0	0
Cat Island	0.5	11.7	6.0	6.0	0
North Andros	5.3	13.3	2.0	5.0	58.3
New Providence	19.8	2.0	12.0	6.0	1.4
Exuma	0.2	5.0	10.0	5.0	39.6

Land and water are very limited resources and make the production of root and tuber crops expensive;

Available data that would help overcome some of the production expansion constraints are lacking;

Consumer preference—Bahamians have shown a preference for rice, white potato, and wheat flour as their main carbohydrate sources. In addition, there is a lack of acceptable processed products from roots and tubers;

Crop duration—some root crops, for example, cassava, occupy the land too long, making the crop a hurricane risk. Consequently, many farmers are reluctant to tie up their limited areas with a long-standing root crop such as cassava;

The stony nature of Bahamian soils limits root and tuber crop production; and

A lack of contract-production programs.

There are no large-scale commercial producers of roots and tubers and technological development is very limited. The costs of production for cassava, eddoe, and yams are highly variable.

Costs of production for sweet and white potato are presented in Tables 4 and 5 and were budgeted under the assumption that a machinery pool would be available from which farmers could rent equipment. Equipment costs were calculated high enough to ensure the machinery pool a profitable operation on the rocky soils of the pine islands.

Total production of root and tuber crops accounts for Bah$109,160 or 0.32% of the total value of the national agricultural production.

Table 4. **Estimated sweet potato production costs, (Bah$/ha)[a] Bahamas.**

Item of cost	Unit price (Bah$)	Value (Bah$)
Growing costs		
Seed (1788 kg)	0.43	769
Fertilizer (807 kg)	0.29	231
Spray and dust		3
Family labor (203 hr)	2.00	406
Machine hire		116
Owned machinery		310
Interest on investment		59
Land rent (1 ha)	51.00	51
Miscellaneous		15
Total growing costs		1960
Harvesting and marketing costs		
Picking (71 hr)	1.75	124
Owned machinery		109
Containers (381)	0.50	190
Hauling		57
Total harvesting and marketing costs		480
Total production costs		2440

a. Exchange rate: Bah$1.00 = US$1.00 (1984).

Table 5. **Estimated white potato production costs (Bah$/ha)[a], Bahamas.**

Item of cost	Unit price (Bah$)	Value (Bah$)
Growing costs		
Seed (2134 kg)	0.34	734
Fertilizer		264
Spray and dust		165
Family labor (203 hr)	2.00	406
Machine hire		135
Owned machinery		731
Interest on investment		69
Land rent (1 ha)	51.00	51
Miscellaneous		25
Total growing costs		2580
Harvesting and marketing costs		
Picking (91 hr)	1.75	160
Owned machinery		109
Containers (508)	0.50	254
Hauling		76
Total harvesting and marketing costs		599
Total production costs		3179

a. Exchange rate Bah$1.00 = US$1.00 (1984)

Marketing and Constraints on Domestic Demand

At the community level root crops are generally prepared as a fresh vegetable or used in soups, cakes, and pastries. Cassava and sweet potato are the two most important root crops produced. At one time it was common practice for housewives to grate and squeeze out the starch from cassava and then boil the liquid which was then used to stiffen laundered clothing before pressing. At the industrial level root crops are dried, chipped, or crushed to a powdered form in order to be evaluated for their potential as animal feeds and for human consumption.

Currently a market exists for cassava in the animal feed industry. A market also exists for good quality sweet potato for local human consumption. Approximately 70% of the products reach the local market. The remaining 30% is sold in local farming communities, fed to animals in confinement, or distributed by other means. See Table 6 for estimates of supply for years 1982 to 1984.

Table 6. **Quantity of supply (kg) and value (Bah$)[a] of root crops, Bahamas, 1982-1984.**

Crop	1982		1983		1984	
	Quantity	Value	Quantity	Value	Quantity	Value
Cassava	14,298	3,152	18,423	3,249	40,892	7,212
Sweet potato	113,063	57,329	165,408	65,639	95,360	39,344
White yams	3,888	1,714	5,628	2,233	2,236	1,232
Eddoe	9,590	4,228	28,545	9,440	23,798	7,869
White potato	--	—	19,732	10,440	83,009	51,240

a. Exchange rate: Bah$1.00 = US$1.00 (1984).

Table 7 shows the local wholesale buying and selling prices by the Government Produce Exchange. The wholesale buying price for yams is Bah$0.13/kg, with a retail price of Bah$0.38/kg. However, local street-vendors usually retail cassava and sweet potato for Bah$1.90/kg, while yams retail for Bah$2.54/kg.

The primary marketing center is New Providence which is centrally located among the Bahama Islands. Although there are three main types of transport (air, road, and sea), practically all of the agricultural produce destined for the local markets are shipped by sea.

The distances of the major producing islands from New Providence are: North Andros, 72 km; Marsh Harbour, Abaco, 174 km; Smith's Bay, Cat Island, 209 km; George Town, Exuma, 278 km; and Deadman's Cay, Long Island, 335 km.

Table 7. **Wholesale buying and selling prices (Bah$/kg)[a] at the Government Produce Exchange, Bahamas, 1985.**

Crop	Buying price	Selling price
Cassava	0.20	0.25
Sweet potato	0.51	0.61
Yams	0.13	0.38
Eddoe	0.38	0.51
White potato	0.61	0.71

a. Exchange rate: Bah$1.00 = US$1.00 (1984).

Table 8 presents data on the demand and value of root and tuber crops. With the exception of cassava, root crops such as sweet potato, yams, eddoe, and white potato are generally used as fresh food. In 1985 approximately 1988 t of these crops were produced and valued at Bah$1,443,195. In the case of cassava, some 41 t enter the market as a fresh food. Most of the available cassava is used as raw material for animal feed. Consumption patterns of certain ethnic groups who have migrated from other Caribbean countries resulted in an increase in demand for roots and tubers as fresh food.

The animal feeds industry, at its present stage of development, has the potential to use approximately 3266 t of processed cassava per annum. This transformed product can either be in the form of chips or pellets, assuming that 60% of the feed is cassava starch. With the development of the government's Food Technology Division and the promotion of locally-produced processed foodstuffs, the demand for transformed products such as sweet-potato flour and pastry filling is growing. Statistical information is being evaluated to obtain a fairly accurate account of the demand for sweet potato as a transformed product.

Root and tuber crop quality is generally not graded for human or animal consumption. However, there is a preference for imported cassava which is more uniform in diameter, size, and length.

Some of the more important constraints on domestic demand include:

A lack of improved postharvest technology;

A preference for cereal grain over roots and tubers by the Bahamian consumers;

Table 8. **Demand of root and tuber crops in the Bahamas, 1984.**

Crop	Quantity demand (t)	Value (Bah$)[a]
Cassava	152	104,892
Sweet potato	820	742,606
White yams	137	149,432
Eddoe	42	23,661
White potato	990	527,496

a. Exchange rate: Bah$1.00 = US$1.00 (1984).

A low developmental rate of acceptable processed root and tuber crop products; and

A deficiency in infrastructural facilities for the efficient development of the root and tuber crop industry.

There is no external demand for roots and tubers as fresh food or as transformed products. However, since cassava is a high-energy root crop and can be grown economically in the Bahamas the potential exists for cassava to be grown and exported for fuel production. One of the constraints for external demand would be quality because roots and tubers are frequently misshapen by the stony Bahamian soils.

The Statistics and Planning Division of the Department of Agriculture supplies a relatively accurate data base for root and tuber crop supply based on the marketing statistics provided by the Government Produce Exchange. In addition, the Department of Statistics of the Ministry of Finance supplies statistical information on total demand.

Government Policies

In 1974 the government of the Bahamas set out a national policy of self-sufficiency in basic food crops. Its production objectives were directed toward increased production of food staples, meat and dairy products, processed foods, and animal feeds. The Department of Agriculture is actively promoting the development of root and tuber crops to increase the potential for agroindustrial development.

Government policy is to allow energy-rich agricultural products to be imported either as a raw material or blended as a compound feed. Cassava has tremendous potential as a high-energy-yielding crop per unit of land. There is the possibility of growing cassava locally to substitute a portion of the imported corn.

One of the Department of Agriculture's major objectives is to use agricultural development to create employment opportunities. Therefore, the possible direction of government policy may be to further restrict the importation of certain root crops, become more instrumental in training and establishing young adults in various agricultural production enterprises, continue to provide price incentives and other support programs such as land clearing and land tenure programs, and to stimulate infrastructural development which, in turn, can encourage contract-production schemes.

Domestic subsidies provided by government to consumers are indirect. The establishment of packing houses eliminated the need for farmers to ship produce to the Government Produce Exchange on the capital island. The government pays haulage for sea transport. This shipping cost is not passed on to the consumer which is advantageous to both the retailer and consuming public. Root and tuber crops are presently not exported from the Bahamas. The current taxes levied on the importation of these crops are: sweet potato, Bah$30.48/100 kg and white potato, Bah$15.25/100 kg.

Since the national policy has been set, with major emphasis on staples (corn, cassava, sweet potato, and white potato), production incentives have also been put into effect.

One of the major production incentives is the land clearing and land tenure program which provides funding for farmers having legal access to agricultural land and who have satisfied other technical considerations. The government finances 50% of the land-clearing cost up to a total of 10 ha. Under the land tenure program government intervention has guaranteed the access to good agricultural land to those farmers who had previously lacked access. The 'lease-hold' system, established under the tenure program, had the following advantages:

It relieved farmers of land purchase responsibilities;

It gave the government control in ensuring that the lands were used effectively; and

It prevented the purchase of agricultural land for speculative purposes.

Further, the Department of Agriculture, through the Fish and Farm Supply Store, extends credit at a maximum of Bah$262/ha to certified Bahamian farmers. In an effort to promote agricultural development, subsidies were provided in the form of duty-free imports on all trucks, machinery, and equipment. Price incentives are also an important aspect of government subsidy efforts.

Research, Training, and Development

The major effort in root and tuber crop research is germplasm collection with emphasis on high yields, disease resistance, fertilizer responsiveness, early maturation, storability, and enhanced nutritional quality. The Department of Agriculture is also committed to training. At present, an officer is training in root and tuber crop production in Ibadan, Nigeria.

The Department of Agriculture has two research institutions which deal with root and tuber crops as part of the overall agronomic research program. The first institution, the Central Agricultural Station, was established in 1967. Its task is to conduct basic, but broad-ranged research on fruits, vegetables, small ruminants, and pigs, and establish and maintain improved pastures.

The second center is the Bahamas Agricultural Research Centre which was established on the largest Bahamian island, Andros. This project was established through the joint efforts of the United States and the Bahamian governments.

The major objectives of the project are:

To establish a 226 ha research station with special emphasis on beef feasibility studies;

To train Bahamian personnel at university, technical, and other levels;

To establish 16 pilot test-farms on approximately 680 ha of land;

To establish a multipurpose cooperative; and

To establish an agricultural credit fund.

One professional staff member is assigned to root crops research on a full-time basis and three work on root crops on a part-time basis. There are no specific training courses in roots and tubers at the country level.

Government funding of research on roots and tubers versus grain and legumes has been unbiased. The markets are available and the intention of the government is to demonstrate the profitability of tubers as well as other food staples in the agroindustrial environment.

Although not specifically designed for the increased production of root and tuber crops, the Pilot Animal Feed Mill and the Food Technology Units demand an increase in production. The Animal Feeds Programme of the Department of Agriculture has been designed to provide a definitive answer to the feasibility of locally producing compound feeds. Consequently, the capability of providing rations for animals with some local raw material input (roots and tubers) from farmers is considered a major step forward for this program. The Food Technology Unit is expected to provide an expanded economic feasibility profile on certain roots and tubers. Two unit objectives are to broaden the local marketing base and to increase the potential for increased production of certain roots and tubers in the Bahamas.

Quarantine Regulations

In the Bahamas the minister responsible for agriculture is the competent authority for the administration and enforcement of the Plant Protection Act and Quarantine Regulations Act, 1983. The Director of Agriculture, appointed by the Minister of Agriculture, acts as an agent in the efficient administration of duties listed under the Import Control Regulations, 1983. No person is allowed to import any plant, fresh fruit, fresh or processed meat, or poultry into the Bahamas except under, and in accordance with, a licence issued by the competent authority under these regulations. The Bahamas Customs Department, which falls under the Ministry of Finance, has controllers at the major ports of entry for regulating the Plant Protection Act and Quarantine Regulations Act of 1983. Also, in exercise of the 'powers conferred' upon agricultural officers under the direction of the Director of Agriculture, officers are called upon to enforce the Plant Protection Act and Quarantine Regulations Act.

Spanish Summary

Cultivos de Raíces y Tubérculos en las Bahamas

Se analizan la oferta, la disponibilidad y las características de la tierra sembrada, los sistemas de cultivo, los rendimientos, el perfil socioeconómico de los productores, el volumen, costos y limitaciones de la producción, y el mercadeo de los productos de los cultivos de raíces y tubérculos en las Bahamas. También se discuten la demanda interna y externa de productos frescos y sus limitaciones. Finalmente se presentan las políticas gubernamentales relacionadas con la producción de cultivos de raíces y se indican las actividades de investigación, capacitación y desarrollo de aquéllos.

Root and Tuber Crops in Barbados

*Leslie Brereton**

Introduction

Barbados has an area of 430 km^2 and a population of 300,000 inhabitants. Farms may be classified as being either small (0.3 to 4.0 hectares) or large (4 to 243 ha). The average farm size is 116 ha. The average farmer is between 45 and 50 years old with a family of five. Farmers usually do not own the farms they cultivate but rather 'manage' them. Many of the farms are leased.

Root and Tuber Crop Production and Constraints

During the period 1970 to 1984 the production of root and tuber crops exhibited a fluctuating but generally downward trend. In fact, the production of yams (*Dioscorea* spp.) decreased from 15,400 tons (t) in 1970 to 4500 t in 1983, while sweet potato (*Ipomoea batatas*) production moved from 5700 t to 4300 t over the same period (Table 1). The production of eddoe (*Colocasia esculenta*) and cassava (*Manihot esculenta*) remained stable at 244 and 119 t respectively during these years.

Contributing factors to this erratic downward trend in production are:

The fall in demand for root crops;

A rainfall pattern change in the country;

Unfavorable farmgate prices and poor storage conditions;

Disease and pest conditions especially with yams and sweet potato; and

Decreasing allocation of land under sugar cane production.

Root and tuber crops can be grown in every parish of the country. In

* Ministry of Agriculture, Food and Consumer Affairs, Greame Hall, Barbados.

Table 1. **Estimated sweet potato and yam production (t), Barbados, 1970-1983.**

Year	Sweet potato	Yams
1970	5,693	15,420
1971	6,761	14,349
1972	7,644	12,043
1973	4,178	7,766
1974	2,041	5,102
1975	4,444	6,609
1976	2,873	5,782
1977	4,989	5,896
1978	4,989	6,851
1979	2,219	5,909
1980	4,631	7,700
1981	3,000	4,000
1982	3,700	4,300
1983	4,300	4,500

Scotland District these crops are produced on a marginal scale. For example, the area of sweet potato planted in 1983 was about 166 ha. This area increased to 215 ha in 1984. No data are available for cassava and eddoe although it is estimated that there is an annual production of 60 and 122 t respectively. They are produced exclusively for local consumption. Cassava is being considered as a possible source of animal feed and a research program in this area is being prepared. No commercial production of white potato occurred during the 1982 to 1984 period.

Declining incomes from the main crop, sugar cane, will result in less land being allocated to this crop and more land becoming available for other agricultural production. It is unlikely that the land made available will be placed under root and tuber crop production because emphasis is being given to those crops with a greater potential for export such as sweet pepper and okra. The potential area for the production of root and tuber crops was 540 ha in 1984. Reasons for this small area are the subdivision of some plantations for housing developments and general emphasis by farmers on the production of more vegetable crops. Most plantations and some small farms are still engaged in the planting of root and tuber crops and in 1984 a total of 79 plantations planted these crops.

Root and tuber crops are usually intercropped with sugar cane. In addition, enterprises such as poultry and other livestock (including

racehorse rearing) can be found on some farms. In some instances farms have moved away completely from planting sugar cane to the planting of vegetable crops.

Since root and tuber crops are intercropped with sugar cane, farmers do not hire labor exclusively for the production of these crops. However, at the time of planting a farm would utilize about ten persons per hectare per day. Since yams and sweet potato are cover crops not much labor is needed for weed control. Systems of mechanized harvesting and spraying for crop pest control are utilized. Little attention had been given to crop fertilizers but more recently the need for fertilizing has been stressed and farmers are now applying fertilizers mechanically.

During the period 1979 to 1983 the average yield of sweet potato was 13 t/ha. During the same period the average yield of yams was 18 t/ha. The data for eddoe and cassava were not available at the time of writing. Table 2 gives the estimated production from 1981 to 1983 and estimated area harvested.

Table 2. **Summary statistics on sweet potato and yam production, Barbados, 1981-1983.**

	Sweet potato			Yams		
	1981	1982	1983	1981	1982	1983
Estimated production (t)	3 ,000	3,700	4,300	4,000	4,300	4,500
Area harvested (ha)	223	285	330	221	250	250
Exports						
Value[a] (FOB)	26,509	70,780	899,711	675,800	124,537	747,765
Quantities (t)	46	35	796	623	116	541
Imports						
Quantity (kg)	—	409	—	367	—	—
Value[a] (CIF)	—	245	—	572	—	—

a. Exchange rate. Bds$1.00 = US$0.50 (1981).

There are numerous cultivars of sweet potato available in Barbados. Some recommended ones are CL04, 426/71, 02/59/94, A26/86, and C26/100. For the past ten years several cultivars of yams were screened for various characteristics which would have made them suitable for commercial exploitation. However, only three cultivars are grown on a large

scale for such purpose. They are Crop Lisbon, Oriental, and Horn Yam. A similar situation exists with cassava where a screening trial is now being conducted. Some of the cultivars are Bank Bank, T1674, Vo6/72, CMC 40, Butter Stick, MMex 55, and S673.

An important constraint in the expansion of root and tuber crop production is the limited experience in the area of export marketing. Despite many years of exporting root crops to extraregional markets the mechanism and structure of the market remain undeveloped and inexperience in export marketing persists.

Competition from imported substitutes also constrains production. Barbadians have shown a very strong preference for imported root crops, notably white potato. The absence of recipes based on nutrition programs utilizing locally produced root crops has further worsened the situation. In fact, the consumption of imported root crops has continued to rise at the cost of domestic counterparts.

Although no root crop processing is carried out several potential opportunities have been identified, among which are animal feed production, composite flour, and dehydration in the production of fast foods. In addition, storage facilities are poor and need further investment although the lack of demand has hindered progress in this area.

The recent project by the Caribbean Agricultural Research and Development Institute (CARDI), making improved planting material available to producers, has improved yam production. However, in sweet potato, insects attack tubers making them unfit for consumption. The pest of major importance is the sweet potato borer *Euscepes postfasciatus*.

Although the system of intercropping root crops with sugar cane will remain the dominant production system for root crops for some years to come, this system carries the disadvantage of a high labor requirement, especially at harvest, and the accompanying costs.

Marketing and Constraints

Wholesale prices of root and tuber crops for the past three years have shown little change (Table 3) and, in fact, are the same as farmgate prices, specially in those cases where farmers sell their produce directly to the retailer.

All of the root and tuber crops produced are absorbed by the fresh market. In the mid-1970's there was a pilot plant operation for the production of 'instant yams' . This plant is no longer functioning but new

Table 3. Average wholesale price (Bds$/kg)[a] for root and tuber crops, Barbados, 1982-1984.

Crop	Wholesale price			Difference (%)	
	1982	1983	1984	1982-1984	1983-1984
Cassava	1.91	1.21			
Eddoe	1.61	1.54	175	+ 8.7	+13.6
Sweet potato	0.52	0.73	0.88	+69.0	+20.5
Yams	1.19	0.95	1.27	+ 6.7	+33.7

a. Bds$1 = US$0.50 (1981).

interest in such a plant is developing. One of the factors for the plant's closure was poor acceptability of the product. Another factor was the unavailability of expertise to diversify the plant production into the processing of other products. In addition, the pilot plant was not suited for commercial production.

Cassava is now being processed for animal feed on an experimental basis. This pilot scheme has good potential but could be hindered by the unwillingness of farmers to plant cassava for such purposes because of the anticipated low price at which the dried chips may have to be sold.

The establishment of a plant for processing yams, sweet potato, white potato, and cassava is being considered. At present all of the root and tuber crops consumed locally are utilized as fresh foods. Some fast-food outlets import small amounts of white-potato chips.

Statistics are not available on the amount of root and tuber crops consumed on farms but from interviews with farmers it appears that farms retain only a provisional amount that any consumer would buy to feed an average household of five or six. Those farmers that keep pigs and other livestock usually supplement purchased feed with those provisions that are not marketable.

The demand for root and tuber crops fluctuates from year to year. This was particularly significant during the period 1981 to 1982. In 1981 the total demand for sweet potato was 2954 t. There were no imports during this period. In 1982 the demand rose to 3665 t with imports estimated at 409 kg. The trend for yams is similar with total demand in 1981 reaching 3377 t and imports for this period at 367 kg. In 1982 the total demand for yams stood at 4384 t with no imports during this period.

In considering the product quality in relation to domestic demand, local consumers prefer 'red skin' to 'white skin' cultivars of sweet potato. Another preference is sweet potato tubers free of perforations or

lacerations. Lacerations indicate possible sweet-potato weevil attack. There is a preference for Crop Lisbon yams to Oriental yams. For white potato there is a preference for the white skin to the red skin cultivars.

There are several health awareness programs being promoted within the Barbadian society such as the problems associated with obesity and hypertension. This awareness is reflected by the slow but visible changes in consumption patterns. The demand for locally grown vegetables is on the increase and many farmers are responding to this demand favorably. One of the main reasons for this quick response by farmers is that the income from sugar cane is on the decrease and farmers are looking for better alternatives.

White potato (*Solanum tuberosum*) is the root crop with the highest level of consumption. The consumption level stood at 31 kg per capita during 1983 while the total consumption of other crops during the same year reached 25 kg per capita. More importantly, however, is the significant lack of foreign exchange required for importing this root crop. Imports of white potato rose from 5385 t with a value of just over Bds$3 million[1] in 1976 to an import level of 9922 t valued at over Bds$5 million in 1981. However, the feasibility of producing white potato locally is being examined. There is no export demand for root crops as processed products. The reason given is that there have been no vigorous attempts to search for external markets. This can be justified by the fact that the processing of root crops is still in the experimental stages and no interest has been generated in foreign investment for root and tuber crop transformation.

Yams and sweet potato are only exported as a fresh food. Table 4

Table 4. **Yam and sweet potato exports, Barbados, 1976-1986.**

Year	Yams		Sweet potato	
	Quantity (t)	Value (Bds$)	Quantity (kg)	Value (Bds$)
1976	3,439	242,848	14,082	6,935
1977	4,427	311,530	52,721	34,885
1978	5,865	421,267	23	18
1979	10,495	654,148	76,350	64,328
1980	4,820	387,300	7,211	6,552
1981	6,230	675,800	45,649	26,509
1982	116	124,537	35,000	70,780
1983	541	747,765	796,000	899,711

1. Exchange rate: Bds$1.00 = US$0.50 (1981).

illustrates the exports of both root crops during the period 1976 to 1983. The export of yams and sweet potato within this same period appears to be just as changeable as their production, with sweet potato being more unstable than yams. Indeed, sweet potato exports moved from 52 t in 1977, to nil in 1978, and then rose again to 76 t in 1979 and 798 t in 1983. The major contributing factor to this situation is the limited experience available on exporting to external markets. In the case of yams, a relatively stable export trade enables projections to be made of future improvements. The export trade in yams had been constrained by a serious disease problem—internal brown spot—but through the assistance of CARDI it has been possible to produce improved planting material.

This planting material is now being reproduced under special conditions for farm distribution so that in the future the entire crop can be produced from such material. The advantage of this development is that a better quality product for both the domestic and export markets can be produced.

Over the past ten years there has been a favorable balance of trade in yams and sweet potato. There were no imports of yams and imports of sweet potato, mainly from St. Vincent, were marginal. At present there is no local production of white potato. Although there is a trade surplus in yams and sweet potato, the consumption of locally grown root crops decreased by approximately 70% between the period 1970 to 1983 moving from a level of 81.4 kg per capita to 25.4 kg per capita. In 1984 the export of sweet potato and yams as a fresh food was constrained by a restricted growing area of 215 ha which satisfied local needs only.

Government Policies

It is of great importance that a credible data base be kept for root and tuber crop statistics. Over the years the Planning Unit within the Ministry of Agriculture has prepared several documents (e.g., AGRINDEX and AGRISTAT) which give an in-depth analysis on the past, present, and future status of the crops in question. The Barbados Marketing Corporation also produces a monthly document ('BASIS') in which the various statistics and trends of root crop development in the Barbados are documented.

Over the period 1983 to 1988 there are some objectives that the root crop sector needs to achieve:

To reverse the downward trend in domestic production and consump-

tion of yams, sweet potato, and other root crops of lesser commercial importance;

To increase exports of yams and sweet potato to extraregional markets and enter those regional markets expressing a demand for root crops;

To reduce the consumption of imported substitutes such as white potato; and

To initiate a comprehensive root crop research program that includes processing and production practices.

One of the government's policies must be that of continual encouragement to rotate root crops and sugar cane as together they afford efficient land utilization and cost effectiveness. On the domestic level the government needs to make every effort to reduce competition being experienced by local producers from root crop substitutes. In addition, the government needs to initiate a nutrition program which will not only emphasize root crops as an inexpensive carbohydrate source but which will also suggest alternative methods in their preparation and utilization. This should increase production opportunities through increased consumption.

During the period 1970 to 1973 researchers examined white potato production for the possibility of commercial production. However, a feasibility study showed that it would not be economically viable to start such an industry in the Barbados. Renewed interest has been taken in this area again with the aim of screening different cultivars along with some of the old cultivars. To date the cultivars that show the most promise are Desiree, Kerrs Penk, and Maris Piper. Kerrs Penk and Maris Piper gave marketable yields of 30.7 and 20.6 t/ha respectively. These trials are being repeated with a view to commercial production, especially now that new technologies such as 'true seed' for propagation are available.

Initial research work has already been undertaken in the processing of root crops mainly in the form of yam flakes and potato chips and further possibilities are being identified with cassava. Processed cassava as a component of livestock feeds and as a means of storage is being further investigated. During the planned period ahead refinements of these projects will be made and further work undertaken to identify additional opportunities. The government in conjunction with the private sector will be seeking to commercialize some of these projects. Processing is expected to improve the possibilities for export while making the product available year-round on the domestic market. As a first step, the University of the West Indies (St. Augustine) has offered to provide assistance in the area of

processing and storage of yams. This project should be finalized and implemented within the planned period.

The planned period will be used not only to develop proper and effective structuring but also to develop root crop exporting experience. Consistent quantities of yams and sweet potato will be shipped annually while the Barbados Agricultural Society, Barbados Marketing Corporation, the Ministry of Agriculture, Food and Consumer Affairs, and other relevant bodies will form a committee to monitor and organize the areas of production and exports.

There are no tariffs on regional imports of root and tuber crops. However, as of 1 June 1985, tariffs on extraregional root crop imports were imposed. Yams, tannia (*Xanthosoma* spp.), dasheen (*Colocasia esculenta* var. *esculenta*), and eddoe are levied with a 30% tariff, while sweet potato is charged a 35% tariff rate. White potato has a set tariff of Bds$1.10/100kg.

Research, Training, and Development

The sweet potato weevil is a dangerous pest to this industry's development and can be found throughout the entire country. As much as 90% of a potato crop can be damaged by this weevil. The research work done in the area of effectively controlling this weevil has concentrated on the screening of several imported cultivars and the use of insecticides for control. The results so far indicate that more work is needed to develop effective control methods in order to eradicate the weevil.

CARDI researchers are currently developing tissue cultures for the propagation of yams—a relatively recent development in the Barbados to fight the internal brown spot disease found in yams. Results so far have indicated some degree of success. Virus-tested material is now being exported to some Caribbean Community (CARICOM) countries for propagation purposes. Researchers at CARDI are also looking into the possibility of processing cassava for animal feed. Researchers at the Ministry of Agriculture, however, are concerned with the screening of sweet potato, yams, and white potato cultivars. Other research work in this area is yam cultivars. The more recent ones are Belep and Kinobayo introduced from Guadeloupe.

The Ministry of Agriculture has three agronomists and three agricultural assistants assigned to the area of root crop research. CARDI has assigned one agronomist and two field assistants to the same area of research. The agronomists from the two agencies are B.Sc. graduates. Of the agricultural

and field assistants only one has a diploma from the Eastern Caribbean Institute of Agriculture and Forestry.

Current research emphasis is on the commercial production of white potato and the processing of cassava for animal feed. Approximately 60% of the research work is conducted on government-owned stations and 40% on privately-owned farms. Most of the work conducted on private holdings is developmental while work conducted on government farms is mainly experimental.

There are no local training courses in root and tuber crop production. However, at a regional level the Centro Internacional de Agricultura Tropical (CIAT) provides some short courses in this area. The Crop Science Department at the University of the West Indies has also been involved in the training of many persons in this area. The Centro Internacional de la Papa (CIP) in Peru and the International Agricultural Center (IAC) in Holland provide extraregional training in this area.

Quarantine Regulations

The quarantine regulations for all of the root and tuber crops produced in the region are the same. The material must be free from all soil and extraneous matter on entering the country. Crops must be free from insect pests and diseases and must be dipped into an insecticide-fungicide mixture or fumigated according to the stipulations on the import permit. The material must also be accompanied by a phytosanitary certificate from the country of origin and an import permit from the exporting country. These regulations are for the regional and extraregional countries. With extraregional countries, however, other specific conditions are imposed and must be specified on the phytosanitary certificate.

Spanish Summary

Cultivos de Raíces y Tubérculos en Barbados

Se discute y analiza la situación de los cultivos de raíces y tubérculos, especialmente malangay, yuca, ñame, batata y papa, en Barbados.

La producción y exportación de ñame y batata disminuyó durante el período comprendido entre 1970-1984; la producción de yuca y malangay,

que es sólo para consumo local, se ha mantenido constante. La papa, cuyo consumo es el más alto, debe importarse.

Para estos cultivos, se describen oferta y demanda, producción, limitaciones de su expansión y área disponible para ésta; características de fincas productoras y perfil socioeconómico de los productores, sistemas de cultivo, rendimiento y cultivares.

Se presentan datos de las exportaciones de ñame y batata entre 1976-1983, y los impuestos de importación para batata, ñame, yuca y malangay.

Finalmente se indican las medidas de cuarentena, el presente y futuro de la política gubernamental, la importancia de una base de datos confiable con estadísticas de los cultivos de raíces y tubérculos y la capacitación en investigación y desarrollo tecnológico de los cultivos ya mencionados.

Root and Tuber Crops in Belize

*S. Serano**

Introduction

Belize has a population of about 150,000 persons and a land area of 22,964 km^2. The main export crops are sugar, citrus, and to a lesser extent, bananas. The cultivation of root and tuber crops is primarily at the subsistence level although one producer recently established 16 hectares of root crops for export. This attempt regrettably failed due to improper marketing arrangements. The staple food crops in Belize include rice, beans, and corn.

Data on research, production, and demand of root crops in Belize are not available. However, an agricultural census sponsored by the government of Belize this year should provide data on root crop production levels in the near future. Within the short time given to prepare this paper, a few interviews were conducted with people involved in the production and marketing of root crops in Belize.

In 1983 the Department of Agriculture estimated that 87 ha of root crops were produced in Belize. In 1982 Belize imported approximately 1610 tons of potato (*Solanum* spp.) valued at $B2.85 million[1]. In 1983 importations rose to 1814 t with a value of $B 3 million (Ministry of Trade, 1982 and 1983).

Root crops are presently grown countrywide with the largest production area being located in the Cayo and Stann Creek Districts (Department of Agriculture, 1983). Both Cayo and Stann Creek are estimated to have approximately 40 ha each in production. Generally, land is available for root crop expansion.

* Department of Agriculture, Belize City, Belize.

1. Exchange rate: $B1.00 = US$0.50 (1983).

Farm Characteristics

In the Stann Creek District the average farm size is approximately 4 ha. In this district cropping systems include crop combinations of cassava and plantains, root crops and citrus, and root crops and coconut. In Toledo District root crops are grown mainly in the backyard garden, on small plots of less than 0.5 ha, and on some *milpas* (land dedicated to a system of shifting cultivation).

Socioeconomic Patterns

Most root crop producers are small farm operators who may be either single or married, young or old. The family size is estimated to be an average of five persons. While many of these farmers are parents of children attending secondary school, the parents themselves have only primary education. The author estimates that farmers involved in root crop cultivation earn less than $B5000 per year. Farms are operated by part-time and full-time farmers. In the Cayo District root crop production is handled by men and women. In the Stann Creek District cassava is grown mainly by women and the other root crops are grown by both men and women. Family members are the main source of labor.

Root and Tuber Crop Production and Constraints

There are no records of root crop yields available. However, the author estimates that yields are normally 7-13 t/ha for cocoyams, 25 t/ha for cassava, and 15 t/ha for yams. High labor requirements, little or no machinery input, little or no fertilizer, and few, if any, plant protection practices characterize root crop cultivation. In the Stann Creek District some labor-saving practices are spreading among small operators. These include the formation of ridges by mechanical land preparation prior to planting and the use of grating machines for the processing of fresh cassava root into starch or cassava wafers (locally known as cassava bread).

Interviews with farmers indicate that the major factor constraining production expansion is that root crops are being produced to satisfy local demand only. There is at present nothing organized for exploiting export markets. If export markets are to be exploited, it would be necessary to consider those factors which limit production such as seasonal variability, varying production costs, and poor product characteristics.

Marketing and Constraints

In the Cayo District about 90% of the root crops produced are sold in Belize City main market. In Stann Creek about 70% of the root crops produced are consumed at home and 20% are sold in the Punta Gorda market. Distances between markets and the most important production areas can be as much as 80 km.

The demand for root crops is far less than for other energy foods such as rice, corn, and wheat. The supply coincides with local demand. There appears to be no yearly price fluctuation except for slightly higher prices demanded by the early suppliers in any given season. Information on the effect of income and price changes on root crop demand is not available. However, in the Cayo District it is reported that the supply is halted when the retail price for cocoyam falls below $B0.22/kg.

The only production of cassava wafer is handled by two small processors in the Stann Creek District and is distributed for sale primarily in Dangriga and Belize City. Vendors transport limited amounts of this product on public transport to other districts. It is not known whether a sufficient demand exists to justify a greater amount of root crop supply. A more systematic distribution and improvements in packaging and advertising would probably lead to an increased demand for the product. However, the relatively small population and the few foods that cassava wafer can substitute are two factors that would inhibit increase in demand even if the previously mentioned recommendations for increasing demand are followed.

The major factor affecting product quality is the root crops' short storage life—this is particularly true for cassava—because of natural physiological processes, insect damage, and damage caused by machines used in production.

One source reported that there are markets for root crops in the United Kingdom and the United States. The primary constraints associated with external demand are:

Inability to immediately supply large quantities of quality produce;

Uncertainty of continuous supply; and

Noncompetitive prices (Table 1).

Table 1. **Average retail prices ($B1/kg)[a] for root crops, Belize.**

Commodity	Price
Yams	1.32
Cassava	0.66
Sweet potato	0.66
Yampie (*D. trifida*)	2.20
Cocoyam (tannia)	0.88

a. Exchange rate $B1.00 = US$0.50 (1983).

Recommendations

In order to achieve a large volume it is necessary to assure the producer that his product will be bought at a minimum set price. By doing so the farmer is encouraged to increase his production to satisfactory levels. To date there has not been a dealer who has been willing to take the risks involved and to offer a guaranteed minimum price.

In making the price competitive certain factors need to be quickly addressed. These are:

The upgrading of production methods and introduction of high-yielding cultivars well adapted to the arable soils of Belize;

The introduction of cultivars with low-disease susceptibility and suitability for mechanization; and

The reduction of transportation costs. One source reported that, up to about a year ago, when preliminary negotiations were made to market some root crops to the United States, the cost of transportation proved to be a major constraint in competing against the price of root crops in that country.

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Spanish Summary

Cultivos de Raíces y Tubérculos en Belice

El cultivo de raíces y tubérculos en Belize es principalmente a nivel de subsistencia y no hay datos disponibles sobre investigación, producción y demanda. Se presentan algunos datos sobre área cultivada, sistemas de cultivo y perfil socioeconómico de los agricultores. Finalmente se analizan y discuten el mercadeo de los cultivos de raíces y los factores que afectan la fluctuación de precios.

The Root and Tuber Crops Program at CARDI

*St. Clair Forde**

Introduction

The stated aim of the Caribbean Agricultural Research and Development Institute (CARDI) is "to contribute to agricultural development through the generation and dissemination of appropriate technology for the benefit of the Caribbean people." Given this goal and the objectives of the Regional Food and Nutrition Strategy, the Institute has formulated a root crop program that is responsive to the needs of its member countries.

To a large extent, the diet of the Caribbean population depends upon several carbohydrate-rich root crops. Through improved production systems, research on high-yielding cultivars, and preventative measures taken to reduce field and storage losses, the Caribbean population can be ensured of a secure and stable food base.

From its inception in 1975 CARDI has expanded its active root crop program. In the beginning the main crops in the program were cassava (*Manihot esculenta*), yams (*Dioscorea* spp.), sweet potato (*Ipomoea batatas*), and white potato (*Solanum tuberosum*) with emphasis being placed on cassava. Although work continues on these crops, the program has been expanded over the past two years to include tannia (*Xanthosoma sagittifolium*), dasheen (*Colocasia esculenta* var. *esculenta*), and eddoe (*C. esculenta* var. *antiquorum*).

Given that sweet potato, aroids, yams, and, to a lesser extent, cassava form the basic traditional carbohydrate crops in the diet of the Caribbean people, the major goals of the program are:

> To contribute to the production of pathogen-free, high-yielding cultivars of sweet potato, yams, cassava, and edible aroids;

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To increase the production and availability of the major root crops through improved planting material, better production systems including pest and disease control, and improved postharvest handling and storage methods; and

To encourage the utilization of crop residues from the primary crop for livestock feed.

Research

Sweet potato is an important staple throughout most of the Caribbean. Research and development efforts have centered on producing high-yielding cultivars that can be adapted to various ecosystems. In conjunction with this, the control of major insect pests (*Euscepes postfasciatus* and *Cylas formicarius* in eastern Caribbean and Trinidad, and *Megastes* sp. in Trinidad) has received attention.

The research activities for sweet potato include:

Maintaining germplasm from local and extraregional sources in Jamaica, Trinidad, and Grenada for breeding and multiplication purposes;

Comparing cultivars introduced from the International Institute of Tropical Agriculture (IITA) and other areas with local cultivars for adaptability, yield, and market qualities through multilocation trials;

Bulking cultivars which have performed well in trials for yield and market acceptability for distribution to farmers through ministries of agriculture;

Controlling major pests (*Euscepes postfasciatus, Cylas formicarius,* and *Megastes* sp.) by chemical and cultural means; and

Improving production through an evaluation of the agronomic factors that contribute to increased yields, i.e., fertilizer requirements, spacing, and postharvest handling.

The Institute's work on yams has centered on solving the problem of virus diseases which cause significant losses in quality and yield. These problems were investigated during 1973 to 1979 and suitable measures were developed for controlling virus diseases using proven tissue culture methods of virus eradication and rapid propagation. In subsequent research these techniques were used to produce commercial quantities of

virus-tested seed stock of 'White Lisbon' yam (*Dioscorea alata*) for distribution to farmers in Barbados and the rest of the Commonwealth Caribbean region. This technique has received worldwide acceptance and is being adapted for use in countries outside the Caribbean.

In eastern Caribbean anthracnose is a serious problem and virus-tested White Lisbon yam from Barbados has been seriously affected. As a result attention is being given to solving this problem. A small quantity of anthracnose-tolerant cultivars of *D. alata* have been made available to St. Kitts from the Institut National de Recherches Agronomiques (INRA), Guadeloupe, for study and evaluation. In addition, material (Coconut Lisbon) from Barbados is being tested.

The principal ongoing activities on yams are as follows:

In vitro maintenance of virus-tested planting material through the maintenance of a tissue culture stock of all *D. alata* and *D. trifida* accessions;

Improving planting material through studies leading to Grade A material production;

Monitoring of all materials produced by registered growers for virus affected plants through the regulation of stock deterioration and foliage disease symptoms of Grade B and C multiplied materials;

Extending tuber dormancy on a commercial scale through storage trials aimed at developing economically practical systems for the treatment of harvested tubers;

Evaluating the intercrop system of White Lisbon yam with 'Antigua' yam (*D. rotundata*) and its effect on anthracnose incidence levels in *D. alata* caused by *Glomerella cingulata;*

Improving the yield and quality of White Lisbon yam through selective fungicide evaluation in anthracnose control; and

Developing mechanized production systems for planting, crop husbandry, and harvesting.

The emphasis given to cassava at the start of the root crop research program in 1976 was predicated on the possibility of substituting up to 10% of wheat flour with flour made from starchy crops such as cassava and sweet potato without a significant loss of bread quality. However, development has not taken place along those lines.

The present interest in cassava is its use as a corn substitute in animal feeds. Consequently the following activities are in progress:

Introducing and evaluating CIAT cultivars in multilocational trials for the assessment and rapid multiplication of selected superior cassava cultivars;

Studying cassava bacterial blight (CBB) through investigations of selected cassava lines resistant to CBB;

Developing improved cassava production through mechanized systems of planting, fertilizer and herbicide application, and harvesting; and

Developing systems for chipping and drying cassava for use in animal feeds through machinery and production system testing and development.

Tannia and dasheen are important starchy foods widely used in the Windward Islands. Tannia is primarily traded intraregionally and a small amount is exported to the United Kingdom.

The potential for the export of tannia has not been realized because of low average yields of 4250 kg/ha on small farms. In addition plantings have been affected by tannia leaf burning disease, also called 'tannia root-rot disease'.

A program aimed at crop improvement and clarification of the disease problem was begun in 1980 and considerable progress has been made. The causal agent *Pythium myriotylum* has now been identified by Koch's postulate and control measures have been devised.

The work program on aroids can be summarized under four headings: genetic improvement; agronomic improvement; pathological studies; and postharvest studies.

Genetic improvement involves the collection of aroid germplasm and the screening of tannia seedlings for disease tolerance. Screening is accomplished by detecting clones with high levels of adaptibility and tolerance or resistance to major eastern Caribbean disease, in particular tannia root-rot disease. Selected clones are multiplied rapidly through tissue culture and other methods, and elite cultivars are evaluated through multilocational trials.

In agronomic improvement the major emphasis is on developing improved tannia production systems through nursery management, weed

and disease control measures, and nutritional requirements considerations.

Pathological studies include pathogenic testing to confirm that *Pythium myriotylum* is the causal agent of tannia root-rot disease and to determine the roles of *Pythium* spp., *Rhizoctonia* spp., and *Fusarium* spp. in tannia root-rot disease. Plans are also underway to utilize disease management practices in order to determine the appropriate application, timing, and minimum effective quantity of Ridomil MZ 58 to be used in the control of tannia root-rot disease.

Postharvest studies include the control of postharvest rot of tannia and dasheen through chemical treatment and by other means involving the determination of the principal pathogens causing postharvest rot and the implementation of preventive measures. Studies are also planned to develop aroid maturity indices through the identification of maturity standards in high quality aroid production and to evaluate the effect of maturity on quality and shelf life.

Training

During the course of research and developmental work on yams the Institute conducted a number of short training courses on tissue culture for the benefit of technicians in various ministries of agriculture. Some of the Institute's scientists also received advanced training at CIAT. In support of the program for monitoring the production of virus-tested yam planting material by registered growers, plant protection officers of the Ministry of Agriculture, Barbados, were trained in the identification of foliar virus symptoms.

Although scientists and technologists are conscious of these improvements, informal technical training must be supplied to the long-neglected ultimate user, i.e., the extension staff and, more importantly, the farmer. This increase in information transfer would ultimately lead to a greater amount of technological appreciation and increased adoption of technology by the user, especially with regard to postharvest handling and storage technologies.

Recommendations

The Institute will continue to be responsive to researching the challenges of production of primary material so as to contribute to food security. Once this has been achieved emphasis must be on crop improvement through

higher-yielding planting materials that are resistant to the major pests and diseases of the region. Emphasis must also be given to improving crop management systems involving mechanization where possible to ensure efficiency in production.

At the same time attention must be given to providing the base of an agroindustry that can utilize, in an efficient manner, the several root crops which the region is capable of producing. Therefore, appropriate training programs must be devised to equip our scientists and technicians for these new directions.

Spanish Summary

Programa de Raíces y Tubérculos del CARDI

El programa de cultivos de raíces del Caribbean Agricultural Research and Development Institute incluye los cultivos de yuca, ñame, batata, papa y aroides comestibles. Los principales objetivos del programa son la producción de cultivares libres de enfermedades, el aumento de la producción y de la disponibilidad de los cultivos de raíces, y el estímulo de la utilización de los residuos del cultivo primario en la alimentación animal. Se presentan las actividades de investigación, capacitación y desarrollo relacionadas con la batata, el ñame, la yuca y los aroides.

Root and Tuber Crops in Dominica, West Indies

*C.A. Sorhaindo**

Introduction

The total amount of land under root and tuber crops in Dominica in 1984 was 3650 hectares. This total comprised six root crops: dasheen (*Colocasia esculenta*) (1700 hectares); tannia (*Xanthosoma sagittifolium*) (850 ha); yams (*Dioscorea* spp.) (769 ha); sweet potato (*Ipomoea batatas*) (243 ha); cassava (*Manihot esculenta*) (81 ha); and white potato (*Solanum tuberosum*) (7 ha).

Dasheen, tannia, and sweet potato are grown islandwide while white potato is grown at 300 m above sea level in the south central part of the island. Yams are grown in the north and southeast while cassava is also grown in the southeast but on specific plots.

It is estimated that a 30% increase in the present area is possible within the next year should price and market arrangements prove satisfactory. This would increase the existing 3650 to 4745 ha. A 50% increase over four years in available land would make 5475 ha available for root and tuber crops.

Farm Characteristics

The average farm size for root crops is between one and four ha. There are approximately 10,392 farms producing root crops in Dominica: 5173 farms produce dasheen; 2983 produce tannia; 1432 produce yams; 575 produce sweet potato; 179 produce cassava; and 50 produce white potato.

* Ministry of Agriculture, Dominica.

Of the 10,392 farms producing root crops in Dominica, 3000 are self-owned, 3180 family-owned, and 3150 rented. Eight-hundred and five farms are operated by 'squatters' and 257 farms are held by other means.

The majority of farms producing root and tuber crops can be described as small family farms of less than 5 ha. They usually incorporate a range of enterprises on a small scale in combination with root and tuber crops. For example, fruit tree crops are grown on 40% of the farms that are larger than 10 ha, 30% of small home-farms (about 0.5 ha) and larger commercial farms (4 to 10 ha) raise chickens, and 20% of farms (0.5 to 4 ha) raise either cows or goats. A lesser percentage of farms have enterprises consisting of pigs, sheep, vegetables, or the production of copra, bay oil, or farine.

Thirty-five percent of farmers do not engage in any kind of small stock or dairy production. There are very few instances of farms with less than 0.75 ha growing only root and tuber crops.

Socioeconomic Patterns

The average farmer is 52 years old and 26% of farmers are in the 26- to 40-year-old group. Very few farmers are under 25. Age differences are not significantly correlated with levels of income in Dominica. Literacy is about 70%. Although the majority of farmers have formal education at the primary level and 5% have secondary education only 7% of farmers keep farm records. Out of 120 farm households surveyed, only 14 households had members who were illiterate. Farmers depend highly on the opinions of sons and daughters and on extension officers. Radio is regarded as the most important of the media sources on improved practices.

The average size of the household is 5-9 persons. Seventy percent of farms are mainly dependent on family labor—an important factor in family-farm incomes.

The farmer's food is grown on his farm. The main staples are root and tuber crops and bananas. Meat and eggs are eaten at least three times a week.

Employment in root and tuber crop production as a percentage of total agricultural employment, from land clearing to marketing, is estimated at 15%. In farms ranging from 0.4 to 4.0 ha root crops are responsible for 47% of the farmer's total income. In farms ranging from 4 to 10 ha, root crops contribute 24% to the farmers' total income.

Root and Tuber Crop Production and Constraints

See Table 1 for the yields of root and tuber crops in Dominica, and Table 2 for the volume of production.

Root and tuber crops are important in multiple-cropping practices in Dominica. However, there are no precise systems which are repeatedly identifiable as multiple-cropping systems. Intercropping occurs with crops such as bananas, vegetables, fruit tree crops, and coconuts.

Eighty percent of all dasheen grown in Dominica is intercropped as are 29% of yams, 64% of tannia, 13% of sweet potato, and 10% of cassava. White potato, a relatively new crop, is always planted in pure stands. Approximately 67% of the root and tuber crop farmers use chemical fertilizers in the commercial production of these crops.

The major factors restraining root crop expansion are:

Poor markets due to high costs of production compared to the low production costs of other carbohydrate sources such as rice, flour, and potato;

Inadequate credit facilities with collateral being necessary (i.e., land title); and

Limited potential for farm expansion and loss of rental income due to restrictions on farm size.

Marketing and Constraints

Both tannia and dasheen cost EC$0.67/kg[1] to produce (EC$6389/ha). Yams cost EC$0.33/kg (EC$3304/ha), and white potato costs EC$0.51/kg (EC$5067/ha).

Table 1. **Root and tuber crops yield (kg/ha) in Dominica, 1984.**

Crop	Yield
Tannia	10,323
White potato	10,369
Dasheen	12,328
Cassava	13,826
Sweet potato	13,826
Yams	13,826

1. Exchange rate: EC$1.00 = US$0.37 (1984).

Table 2. **Production volume (t) of selected root crops, Dominica, 1980-1984.**

Crop	Year				
	1980	1981	1982	1983	1984
Dasheen	10268	10446	10521	10700	11000
Tannia	6429	6696	6905	7100	7400
Yam	4018	4286	4343	4400	5000
Sweet potato	1429	1400	1358	1400	148
White potato	10	16	30	45	50
Cassava	560	600	700	650	775

During 1984 dasheen retailed for EC$1.06/kg and had a farmgate price of EC$0.86/kg. Tannia retailed for EC$1.98/kg while its farmgate price was EC$1.54/kg. Sweet potato retailed for EC$1.87/kg while its farmgate price was EC$1.21/kg. Yam retailed for EC$2.64/kg while its farmgate price was EC$1.43/kg. White potato retailed for EC$2.75/kg while its farmgate price was EC$1.65/kg.

Few wholesale operators function in the root and tuber crop marketing chain. Wholesale purchases are made directly from the farmer. The farmer himself or his family retails directly from the farm or at the market. Exporters [Dominica Agricultural Marketing Board (DAMB)], peddlers, Joseph Exotics, CARICOM Associates, etc. buy at farmgate prices.

The total value of root and tuber crops as a percentage of total agricultural production is between 8 and 10%.

At the local community level cassava is processed into farine. This is done mainly in southeastern Dominica. Some households on the east coast prepare flour from dasheen, tannia, and sweet potato but throughout Dominica the vast majority of root and tuber crops are utilized in the fresh state.

Root crops are distributed in the following manner: onfarm consumption (10%); local market (60%); and onfarm, animal feed (10%). The remaining 20% is exported to regional markets in the Barbados, Martinique, Guadeloupe, St. Croix, St. Thomas, and extraregional markets in the United Kingdom.

The main local market (Roseau) is situated 3 to 145 km from production areas which themselves are not usually situated more than 3 km from a vehicular road.

The present domestic demand for root crops on the island is 10,584 t for dasheen, 4908 t for yams, 3770 t for tannia, 1488 t for sweet potato, and 21 t for cassava. Twenty-one tons of cassava are eaten fresh and 750 t are converted into farine of which 10 t are exported.

The major constraints on domestic demand are:

Superior storage of other carbohydrate sources such as rice, flour, and imported white potatoes;

High price for root and tuber crops when compared to other carbohydrate sources;

Seasonality; and

Ease of incorporation of the other carbohydrate sources into familiar recipes.

The major constraints on external demand are:

High production costs resulting in the high cost of the product when compared to other carbohydrate sources;

Poor crosscultural acceptability in nonregional countries;

Short shelf life;

Limited availability, and delays in shipping arrangements; and

Lack of promotional efforts in foreign markets.

Government Policies

Except for white potatoes, energy-rich imports are not restricted. The import of white potatoes is restricted between January and April to ensure a market for the local production of 69,400 kg. There are no domestic subsidies or taxes on competing crops and products. However, the Ministry of Agriculture assists white potato growers by importing and reselling seed at cost price. Crop protection inputs are also provided free. Potato growers are encouraged to form an association to substitute imports and loan availability is facilitated through an International Foundation for Agricultural Development (IFAD) low-interest (5%) loan scheme.

Future policy direction may be determined by trends in production, promotion, and marketing. At present there are no clear and identifiable positions for future policy, apart from an increased interest in research.

Research

Institutes conducting research on the island include the Caribbean Agricultural Research and Development Institute (CARDI) which conducts onfarm and center research both at the local and regional levels. It is staffed by a full-time plant breeder, pathologist, two postharvest technologists, and one laboratory assistant. The Ministry of Agriculture (MINAG) conducts onfarm local research. It is staffed by a part-time research officer, and the French Technical Cooperation (FTC) also conducts local onfarm research and is staffed by two part-time agronomists.

In 1985 the government budget of EC$95,000 allocated to root crops was distributed in the following way: annual funding to the CARDI Aroid Project (EC$4000); building of the CARDI Aroid Project (EC$40,000); site rental (EC$500); field experiment cost (EC$500); and extension labor costs (EC$50,000).

The main areas of research are:

Aroids—the three institutions (CARDI, MINAG, and FTC) will be emphasizing development in the areas of agronomy, genetics, postharvesting, and multiplication by asceptic meristem cultures.

Yams—the introduction of clean planting material for *D. alata* cv. White Lisbon is being undertaken by CARDI, MINAG, and FTC. These three institutions are also identifying and distributing various varieties. MINAG, in particular, is collecting the following 23 varieties of *Dioscorea* spp. at the La Plaine Botanic Gardens:

Adon	Glo	Violette
Antoine	Inra 520	White Cush Cush
Babawole	Ladies	White Lisbon
Belep	Patte D'elephant	White Scully
Capalau	Purple Cush Cush	White Yam
Choucoune	Red Scully	Yam Soie
Coves	San San	Yellow Yam
Gineau	Sea 189	

Propagation experiments are being conducted by MINAG and the treatment of planting material is being undertaken by FTC. CARDI and FTC are evaluating anthracnose, and FTC and MINAG are responsible for the development of training seminars;

Cassava—CARDI and MINAG will be responsible for the introduction, testing, and distribution of the cultivar Maracas Black Stick. Maintenance of planting plots on experiment stations will be emphasized;

Sweet potato—sweet potato cultivars will be introduced and maintained on the stations;

General research—this will emphasize onstation experimentation of variety plots, yield trials, multiplication and propagation trials, and disease monitoring; and

CARDI research—CARDI will conduct pathology studies by isolating pathogens and investigate preparation through apical meristem cultures. The Institute will also conduct postharvest technology studies (storage potential) as well as leaf nutrient studies.

Quarantine Regulations

Talks are to be held with the Instituto Interamericano de Cooperación para la Agricultura (IICA) and CARDI concerning quarantine regulations and restrictions for root crops. At present there are no specific regulations. Incoming material is inspected on arrival by a quarantine officer at port. An import permit and a phytosanitary certificate from the country of origin is required for all incoming plant material. Export phytosanitary certificates are necessary for exported material. Much more detailed and stringent requirements must be employed with the start of CARDI's development program which will involve the interregional shipment of aroid plant material.

Sources of Additional Information

The data base, Dominica Farm Registry Survey (MINAG), includes information on the number of farmers in root crop production, type of farm tenure, area under root crops, and the number of farms producing root crops.

The 1977-1980 Agricultural Sector Plan provides general agricultural statistics such as per capita consumption.

The Statistics Unit provides data on exports and imports.

The Market Intelligence Unit provides data on market prices, exports, production, and local consumption.

IFAD provides information on production costs, credit availability, and loans for root crop production.

CARDI Small Farm Survey.

Extension officers of the Ministry of Agriculture, Commonwealth of Dominica.

Spanish Summary

Cultivos de Raíces y Tubérculos en Dominica

Se hace un análisis tanto de la tierra que hay disponible para seis cultivos de raíces —taro (malanga, bore, dasheen), ocumo (mafafa, yautía, tania, cocoyami), ñame, batata (sweet potato), yuca y patata irlandesa— como del potencial de tierra para la expansión de esos cultivos que se calcula en un 50% durante los próximos cuatro años. Se describen también las características de las fincas y los sistemas de cultivo de estas especies de raíz cultivable. Los costos de producción de estos seis cultivos se consideran altos y por lo tanto restringen su demanda. Se consideran también las restricciones tanto de la demanda interna como de la externa y se discuten las directrices que en el futuro deben seguirse para contrarrestar esas restricciones. Por último, se discute el papel que pueden desempeñar los institutos de investigación en un mayor desarrollo de las industrias dedicadas a las raíces amilaceas.

Root and Tuber Crops in Grenada

*K.U. Buckmire, R.L. Benjamin, and N. Burris**

Introduction

In this paper root and tuber crops refer to tannia (*Xanthosoma* spp.), dasheen (*Colocasia esculenta* var. *esculenta*), eddoe (*C. esculenta* var. *antiquorum*), yams (*Dioscorea* spp.), sweet potato (*Ipomoea batatas*) and cassava (*Manihot esculenta*).

In Grenada it is estimated that a total of 385 hectares (ha) is cultivated to roots and tubers. Theoretically there are about 510 ha of suitable land for roots and tubers. However, the steep terrain and the abundance of banana and tree crops limit the cultivation of root crops. It is estimated that 60-80% of the suitable lands are intercropped. Any additional land area would have to be new lands, at present lying idle but with difficult access.

Farm Characteristics

It is difficult to estimate the number of persons employed in root crop production. Bearing in mind that there are about 2217 farmers, with an average family size of four, it can be said that approximately 8868 persons are directly or indirectly involved in root and tuber production. Hired labor is seasonal with most being needed for land preparation and the first weeding. Harvesting is generally done by the farmer and his family. According to the Caribbean Agricultural Research and Development Institute (CARDI) Baseline Survey Study (CARDI, 1980), of the 120 small farmers (0.4-2 ha) the generalization can be made that there are 1987 small root crop farmers. To this can be added another 230 farmers who cultivate larger farms.

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Root crops are grown mostly on small holdings of 0.25 to 4.0 ha mainly for subsistence. There are few commercial producers. Cultural practices are traditional, involving mixed cultivation with a heavy reliance on manual labor. Recently some commercial sweet potato and yam producers have been relying heavily on the tractor for land preparation.

Root and Tuber Crop Production and Constraints

Most farmers produce aroids and cassava in mixed cropping while about 50% of the yams are grown in pure stand. It is uncommon to find pure stands of tannia and cassava. Dasheen, grown in swamps, along streams, or in near-waterlogged conditions, is planted in pure stands. This accounts for about 40-50% of the dasheen cultivation. The other half of the production comes from mixed cropping with banana and tree crops. Among the more important combinations involving root crops are: aroids with banana; yams with corn; and sweet potato with corn and pigeon pea.

Farmers generally plant sweet potato from August to December with the major harvesting occurring between January and May. In the sugar cane belt, in southern Grenada, sweet potato is intercropped with sugar cane and corn, improving the farmers' income and, because the harvesting of sweet potato facilitates weed control, assisting in the cultivation of sugar cane.

Root and tuber crop production grew at 15% between 1975 and 1978 but has since declined from 1151 tons (t) in 1979 to 704 t in 1984 (Table 1).

Although there are many hectares of suitable land for the production of roots and tubers there are several major factors constraining expansion. A major constraint is the topography of the land. Because tree crops occupy most of the potential root and tuber crop area, available land is relatively steep. Increased root and tuber crop production would therefore require a greater amount of labor and the practicing of hillside farming.

Table 1. **Production (t) of selected roots and tubers in Grenada, 1979-1984.**

	Year					
Commodity	1979	1980	1981	1982	1983	1984
Sweet potato	372	277	269	297	277	109
Tannia	272	145	148	155	141	95
Yams	507	460	483	507	454	500

Although Grenada has an extensive and well laid network of vehicular roads, deterioration over the last 20 to 30 years has reached the point where only the bare outline can be seen in about one-half of these roads.

Despite there appearing to be extraregional markets for roots and tubers the farmers complain of an inadequate demand for their products (yams, aroids, sweet potato). The Marketing and National Import Board (MNIB), on the other hand, claims that production is not large enough to satisfy the minimum shipping requirements. Cassava, for example, has a ready market for processing into farine and wafers—in fact, demand exceeds production. It is our view that the market constraints are a result of the poor quality of the products, the seasonal nature of the commodities, and the high price demanded by the farmers.

Sociocultural factors also restrict production potential. From interviews with farmers we ascertained that farmers strongly believe in planting and harvesting root crops according to lunar cycles. The traditional methods of land preparation also serve as serious limitations to the expansion of production and, moreover, farmers regard root crops as being a side dish to complement the main meal, and hence of minor importance compared to other crops.

The adoption of appropriate technology in root and tuber production is related to the socioeconomic position of the farmer and his experiences. The resource base determines the fertilizer quality and the number of times a farmer is able to weed his field. The combined costs of staking yams and labor in land preparation on steep hillsides make the adoption of improved cultural practices less attractive to the farmer. We suggest that the introduction of improved high-yielding cultivars with shorter harvesting periods would make a positive impact on the farmer's ultimate yields. Furthermore, the lack of sufficient high-quality planting material at the appropriate time of year severely limits any increase in land area. In both aroids and sweet potato, the inability to forecast yields by growth indices restricts the planning and establishment of contract markets.

It is interesting to note that despite high levels of unemployment and low rates of urbanization, the availability of labor for farm activities is low. Because of the high labor input needed for yams and aroids it is difficult for the farmer to increase land area. Increasing the land area under cassava and sweet potato can be accomplished by mechanization especially for harvesting.

A look at the inputs of the three major root and tuber crops (sweet potato, tannia, and yams) shows that the technology utilized includes all

the standard practices. Fertilizer application and the use of fungicides are also included in the costs of production. In yam production some farmers use pen manure which increases the costs of production by approximately EC$2000/ha[1]. The increased yields do not seem to justify this additional expense. The costs of production (Table 2) show that producing sweet potato and yams give a better return than producing tannia.

It should be noted that commodity selling prices generally do not reflect production costs. The pricing seems to be associated with supply and demand, and the weekly shopping basket requirements of the farmer.

Marketing

Although farmers grow root and tuber crops mainly for home consumption, the roots and tubers also provide some cash while the other crops are in the growing stages thus allowing for a better distribution of cash incomes in the household. Sweet potato farmers tend to grow the crop for sale to one of the local outlets, but of the roots and tubers grown, only cassava is utilized in processed form as farine and cassava bread. The bulk of the processed food is produced in three villages in Grenada and Carriacou. There is a relatively large factory in Grenada but at present it is operating well below its capacity because of a lack of raw materials. An interesting development is the increasing use of tannia porridge, known as ' tannia-log ', as infant food and as a breakfast meal.

The surplus of onfarm consumption is either sold to middlemen, who ship to the regional markets, or shipped directly to the local markets, the MNIB, and the supermarkets.

Table 2. **Production costs and returns (EC$/ha)[a] for roots and tubers, Grenada.**

	Production costs			Returns	
Crop	Labor[b]	Material[c]	Service[d]	Gross[e]	Net
Sweet potato	3680	3066	568	16481	9167
Tannia	5456	2382	729	11861	3294
Yam	11716	8902	1011	30928	9299

a. Exchange rate: EC$1.00 = US$0.37 (1984).
b. Cultural practices and land preparation
c. All inputs excluding labor.
d. Transportation and land rental costs.
e. Gross value based on a selling price of EC$1.10/kg at the market depot for all commodities.

1. Exchange rate: EC$1.00 = US$0.37 (1984).

Although local consumption of root crops has shown little increase the export demand for the crops has increased both in the United Kingdom and Trinidad. The opening of the International Airport at Point Salines has made available the North American market, thereby increasing export demands.

Examination of the sweet potato market reveals that sales vary tremendously and that there are periods of peak production during the first quarter of the year (Table 3). Surveying the three outlets shows that between 1981 and 1984 about 4% of sweet potato sales were exported to Trinidad. It is estimated that another 40,000 to 60,000 kg of sweet potato is produced and used on the farm or given to friends.

Large quantities of yams are consumed on the farm, given away, or used to feed pigs.

Production figures indicate significant declines of aroids since 1979. However, with the increased use of both tannia and aroids as a staple food it is estimated that in recent years the onfarm consumption has increased by 30-40%. The market has remained relatively stable but there is a growing export demand for good quality products.

Government Policies

From the programs now implemented it appears that the government's emphasis is to increase the production of roots and tubers and to provide

Table 3. **Monthly sales (kg) of sweet potato, Grenada, 1981-1984.**

	Year			
Month	1981	1982	1983	1984
January	5704	6793	11962	17802
February	9132	7969	13899	15561
March	5298	7253	12303	17195
April	6420	9369	5744	6800
May	4754	10739	2075	6573
June	2211	5247	777	4007
July	1245	2615	2851	3247
August	1659	2631	3202	2569
September	1714	2705	4094	3150
October	2389	4127	2364	3161
November	5405	7717	6886	5492
December	9611	11759	4226	9923

the farmers with facilities for better incomes. The proposed projects are:

Improved aroid production methods. These include germplasm improvement, techniques for rapid multiplication of planting material (CARDI and the Grenada Ministry of Agriculture have already multiplied improved cassava cultivars), nutritional crop requirements, and disease control (virus-tested Lisbon yam has already been introduced from the Barbados);

Improved cultural practices for sweet potato production. These include mixed cropping and the introduction of improved high-yielding cultivars;

Introduction of improved high-yielding cassava cultivars and associated cultural practices; and

Agricultural diversification in areas where the infrastructure is being improved to allow for access to areas suitable for roots and tubers.

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Spanish Summary

Cultivos de Raíces y Tubérculos en Grenada

Se presenta la situación de la batata, la yuca, el ocumo, el malangay y el ñame, cultivados principalmente para subsistencia en Grenada.

Se discuten su oferta, sistemas de cultivo, rendimientos, costos y

limitaciones de la producción y el perfil socioeconómico de los productores.

Se analizan también los procesos de transformación (principalmente yuca y malangay), el mercadeo de batata, ñame y aroides, y las políticas gubernamentales relacionadas con el apoyo a los proyectos de mejoramiento de los cultivos de raíces.

Root and Tuber Crops in Guadeloupe

*L. Degras**

Root and Tuber Crop Production and Constraints

The Food and Agriculture Organization of the United Nations (FAO) statistics for root crop production in Guadeloupe are presented in Table 1 where they are compared with data from Martinique, Barbados, and Trinidad and Tobago. The data are perhaps questionable for the two French islands. A recent survey on nutrition has shown that the annual root crop consumption in Martinique from local production was about 47.5 kg per person which reflects a total production of 16,000-17,000 tons per year (t/yr) for the island. On the other hand, the annual root crop consumption appears to be higher in Guadeloupe by about 1.5 kg per person, which reflects a production of 24,000-26,000 t/yr of root crops.

Table 1. **Total production of root crops in Guadeloupe and three other Caribbean countries, 1972-1981.**

Country	Area (km^2)	Total production by year (thousand t)									
		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Guadeloupe	1709	48	48	59	72	59	59	23	20	21	21
Martinique	1080	30	33	33	33	33	33	26	22	27	25
Barbados	430	19	23	23	24	17	17	15	10	14	16
Trinidad and Tobago	4827	18	20	20	20	21	22	22	21	22	23

SOURCE: Food and Agriculture Organization of the United Nations (FAO). 1973, 1975, 1977, 1980, and 1981.

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The last general agricultural census estimated that 3200 ha were under food crops which comprised root crops, plantain, banana, and fruit trees such as breadfruit. Assuming an average yield of 10 t/ha for root crops, the calculated land area is about 2500 ha. Current data from the local statistical service mention 800 ha in yams which we believe to be an underestimate of actual production.

The number of farmers growing root crops is estimated at about 10,000 and over 200 farms are believed to be involved in mixed-cropping systems (creole garden) and mixed-cultivar yam systems. Figure 1 shows the distribution of crops in creole gardens. They can be defined either as yam-based or banana-based cropping systems.

A phytosociological study of the creole gardens near Petit-Bourg shows that there are no less than 108 species distributed among 78 genera and 45 families. Fifteen percent of the species identified are root crops.

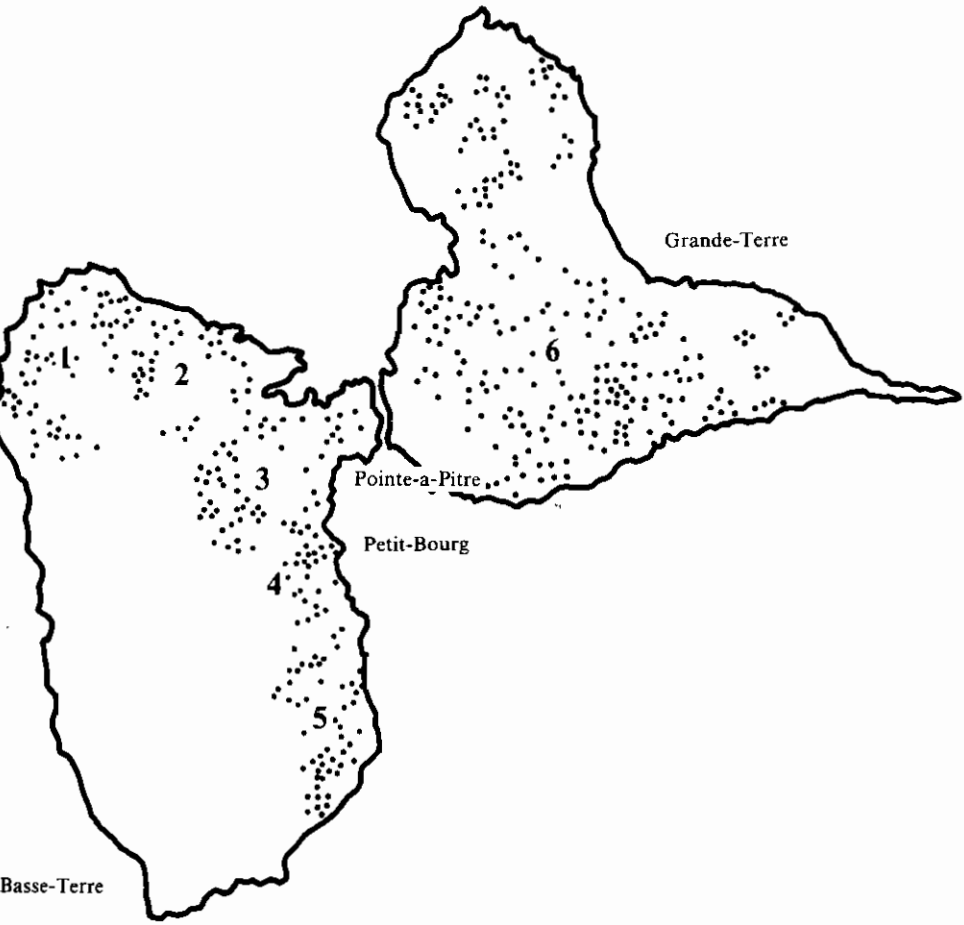
Table 2 gives production systems for root crops in Guadeloupe and Figure 2 gives planting and harvesting times for various root crops.

Yam is grown within a mixed-cropping system with, for example, no less than twenty cultivars from six species in cultivation in the center and north of Basse-Terre (Figure 3). Usually each field has two or three species with three or more cultivars of different maturation rates and sometimes of different harvesting dates. Large monoclonal, or mostly monoclonal areas are also grown around Petit-Bourg (*D. cayenensis* spp. and *D. rotundata* cv. Grosse Caille) and in the north of Grande-Terre (*D. alata* cvs. of the Pacala group).

Table 2. **Root crop production systems, Guadeloupe.**

System	Yams (*Dioscorea* spp.)		Aroids		Sweet potato	Cassava
	alata	*cayenensis*	*Xanthosoma*	*Colocasia*		
Protoculture	+			+		
Bush fallow	+	+	+	+	+	+
Rotational	+	+	+	+	+	+
Semi-industrial	+[a]				+[a]	+

a Tentatively or occasionally processed



Different mixed-cropping systems based on yams and bananas and including:

1. Aroids/Cassava/Cocoa/Coffee
2. Aroids/Sweet Potato/Cassava
3. Aroids
4. Aroids/Beans
5. Cassava/Sweet Potato
6. Aroids/Pigeon pea

Figure 1. *Mixed - cropping systems in creole gardens, Guadeloupe, 1980.*

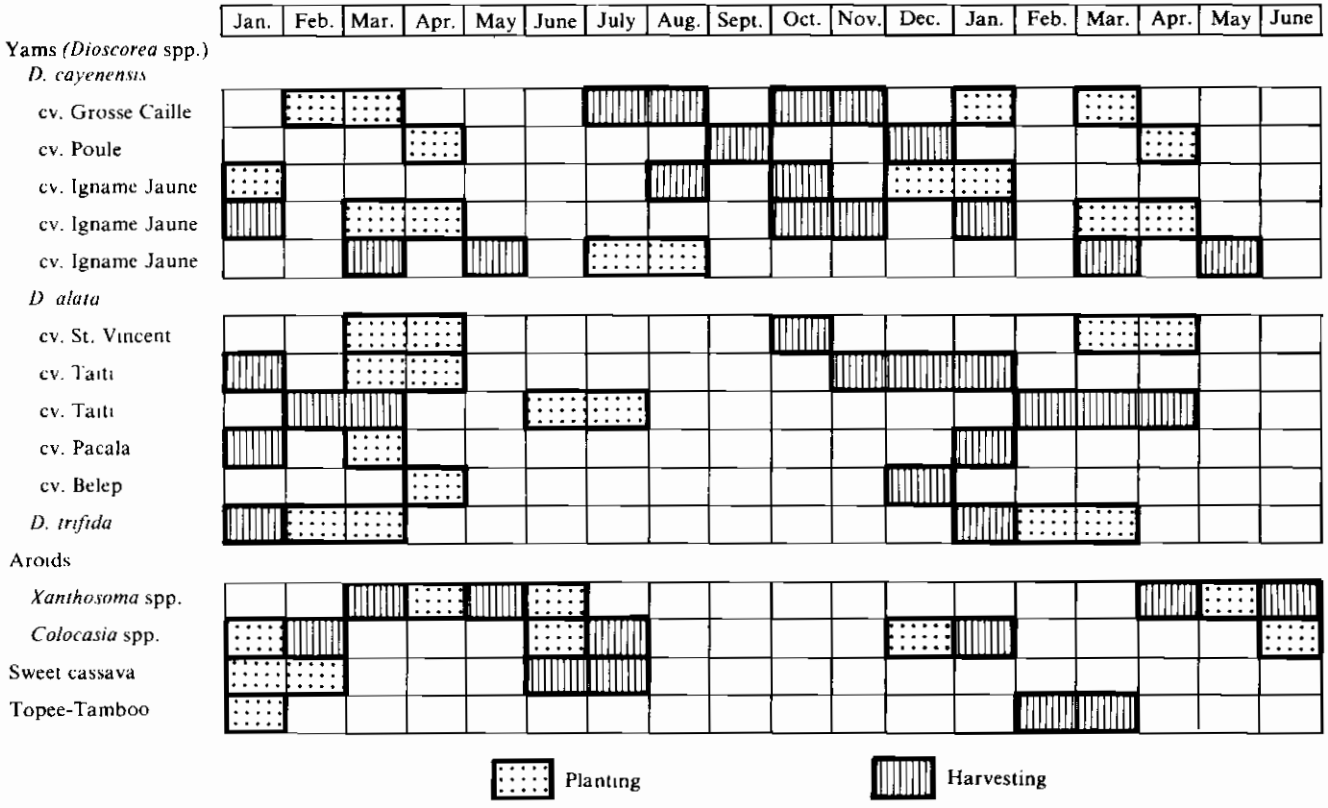


Figure 2. *Planting and harvesting calendar of root crops, Petit-Bourg, Guadeloupe (sweet potato is planted and harvested throughout the year).*

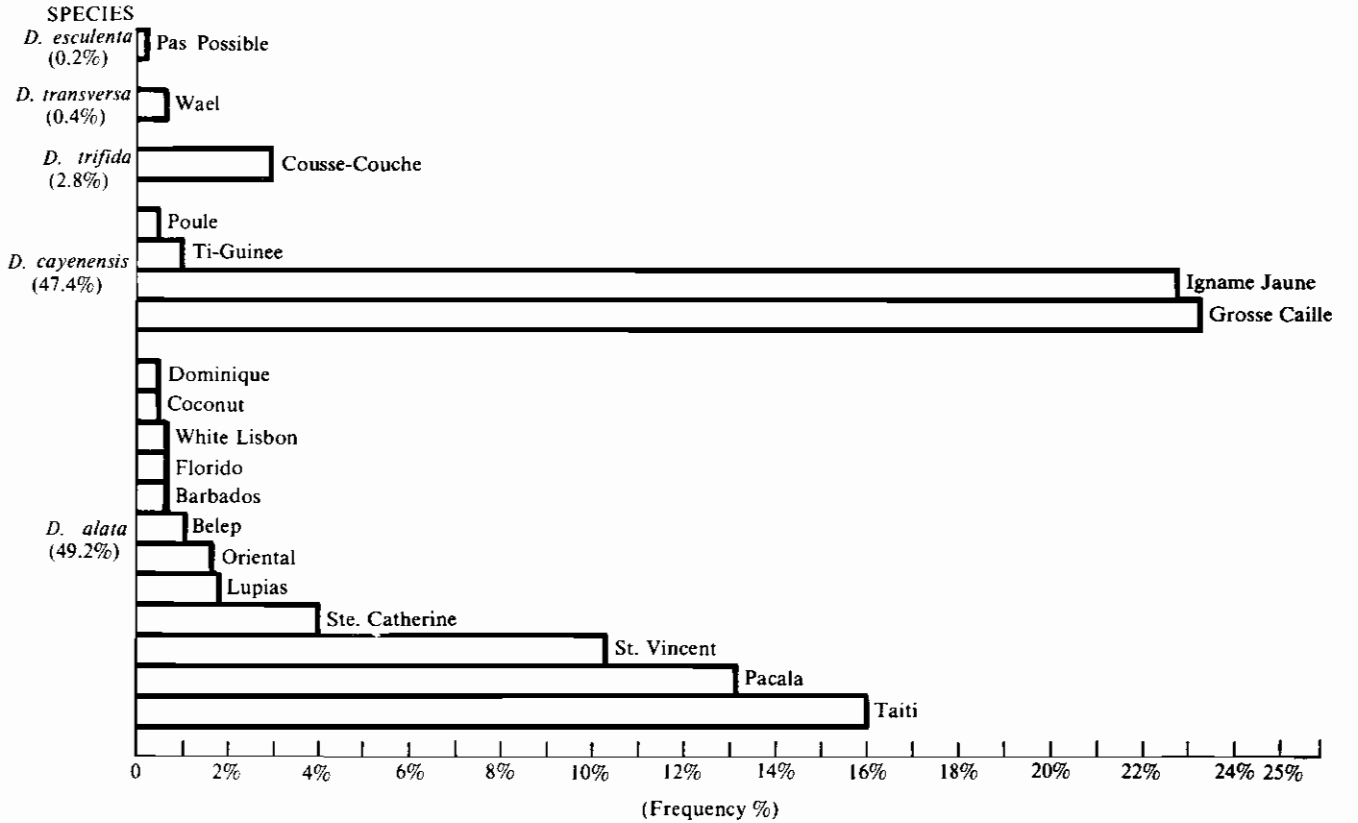


Figure 3. *Yam* (Dioscorea *spp.) cultivar frequency in the center and north of Basse-Terre, Guadeloupe, 1980.*

The cultural practices used in yam growing are found throughout the Caribbean area. They include staking, both natural and artificial, building mounds and ridges by hand or mechanically, digging holes and pits, and mulching with sugar cane leaves.

Sweet potato is an underexploited crop and is either grown in small monoculture-areas scattered all over the island or in mixed-cropping systems. With more than twenty cultivars and year-round planting and harvesting the crop has a high potential. Selection from among local cultivars has proved valuable and two cultivars, Duclos XI and Malesco, are important in French Guiana and Cuba (Nodales, 1977).

The sweet potato weevil (*Cylas formicarius*) which imposes severe restrictions on the importation of foreign vegetative material is not a problem, but the sweet potato borer (*Euscepes postfasciatus*) is present and is being spread by inadequate land-clearing methods (Bonfils and Jean-Bart, 1967).

The value of sweet potato tubers as animal feed for pigs has been well documented by Corring et al. (1969) and the vines and leaves have been used for feeding cattle and goats (Chenost et al., 1969). Though sporadic attempts have been successful in the production of high-quality canned marmalade, an appropriate production scheme for large-scale production has not yet been developed, despite its advantages when compared with the costly imported chestnut marmalade and other chestnut products.

Colocasia esculenta (madere), that is, dasheen (*C. esculenta* var. *esculenta),* and eddoe (*C. esculenta* var. *antiquorum*) thrive in swamp and stream areas as well as on dry land. In swamps it is a monoculture crop. Swamp cultivation can be done either within cleared spaces under *Pterocarpus officinalis* on the inland edges of mangrove swamps, or in upland marshes within the mesophytic, windward forest. In dry conditions it can be mixed with *Xanthosoma* or yams or both. The flesh of the roots of various cultivars are white, yellow, or a variable violet. The cultivars differ somewhat by their aboveground and underground morphology—some having superficial stolons. They may also differ in their organoleptic properties.

Tannia (*Xanthosoma sagittifolium*) (malanga) is grown mostly in mixed-cropping systems. Production is decreasing because of root rot and leaf burning diseases linked to a complex of fungi in which *Phythium myriotylum* is dominant but in which *Rhizoctonia* and *Fusarium solani* are also important. All varieties of tannia are susceptible, although farmers consider the violet variety as tolerant.

Very few areas of cassava are under cultivation. It is grown in mixed cropping or in monoculture in the north of Grande-Terre, in Marie-Galante and over the Capesterre-Belle-Eau area of Basse-Terre. Sweet (camanioc) and bitter cultivars are grown.

For some years low production of white potato (*Solanum tuberosum*) has been maintained, using imported seed, by small farmers in the highland area (600-800 metres above sea level) of the La Soufriere volcano (Messiaen, 1975).

As on all Caribbean islands, root crop production in Guadeloupe, especially cassava, suffered a marked decline since the Second World War. The major factors responsible are: large increase of imports of carbohydrate commodities; a trend away from agriculture; good prices for export crops; a lack of growers' associations; and the adoption of European and North American consumption patterns.

Economic development plans for the island emphasize the export crops, sugar cane and banana, and tourism.

FAO statistics (Table 1) show the decline of root crop production between 1977 and 1978 as being more than 50%. This was a result of a major outbreak of anthracnose. Controlling this disease is not possible without a technological package from pathology, breeding, seed production, an analysis of the agricultural environment, and professional assistance.

Research, Training, and Development

The Institut National de Recherches Agronomiques (INRA, 1981) is conducting research on the differential susceptibility of cultivars to the fungus *Colletotrichum gloeosporioides* and its control by the use of the fungicide benomyl (Fournet et al. as cited by Toribio et al., 1980). The search for less costly and alternative fungicides is continuing in the Plant Protection Service. Applications at the farm level are now common, thereby maintaining the choice *D. alata* cv. Pacala on the market.

Because the improvement of *D. alata* by crossbreeding is still in its developmental stages, clonal selection from widely-introduced material has been used. The cultivars Belep from New Caledonia and Kinabayo from the Philippines are, among others, favored by farmers. Alternative species have also been studied, each one showing some limitations:

The valuable *D. cayenensis* ssp. and *D. rotundata* cv. Gross Caille suffer from their staking requirements, short dormancy, and low rate of seed multiplication;

Introduced cultivars and hybrids of *D. trifida* are limited by narrow ecological adaptation, short dormancy periods, and nematode and virus susceptibility (Marchoux, 1980); and

The recently introduced *D. transversa* cv. Wael from New Caledonia does not store well.

The start of a breeding program from the sexual seed of *Dioscorea cayenensis* and *D. rotundata* received from the International Institute of Tropical Agriculture (IITA), Nigeria, has been an important development. One hundred clones are now under selection after having been through three cropping seasons (Degras, 1985).

The best cultivars of each species are generally requested by the farmers. A seed production scheme is operating from the INRA Plant Breeding Station and supplies to a network of nurseries held by a farmers' cooperative. The central nursery applies intensive technologies in order to ensure a good yield of seed. Some of these developments are: small seed pieces (150 g) (Mathurin and Degras, 1974); high planting densities (25,000-30,000 plants/ha) (Arnolin et al., 1973); appropriate fertilization based on soil characteristics and plant nutrient-uptake determined by the Agronomy Station; and preemergent herbicide application, mechanized harvesting, and cool storage temperatures (16 to 18°C).

As noted earlier, 50% of yams are grown in mixed-cropping systems. Two characteristics of the anthracnose problem emerge within the mixed-cropping systems. First, a lesser impact of the disease has been observed in mixed cropping (Clairon and Nagou, 1978) and second, the search for a high level of crop security by farmers has led to the appearance of new cultivars with varying tolerance levels. Experimental work is in progress or is planned for the appraisal of aroids/yams, grain/legume/yams, cereal/-yams associations and sexual *D. trifida* selection in different associations.

This research would be meaningless without progress in the development of root crop grower organizations. Based primarily on yam seed production, a cooperative society was formed three years ago and will expand to include other root crops within the next few years. About 140 members will share its modest capital.

We consider as being of equal importance, the need to develop techniques such as in vitro tissue culture (Arnolin and Degras, 1983) and to

renew creole-garden research. The extensive use by traditional farmers of new cultivars is evidence of their positive attitudes toward new technology.

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Spanish Summary

Cultivos de Raíces y Tubérculos en Guadeloupe

Se presentan los principales cultivos de raíces y sus tasas anuales de producción; hace un análisis de cada uno de ellos y de los sistemas de cultivo empleados para producirlos. Se discuten también las dificultades con que tropieza la producción de estas raíces amiláceas, especialmente la importación de alimentos considerados fuentes de carbohidratos. Este capítulo da soluciones pormenorizadas a los problemas de producción de estos cultivos y señala la necesidad de desarrollar cultivares de alto rendimiento.

Root and Tuber Crops in Guyana

*Brenda Forde**

Introduction

The agricultural sector is a fundamental component of the Guyanese economy. During the period 1980 to 1984 this sector remained the largest single contributor to the gross domestic product (GDP) (Table 1). The sector's contribution to the GDP averaged 23.4% between 1980 and 1984. The value of the country's agricultural production has been relatively stable, reaching its highest level of contribution in 1980 (25.3%) and its lowest in 1983 (22.1%).

Table 1. **Contribution of economic sectors to the gross domestic product (GDP), Guyana, 1980-1984.**

Sector	Contribution to GDP (%)				
	1980	1981	1982	1983	1984
Agriculture	25.3	23.2	23.2	22.1	23.4
Fishing	1.3	1.5	1.8	2.5	2.5
Forestry	1.2	1.4	2.0	2.5	2.5
Mining and quarrying	16.6	7.5	7.0	1.4	4.6
Food and tobacco manufacturing	7.7	11.1	10.8	10.4	9.2
Distribution	8.6	10.7	9.8	10.0	8.9
Transportation and communication	5.6	6.6	6.8	8.1	7.1
Engineering and construction	7.1	8.2	7.6	8.1	7.1
Rental of dwellings	1.4	1.7	2.0	2.3	2.1
Financial services	4.0	4.7	6.4	7.3	6.7
Other services	2.5	3.0	3.6	4.0	3.6
Government	18.7	20.4	19.0	21.3	22.3

SOURCE. Bank of Guyana 1985.

* National Agricultural Research Institute, Coastal Plains Field Research Unit, Burma, Mahaicony, East Coast Demerara, Guyana.

The main crops planted in Guyana in 1982 are shown in Table 2. Sugar cane occupied the largest land area (52,105 ha), followed by rice (45,344 ha), coconut (13,885 ha), fruit (4,167 ha), and root crops (2,980 ha).

Root crops have been consumed in Guyana for many years. These crops assumed greater importance, however, when wheat imports stopped in 1982. The important root crops are cassava (*Manihot esculenta* Crantz), eddoe (*Colocasia esculenta* [L.] Schott var. *Antiquorum*), yams (*Dioscorea trifida* L.), and sweet potato (*Ipomoea batatas* [L.] Lamk). Small areas of dasheen (*Colocasia esculenta* [L.] Schott var. *esculenta*), tannia (*Xanthosoma sagittifolium* [L.] Schott), and white potato (*Solanum tuberosum* L.) are also planted.

Root and Tuber Crop Production and Constraints

Table 3 shows the amount of land and the most important regions where root crops are produced. In 1978 the total area under root crops was 2247 ha. This land area increased to 2980 ha by 1982—an increase of approximately 25%. This was due primarily to an increase in yam and cassava production. The area of yams expanded by 73% and that of cassava by 31%.

The largest land areas of cassava are found in the North West and Pomeroon, East Demerara, and West Coast Demerara regions. Cassava is also grown in the Rupununi region (Figure 1), where there is a large Amerindian population. All the cassava produced in the Rupununi is consumed within that region.

Table 2. **Area (ha) planted to the main food crops, Guyana, 1982.**

Crop	Area planted
Sugar cane	52,105
Rice	45,344
Coconut	13,885
Fruits	4,167
Root crops	2,980
Plantain	2,405
Vegetables	400
Legumes	260

SOURCE: Ministry of Agriculture, Planning Department, Guyana 1982.

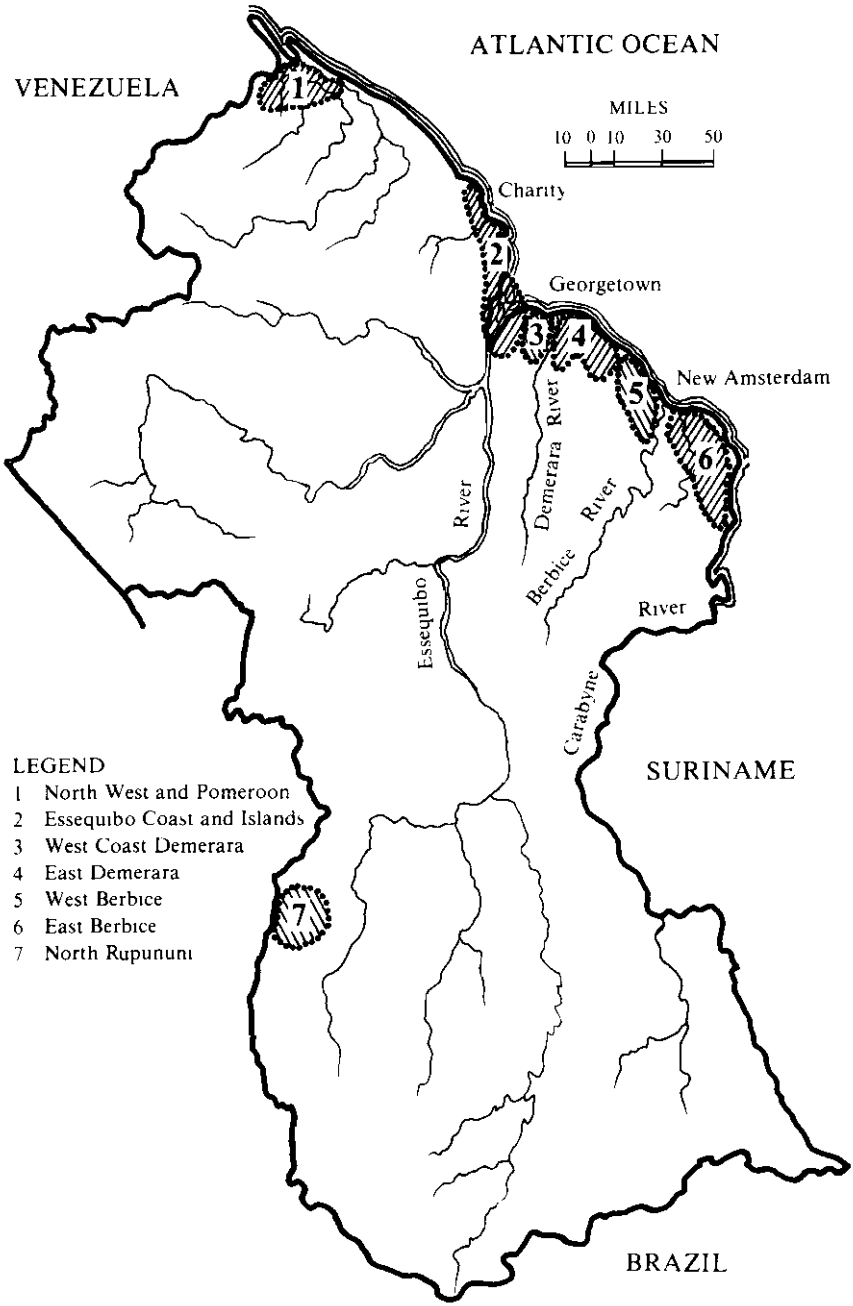

Figure 1. *Map of Guyana showing area (numbered) of root and tuber crops production.*

Table 3. **Land area (ha) in pure stands of root and tuber crops by region, Guyana, 1978.**

Crop	Total	North West and Pomeroon	Essequibo Coast and Islands	West Coast Demerara	East Demerara	West Berbice	East Berbice
Cassava	1436.0	724.0	100.0	148.4	304.0	39.2	120.4
Eddoe	567.6	116.0	232.8	29.2	61.6	3.6	124.4
Yam	50.4	28.0	12.0	3.2	7.2	—	—
Other ground crops	193.6	102.0	0.8	6.8	18.4	4.8	60.8
Total	2247.6	970.0	345.6	187.6	391.2	47.6	305.6

SOURCE: Guyana Rural Farm Household Survey 1978.

Eddoe is produced mainly on the Essequibo Coast and Islands, East Berbice, and North West and Pomeroon regions. The North West and Pomeroon region produces most of the yams, followed by the Essequibo Coast and Islands.

Table 4 shows that a total of 33,201 ha of cultivable land was not cultivated in 1982. It is difficult to ascertain, however, how much of this land area is available for root and tuber crop expansion. The coastal regions of Guyana are mainly cultivated with sugar cane and rice and most of the cultivable land is likely to be expanded to these two crops. It is possible that most of the land in the North West and Pomeroon may be available for root crop expansion with smaller areas in other regions.

Table 4. **Cultivable land (ha) out of production by region, Guyana, 1982.**

Region	Area
North West and Pomeroon	2,940.4
Essequibo Coast and Islands	5,561.6
West Coast Demerara	5,141.1
East Demerara	914.3
West Berbice	12,451.6
East Berbice	6,192.0
Total	33,201.0

SOURCE. Ministry of Agriculture, Planning Department. 1982 Guyana.

Root crops are primarily produced on small farms of one ha or less (Table 5). Approximately 12,500 farms produce root and tuber crops in Guyana.

Root and tuber crop yields have been estimated to be between 6 t/ha and 10 t/ha. The total production in 1978 was over 5000 t (Table 6). Cassava was the largest contributor to total annual root crop production with over 2000 t, followed by eddoes with 1677 t.

Table 5. **Number of farms producing root crops by farm size, Guyana, 1978.**

		Size of farm (ha)						
Crop	Total	<1	1-1.9	2-3.9	4-5.9	6-9.9	10-19	≥19.9
Cassava	6172	1594	961	1014	935	811	488	369
Eddoe	3857	924	617	605	534	492	365	320
Yam	866	105	146	85	173	206	79	72
Other ground crops	1666	510	143	262	273	225	115	138
Total	12561	3133	1867	1966	1915	1734	1047	899

SOURCE Guyana Rural Farm Household Survey 1978

Table 6. **Production (t) of root and tuber crops by region, Guyana, 1978.**

Crop	Total	West and Pomeroon	North Coast and Islands	Essequibo Coast Demerara	West East Demerara	West Berbice	East Berbice
Cassava	2681.6	1414.8	210.9	110.9	700.1	64.4	180.5
Eddoe	1677.1	337.1	624.7	108.7	277.9	7.7	321.0
Yam	621.1	546.0	29.2	4.5	39.9	a	1.5
Other ground crops	575.2	374.2	5.8	9.0	94.7	11.9	79.6
Total	5555.0	2672.1	870.6	233.1	1112.6	84.0	582.6

a. The total amount of yams produced was 40 kg.
SOURCE: Guyana Rural Farm Household Survey 1978

Farm Characteristics

Farm characteristics are similar in the different regions of Guyana in that there are several enterprises within each farm. The number and types of enterprises differ from region to region. In the North West region for example, there may be as many as five enterprises within one farm such as root crops, legumes, plantain, peanuts, and ginger. In the Pomeroon farms produce citrus, avocado and other mixed fruits, root crops, and legumes. In the coastal areas farm enterprises are rice, cattle, legumes, root crops, and vegetables.

Most farms engaged in root crop production are also involved in other crop enterprises. Although several crops may be planted on the farm they are restricted to different areas.

There are several farms, however, that intercrop root crops with other crops. In the Pomeroon region cassava is planted as an intercrop with tree crops such as citrus, avocado, and other mixed fruits. In the North West region yams are often intercropped with corn.

Root crop farmers own or lease their holdings. In general, production is labor intensive rather than mechanized. On larger farms the farmers may own machinery for land preparation. The labor on root crop farms comes mainly from the farm household, although some labor may be hired at peak periods such as at planting and harvesting.

Most farms producing root crops are small and land is not available for root crop expansion. Generally, the farmers prefer to spread their risks over several crops rather than concentrate on any one crop. These farmers do not usually apply for credit and in some cases do not have the necessary collateral for obtaining loans.

Marketing and Constraints

Farmgate prices from 1975 to 1979 are shown in Table 7. The lowest price was paid for cassava; the price of sweet potato was higher; and the price paid for eddoe was greater than that of both sweet potato and cassava. Farmgate prices for yams are unavailable, but this crop usually commands the highest price.

Table 8 shows the wholesale and retail prices of root crops in Georgetown from 1981 to 1984. Generally, both wholesale and retail prices increased over the period with cassava being the cheapest root crop and yams the most expensive.

Table 7. **Farmgate prices (G¢/kg)[a] of some tuber crops, Guyana, 1975-1979.**

	Year				
Crop	1975	1976	1977	1978	1979
Eddoe	30.6	35.2	42.0	46.2	61.2
Sweet potato	30.4	55.0	40.0	48.4	50.2
Sweet cassava	15.6	17.6	33.0	24.2	24.0
Bitter cassava	11.0	11.0	11.0	11.0	11.0

a. Exchange rate G$1.00 = US$0.33 (1984).
SOURCE Ministry of Agriculture, Planning Department, 1980 Guyana.

Table 8. **Average wholesale and retail prices (G¢/kg)[a] of root crops at municipal markets in Georgetown, Guyana, 1981-1984.**

	Wholesale price for year				Retail price for year			
Crop	1981	1982	1983	1984	1981	1982	1983	1984
Cassava	39.3	108.1	67.6	73.8	62.6	153.8	91.3	96.3
Eddoe	42.7	83.6	91.3	120.7	58.6	108.5	122.5	140.9
Sweet potato	71.3	109.0	106.9	133.1	97.3	157.3	115.4	165.7
Yam	106.4	140.0	190.5	227.7	146.1	182.0	221.2	281.6
Tannia	93.6	122.5	116.4	149.8	122.9	153.4	156.1	183.8

a. Exchange rate. G$1.00 = US$0.33 (1984)
SOURCE Ministry of Agriculture, Planning Department Guyana

The prices given are average prices for the period but there are usually seasonal fluctuations in price, with prices being lowest when supply is highest.

Most of the transformation processes in Guyana are effected with cassava. At the community level, cassava is processed into cassava bread, *cassareep*, starch, and farina. Yams are processed into chips and sold as a snack food. Industrial processing is done only with cassava. There are three mills, located in North West, Pomeroon, and West Demerara regions, which are used for cassava processing. The main product of the mills is flour but small quantities of starch, *cassareep*, and livestock feed are also produced.

Table 9 shows the percentage of root crops used for different purposes. These figures represent the use of fresh root crops. Data on the markets for transformed products are not available at this time.

Domestic demand for root and tuber crops is primarily as fresh food. Export of root crops is insignificant and practically all root crop products are consumed locally. However, cassava is also bought in the form of cassava bread, *cassareep*, farina, flour, and starch but data are not available on the actual quantities of these products. Cassava starch is also used in the manufacture of adhesives and as a flocculant (bauxite industry).

Generally, the quality of root crops is considered satisfactory. In the case of yams, however, a virus causes discoloration of the tubers making them physically unattractive to consumers. The most important constraint to domestic demand is price, particularly of fresh yams. Consumers also consider cassava flour expensive.

Root and tuber crop statistics are available from the 1978 Rural Farm Household Survey which is essentially a census of farm households in Guyana. A land use and production survey was begun in 1983, but there were problems with both data collection and processing.

Monthly reports on wholesale and retail prices of root crops at municipal markets in Georgetown are compiled by the Planning Department of the Ministry of Agriculture, and provide data on the volume of produce transported from hinterland areas and prices of agricultural machinery, implements, and chemicals.

Table 9. **Percentage of root crops used for different purposes, Guyana, 1978.**

Crop	Sold	Used for food	Used for other purposes
Cassava	63.8	28.8	7.4
Eddoe	83.3	15.2	1.5
Yam	90.8	8.9	0.3
Other ground crops	88.4	10.2	1.4

SOURCE. Rural Farm Household Survey, 1978 Guyana.

Government Policies

In the early 1970's the government of Guyana embarked on a policy of "import restriction and import replacement." During this period several products were banned, including energy-rich agricultural products such as potato. The use of potato has been partially replaced by locally produced root and tuber crops. Since 1982 wheat has not been imported and Guyanese have been urged to replace wheat flour with both cassava and rice flours. As the Guyana government continues to advocate self-sufficiency in food, it is unlikely that there will be a change in policy with respect to imported energy-rich products.

Available statistics do not indicate the amount of credit provided specifically for root and tuber crops. However, in 1982 the major portion of the loans went to the livestock sector and the second largest disbursement went to arable crops. The loans to arable crops may include loans to root and tuber crops but it is impossible to ascertain what percentage went to these crops.

A program called the Accelerated Production Drive (APD) was started in 1970. Cassava was the only root crop included in this program. The objective of APD was to encourage production of cassava for processing into flour and animal feed (Smith, 1977). Incentives included free planting material, land clearing, loans for planting, harvesting and drainage, and the availability of pesticides on credit. The success of the APD was minimal because incentives were based on area planted rather than area harvested. Farmers planted larger areas but failed to maintain the area of production after receipt of subsidies. The program was stopped in 1976 and no similar incentive scheme has since been put into effect.

Research, Training, and Development

Root and tuber crop research was formerly a function of the Ministry of Agriculture. In 1984, however, the National Agricultural Research Institute was formed and given full responsibility for agricultural research in Guyana.

There are two staff members assigned part time to agronomic research on root and tuber crops. One researcher holds a master of philosophy degree (crop science) and the other a bachelor of science degree (general agriculture). A pathologist, with a master of science degree, and an entomologist, with a bachelor of science degree, are assigned to the research station and are available to the root and tuber crop research section.

In the budgetary allocation for research in 1985 the major portion was earmarked for rice research. The allocation for root crops research is about 9% of the rice allocation.

The main research efforts in root crops have been centered on cassava. The main areas of investigation were cultivar evaluation and plant protection. Some new cultivars of cassava were introduced to farmers as a result of cultivar evaluation trials conducted by Wahab, et al. (1976) and Forde, et al. (1977). The Guyana Sugar Corporation now maintains multiplication plots to supply cassava planting material to farmers.

Several insecticides were tested on cassava planting material (Rai, 1978). From the results of these trials, it was recommended that cassava sticks be soaked in 0.3% monocrotophos for 12 hours before planting.

There has been little sustained research effort on sweet potato. Several attempts have been made to build a sweet potato germplasm collection but most of the cultivars were lost. Cultivar evaluation of sweet potato started in 1967, when it was reported that the highest-yielding cultivar was T67. No further trials were done until 1970 when T67 was again the highest-yielding cultivar. There is no record of the introduction of this cultivar to farmers.

The major pest of sweet potato in Guyana is the sweet potato weevil (*Cylas formicarius*). It has been reported that this pest can reduce the yield of tubers by up to 80% (Rai, 1978). Some research was initiated to test insecticides for controlling the weevil (Rai, 1978). As a result, it was recommended that sweet potato slips be tied in bundles of about 20 and dipped into a 2% triazophos emulsion for one minute, then left in the shade for one day before planting. Rai (1978) also recommended that vines be sprayed with 300 g of emulsifiable concentrate (EC) triazophos per ha in cases of extreme field infestation.

Yams and eddoe have received little research attention. In 1981 two nurseries were established on farms in the North West district in order to multiply high-yielding, least-virus-infested yam clones (Ramroop and Persaud, 1983). However, this program was not completed primarily because of inadequate research staff.

As a result of reports that *Dioscorea alata* (L.) is higher yielding than *D. trifida* (L.) (the major species grown in Guyana) attempts were made to introduce and test cultivars of *D. alata*. These trials were, however, not completed.

Research on root crops has been conducted on research stations and the results were later verified on farmers' plots. Two persons in Guyana are trained in root and tuber crops, one of whom is engaged in agronomic research on root crops. There are no specific courses on root and tuber crops in the country.

The development projects proposed for sweet potato, yams, and cassava are: a survey and collection of cultivars of the yam *D. trifida* in Guyana; the introduction and testing of cultivars of the yam *D. alata* (two cultivars of *D. alata* have already been received from Guadeloupe); a collection to be made of sweet potato cultivars grown locally which will be observed with cultivars introduced in order to find high-yielding adaptable cultivars; a continued evaluation of untested cassava cultivars; and the survey of different cassava cropping systems.

Quarantine Regulations

The quarantine regulations require that all plant material coming into Guyana be accompanied by a phytosanitary certificate from the country of origin. The quarantine service normally requests samples of the planting material or inspects the material while it is growing.

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Spanish Summary

Cultivos de Raíces y Tubérculos en Guyana

En Guyana, la yuca es el cultivo más importante dentro de los cultivos de raíces, los cuales ocupan el quinto lugar de importancia en el contexto de la producción nacional. Se describen los principales sistemas de cultivo empleados por los agricultores en las diferentes regiones del país; generalmente se siembra más de un cultivo para minimizar riesgos. La yuca es el cultivo de raíces menos costoso y el ñame el más costoso; la demanda doméstica de los cultivos de raíces y tubérculos es en su forma fresca; sin embargo, la mayoría de los procesos de transformación artesanal e industrial se realizan con la yuca. Desde 1970, el gobierno de Guyana restringió las importaciones de productos agrícolas ricos en energía; por lo tanto, su uso se reemplazó con los cultivos de raíces y tubérculos producidos localmente. En el mismo período, se creó el programa Accelerated Production Drive, cuyo fin era promover la producción del cultivo y procesamiento del producto en harina y alimento animal; desafortunadamente el programa no tuvo éxito. Se enumera el personal del National Research Institute, cuyo interés se ha enfocado principalmente en arroz y yuca. Se presentan brevemente los resultados de algunas investigaciones hechas sobre cultivos de raíces y se proponen proyectos de desarrollo para batatas, ñame y yuca.

Les Racines et Tubercules en Haïti

*Anne Tremblay et Luc Pierre-Jean**

Introduction

Les tubercules représentent au même titre que les céréales, l'alimentation de base de la population haïtienne. Les données existantes sont éparses et traitent tantôt des aspects micro-économiques (Bellande, 1982; Pierre-Jean, 1984; Regis, 1982), tantôt des aspects macro-économiques (Capital Consult, 1982).

D'autres entités (organismes de recherche et projects de développement) abordent les tubercules sous l'angle de la recherche agronomique dans la perspective de répercussions positives au niveau de l'exploitation.

L'objectif de ce travail est de rassembler l'ensemble des données disparates afin de constituer des éléments de base permettant de réfléchir sur la problématique des tubercules en Haïti. De la production à la consommation tous les aspects seront abordés ainsi que les facteurs limitants pour une amélioration de la production des tubercules en Haïti.

Situation Géographique

D'après des estimations faites par le Ministère de l'Agriculture, des Ressources Naturelles et du Développement Rural (MARNDR), les tubercules occupent environ 150,000 des 1,400,000 hectares cultivables en Haïti (Tableau 1).

Sauf pour la pomme de terre (*Solanum tuberosum*) qui est assez circoncise à un périmètre donné, la production des tubercules serait plutôt éparpillée.

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Les aires de production varient en fonction des exigences écologiques des différentes espèces. Ainsi, comme le montre le Tableau 2, la culture de l'igname (*Dioscorea* spp.) est surtout concentrée dans les montagnes humides qui représentent 15% de la surface cultivable, alors que la patate douce (*Ipomoea batatas*) ou le manioc (*Manihot esculenta*) ont une diversité écologique beaucoup plus forte qui les fait s'adapter aux sols moins favorables.

En Haïti, il n'existe plus de terres disponibles pour étendre les cultures des tubercules vivriers à moins que ne soient récupérées les terres érodées

Tableau 1. **Situation géographique de la production, Haïti.**

Produit	Superficie (ha)	Grandes aires de production
Patate douce	55,550	Port-au-Prince, Port-de-Paix, Les Cayes, Cap Haïtien
Manioc	57,900	Les Cayes, Hinche, Cap Haïtien, Port-de-Paix, Fort Liberté
Igname	30,653	Cap Haïtien, Jérémie, Jacmel
Pomme de terre	1,000	Port-au-Prince (Kenskorff), Jacmel (Seguin, La Vallée), Salagnac
Mazombelle	négligeable	En petite quantité partout où les conditions d'humidité sont satisfaisantes

SOURCE. Capital Consult Promotion des investissements dans l'agriculture.

Tableau 2. **Répartition écologique des différentes espèces, Haïti.**

Tubercules vivriers	Grandes aires de production[a]	Pourcentage
Patate douce	Montagnes humides et sèches, plaines humides	50
Manioc	Montagnes humides, plaines semi-arides	60
Igname	Montagnes humides	15
Pomme de terre	Montagnes humides	15
Malanga, mazombelle	Montagnes humides, plaines irriguées	20

a. Montagnes humides (15%), montagnes seches (25%), plaines humides (10%), plaines semi-arides (45%), plaines irriguées (5%).

SOURCE. Capital Consult, Promotion des investissements dans l'agriculture.

ou que l'on mette en valeur quelques plaines arides. L'amélioration la plus évidente passe donc par l'amélioration de la productivité des espaces cultivés.

L'Exploitation Agricole

Une forte proportion des exploitations agricoles en Haïti ont une dimension allant de 0 à 1.29 ha et occupent 32.5% de la superficie cultivable (Tableau 3). Seulemente un faible pourcentage dépasse 3.9 ha (3 carreaux; 1 carreau = 1.29 hectares).

On ne connaît pas exactement le nombre de'exploitations agricoles produisant des tubercules, mais, à partir des observations et de certaines études spécifiques faites dans certaines zones, on peut se permettre de faire les approximations suivantes (ces considérations ne sont vraies que dans la mesure où l'on se réfère aux grandes aires de production).

La culture des tubercules est un fait dans la plupart des exploitations agricoles. On peut dire que 70.7% des exploitations ont des tubercules dans leur production. Chiffre qui correspond à la population rurale agricole ayant de 0 à 10 carreaux.

Cependant les calculs suivants montrent que 1.68% de la population haïtienne est occupée à temps plein à la production des tubercules.

Si l'on part des hypothèses émises au Tableau 4, ainsi que des études plus précises réalisées dans les zones écologiques du Sud d'Haïti, en particulier La Vallée de Jacmel (Bouchet *et alii*, 1983) et Salagnac (Bellande, 1982), on peut distinguer huit types de'exploitations agricoles (E.A.). La proportion des tubercules dans chacun des groupes varie en fonction de l'appartenance des agriculteurs à l'un ou l'autre de ces groupes.

Tableau 3. **Dimension et importance des différents types d'exploitation, Haïti.**

Taille[a]	Nombre d'exploitations	%	Superficie[a]	%
0 à 1	438,000	71.1	218,000	32.5
1.1 à 3	147,000	23.8	271,000	40.5
3.1 à 10	30,000	4.8	146,000	21.9
10 et plus	2,175	0.3	34,000	5.1

a. L'unite utilisée est le carreau 1 carreau = 1.29 hectares.

SOURCE: Ministère de l'Agriculture des Ressources Naturelles et du Développement Rural. 1979

Tableau 4. **Types d'espèces cultivées en fonction de la dimension de l'exploitation agricole (E.A.), Haïti.**

Taille des E.A. (carreau)	Igname	Pomme de terre	Malanga et mazombelle	Manioc et patate douce
0.0 à 1.0	+	+	+	+++
1.1 à 3.0	++	+	+	++
3.1 à 10.0	+++	+	+	+
10 et plus	divers	divers	divers	divers

Les travaux effectués dans la zone Nord du pays (Remi, Courtier, et alii) où six groupes d'agriculteurs on été répertoirés dans onze zones, prouvent que le manioc est le tubercule le plus courant et se retrouve parmi les cultures à produit brut faible et à haute intensité de travail. Cette culture est pratiquée principalement par les agriculteurs qui ont de 0 à 0.5 carreaux de terre.

A partir d'un transect allant de 100 à 300 m d'altitude on peut facilement recouper les grands ensembles écologiques avec les systèmes de culture où les tubercules sont apparus en association avec d'autres espèces végétales. Les critères qui se révèlent les plus pertinents pour expliquer ces systèmes sont: la pente, l'altitude, les caractéristiques des sols et le degré d'érosion. Les autres composantes des systèmes tels que les systèmes d'élevage ainsi que la durée des jachères sont des conséquences logiques des systèmes de culture pratiqués.

L'igname, la patate douce et la pomme de terre sont les composantes principales des zones situées à 900 m d'altitude ou plus, à pente nulle, sur des sols ferrallitiques.

Dans les rendzines calcaires seule la patate douce est présente entre 800-900 m. Ceci en raison de la faible profondeur de ces sols.

Le manioc commence à apparaître surtout à des altitudes beaucoup plus basses et en association avec beaucoup plus d'espèces végétales.

La prèsence par la suite du manioc, de la patate douce et des aracées, malanga (*Colocasia esculenta* var. *esculenta*) et mazombelle (*Colocasia esculenta* var. *antiquorum*) dans les autres écosystèmes est directement liée soit au degrée d'erosion de sols, soit à l'humidité. Ainsi la patate, dans les cas extrèmes d'érosion des basaltes, est-elle le seul tubercule qu'on rencontre dans les moyens et bas mornes (montagnes) alors que les aracées ne se rencontrent que dans les fonds frais et sur les berges des rivières. Plus

haut, les aracées doivent être cherchées près des habitations où les conditions de leur développement sont réunies dans un micro-climat arboré.

Des travaux effectués dans le Nord du pays (ODN) ainsi que d'autres essais réalisés par le PDAI (Projet de Dévelopment Agricole Intègre) on montré qu'en station expérimentale, on peut obtenir:

Pour certaines variétés de manioc 15.6 t/ha;
Pour certaines variétés de patate douce 20.0 t/ha; et
Pour l'igname et la pomme de terre 10.0 t/ha.

Au niveau de l'exploitation agricole, les rendements son plus faibles et variables avec les zones écologiques (Tableau 5). Il est à noter que, exception faite de rares plaines irriguées où l'on cultive les tubercules en culture pure, les tubercules sont associés à une où plusieurs espèces.

Coût de Production des Espèces et Economie d'Echelle

Les coûts de production varient beaucoup selon l'échelle de production considérée. En dessous d'un hectare les coûts sont plus élevés. Ce qui explique pourquoi certaines cultures faites à petite échelle comme le malanga et la pomme de terre ont des coûts de travaux aussi élevés à l'hectare (Tableaux 6 et 7).

Par ailleurs, ces chiffres montrent pourquoi l'igname est surtout une culture de rente tandis que la patate douce et le manioc sont davantage des cultures d'auto-consommation.

L'ordre des prix de détail à la ferme va croissant: patate douce

Tableau 5. **Rendements au niveau des exploitations agricoles (t/ha), Haïti.**

Zones écologiques	Igname	Patate douce	Manioc	Pomme de terre
Haut plateau	1.9	1 à 2.3	1.8	20.0
Haut morne		0.5		
Moyen plateau	9.0	2.6	3.6	11.9
Moyen et bas M		0.5 à 1.0	1.0	
Plaines sèches		—	—	
Plaines semi-arides		3.38	0.1 à 1.3	
Plaines irriguées		8.0	5.0	
Valeur générale	5.5	2.5	1.5	11.9[a]

a. Système semi-traditionnel.

Tableau 6. **Population haïtienne affectée à la production des tubercules en Haïti, 1979.**

Tubercule	Besoin en M.O. (No. jours/ha)	Equivalent/hr (hr/ha)[a]	Superficie (ha)	Population
Patate douce	110	44	55,550	24,442
Manioc	150	60	57,900	34,740
Igname	200	80	30,653	24,522
Pomme de terre	110	44	1,000	440
Moyennes et totaux	145	58	145,103	84,144

a. Un équivalent/homme correspondant à 250 jours de travail par an (50 sem. x 40 hr).

Tableau 7. **Coûts de production (US$/ha) 1985, Haïti.**

Operations culturales	Patate douce	Manioc	Igname jaune	Igname rural	Pomme de terre	Malanga
Fumure	80	80	180	180	310	232
Buttage, sarclage, et plantation	38	34	240	440	310[a]	77
Semences	6	10	4000	800	1937	155
Désherbage	9	8	15	15	77	77
Récolte	15	15	320	160	77	77
Traitements	—	—			116	—
Coûts totaux	148	147	4755	1615	2827	618

a. Sur-évaluation due à l'échelle de production.

(US$88/t), manioc (US$151/t), malanga (US$168/t), mazombelle (US$176/t), pomme de terre (US$372/t), igname (prix normal US$1300/t, luxe US$200/t).

Les prix de gros sont donnés pour quelques produits: patate douce (US/80/t), igname (US/294/t).

Pour qui dispose du capital de départ, d'une voie d'écoulement et de terres, l'igname est le tubercule préféré.

Dans les aires encore limitées des zones proches de Port-au-Prince et dans les aires de certains projets (La Vallée, Salagnac...), la pomme de terre, quoique de marché restreint, offre une alternative au producteur de moindre capital de départ.

Pour les paysans pauvres et/ou disposant de mauvaises conditions climatiques et pédologiques, le manioc ou la patate douce serviront à l'auto-consommation. Les éventuels surplus seront vendus pour acheter l'huile, le sucre, le gaz nécessaires (Tableau 8).

Volume de la Production Nationale

Une estimation de la production a été calculée à partir des superficies emblavées par catégorie de production (Tableau 1) et des rendements moyens en exploitation paysanne (Tableau 5). La patate douce a été ainsi évaluée à 138,875 t, le manioc à 86,850, l'igname à 168,591 et la pomme de terre à 11,900 pour une production totale de 406,216 t en 1979.

Le volume total de la production des tubercules est d'environ 406,000 t. Il occupe 7.4% des productions agricoles et 28% des productions alimentaires (Tableau 9).

Les facteurs limitant la production des tubercules en Haïti sont de deux ordres: les facteurs spécifiques liés à chaque espèce; et les facteurs généraux liés aux structures du pays (Tableau 10).

Transformation et Commercialisation des Tubercules

Exception faite du manoic qui est transformé industriellement, les tubercules ne subissent de transformation qu'à la cuisson. La forme la plus

Tableau 8. **Revenus bruts, productivité et stratégies paysannes de production (US$/ha), 1985, Haïti.**

	Igname	Patate	Manioc	Pomme de terre
Recettes tirées de la vente	7150	220	227	4464
Coûts de production	4755	148	147	2827
Bénéfices	2395	72	80	1637
Productivité du travail par rapport à la terre (ha/homme)	1.25	2.27	1.67	2.27
Rémunération du capital (terre) et de la main d'ouvre (US$/hr)	11.98	0.65	0.53	14.88
Investissements en capital (intrants)	+++	+		++
Stratégies paysannes	rente	auto-consommation		rente

Tableau 9. **Production (t) agricole, 1979, Haïti.**

Produits	Production	Production alimentaire (%)	Prod. agricole (%)
Alimentaires			
Maïs	257,000	17.7	4.7
Haricots	300,000[a]	20.7	5.5
Bananes	191,000	13.1	3.5
Tubercules	406,000	28.0	7.4
Riz	83,000	5.7	1.5
Millet	215,000	14.8	3.9
Total	1,452,000		
Industriels			
Café	33,000	—	0.6
Cacao	3,100	—	0.1
Coton	4,000	—	—
Canne	4,000,000	—	72.8
Tabac	2,000	—	—
Total	5,494,100		

a. Le pois cargo et les autres pois inclus.

traditionelle de la consommation de la patate douce, outre la patate frite et bouillie est le pain patate, sorte de gâteau sucré.

Comme partout ailleurs, le manioc est utilisé sous forme de farine et d'amidon. Le processus de transformation le plus connu est la cassave. En 1976, on a estimé à environ 7,000,000 de gourdes, soit 1,400,000 dollars américains, la quantité de cassaves vendues en Haïti. Il y a une dizaine de cassaveries installées dans deux zones du pays: le nord et la Grand'anse (Tableau 11).

Les tubercules restent, en Haïti, des produits d'auto-consommation par excellence, sauf la pomme de terre et l'igname à un moindre degré. Selon la zone écologique, 4 à 33% de la production d'igname est commercialisée ainsi que 13 à 21% de la production de patate douce. Pour le manioc, la commercialisation du marché se fait surtout sous forme de cassave ou de pain de manioc.

Pour tous les tubercules, le circuit de commercialisation suit le schéma courant des produits vivriers décrit par Didier Pillot. Dans ce schéma deux types de revendeuses (Madame Sarah) assurent le cheminement des tubercules depuis le producteur jusqu'aux consommateurs des villes (principalement Port-au-Prince). L'approvisionnement se fait dans trois types de marchés définis en fonction de leur situation et fréquentation.

L'alimentation animale en matière de tubercules est faite de déchets de cuisine (pelures d'ignames, de patate) et de récoltes (fanes de patates). Ces déchets servaient a l'alimentation porcine principalement.

Tableau 10. **Facteurs limitant la production de tubercules, Haïti.**

Tubercules	Facteurs spécifiques	Facteurs plus généraux
Igname	Manque de semences	Conservation et stockage
	Manque de crédits	Prix faible sur marché
	Attaques phytosanitaires (marocas, nématodes)	Commercialisation
	Risque de sécheresse	
Patate douce	Problème de transformation Ataques d'insectes (*Cylas formicarius*) Problème de marché Variabilité variétale	Manque de travaux de recherche sur les possibilités des génotypes locaux.
Manioc	Manque de débouchés Problème de transformation	Dégradations de l'environment.
Pomme de terre	Coût élevé des semences Maladies phytosanitaires Culture très localisée	Faible fertilité des terres Problème de transformation des produits
Malanga et mazombelle		Manque de crédit

Tableau 11. **Processus de transformation domestique et industrielle, Haïti.**

Tubercules	Au niveau des E.A.[a]	Au niveau artisanal
Igname	Bouillie, purée, gâteau, frite	Aucun
Manioc	Farine, pain (boborie), cassave, boulette	Cassave (10 cassaveries produisant por une valeur de US$1,400,000)
Patate douce	Pain, patate, patate frite, bouillie + lait ou autre	Aucun
Malanga et mazzombelle	Acra, purée	Aucun
Pomme de terre	Frite, purée, gâteau, farine, bouillie	Aucun

a. E.A. = l'exploitation agricole.

SOURCE: Séminaire sur la patate douce. Avril 1985.

Les villes sont en grande partie le marché visé par les producteurs. Le manque de moyens de communication est l'une des contraintes majeures de l'acheminement des tubercules vers les centres urbains. La principale zone de production se situe à 200 km par bateau de Port-au-Prince, principal centre d'écoulement. Par ailleurs, les autres aires de production desservent très mal les villes d'importance économique secondaire telles que Cap Haïtien, Gonaives, Les Cayes, Port-de-Paix, et Jacmel.

Une quasi-inexistence de transformation, un approvisionnement vaille que vaille des marchés secondaires (villes de province), peu de valorisation pour la production animale, deminuent les voies de satisfaction de la demande que l'on traitera dans le chapitre suivant.

La Demande Domestique

La production des tubercules s'établissait en 1979 à 406,500 t, ce qui équivaut à 81.3 kg/ha pour une population estimée en 1980 à 5,002,000 personnes.

Cette production doit répondre aux besoins en semences et en consommation. L'importation n'intervient pratiquement pas pour cette catégorie de produits.

La demande en produits frais doit répondre aux besoins de semence et de consommation fraîche (Tableau 12).

Les besoins de semence ne s'appliquant qu'à l'igname et à la pomme de terre (partiellement), ils n'occupent qu'une part assez faible (11%) de la demande.

Tableau 12. **Décomposition (t) de la demande en produits frais et transformés pour Haïti, 1979.**

Produit	Production	Demande fraîche	
		Consommation	Semence
Igname	168,500	126,600	42,000
Patate	139,000	139,000	—
Manioc	87,000	—	—
Pomme de terre	12,000	10,000	2,000[a]
Total	406,500		44,000

a. Une portion assez faible provenant de l'importation a été retirée.

Les seules entrées de tubercules se font pour l'introduction de variétés hollandaises de pommes de terre (Rezy, Renova, Baraka, Jaerla) par la societé DARBOUCO.

La demande de consommation de produits frais correspond à 72.5 kg per annum. Ceci équivaut aux chiffres obtenus par l'étude de Beghin, Fougère, et King (1970) qui estimait la consommation des racines et tubercules à 69.5 kg/an. Par contre, ils ne sont pas corroborés par DIFPAM (1980) qui estimait la consommation à 106 kg per annum.

Cette demande correspond à 15.4% de la ration alimentaire en volume et fournit avec les bananes, sucres, et céréales, l'énergie de la ration alimentaire (Tableau 13).

Si on analyse l'évolution de la consommation perçue par DIFPAM, on s'aperçoit que les tubercules sont venus en substitution des bananes (fruits) et sucre pour répondre à la demande en glucides. Ceci montre une dégradation du niveau de vie de l'haïtien moyen.

Au niveau de la quantité d'aliments importés pour le bétail, il y aurait sans doute aussi un marché pour les tubercules notamment pour l'apport énergétique.

Au niveau nutritionnel l'apport des pommes de terre pourrait constituer un bon apport protéique. Dans les bouillies de bébé leur apport

Tableau 13. **Composition de la consommation alimentaire, 1970 et 1978, Haïti.**

Groupe d'aliments	Consommation (kg per annum)	% de la ration	Consommation
Racines, tubercules	69.50	15.4	106.0
Céréales	63.00	13.9	63.0
Sucres	66.80	14.8	32.8
Légumineuses	25.60	5.7	25.6
Viandes	8.00	1.8	8.0
Poissons	1.80	0.4	1.8
Oeufs	0.90	0.2	0.9
Produits laitiers	11.20	2.4	11.2
Fruits	145.50	32.2	109.5
Légumes	43.00	9.5	43.0
Matière grasse	6.60	1.4	6.6
Divers	10.60 -	2.3	3.0
Total	452.50	100.0	411.4

SOURCE: DIFPAM Dialogue. Vol. 46. Janv. 1985. p.16 (corrigé).

protéines/hydrates de carbone est très favorable face aux céréales et pourrait venir en remplacement du lait (Lucas, 1981). Sans doute la demande est-elle assez restreinte pour la pomme de terre étant donné le segment de marché actuellemente exploité et les prix qui y sévissent. Son coût est cependant avantageux si on le compare à l'igname vendu à l'unité.

A part le manioc, les tubercules sont toujours vendus frais. Si une demande existe, l'exploitation de ce secteur de marché ne s'est pas faite. Le manioc subit des transformations au niveau du producteur ou de la revendeuse parfois. Cependant il est rare de rencontrer farine ou amidon de manioc sur le marché. Pour le manioc amer, il est transformé au niveau des cassaveries qui l'achètent parfois même sur pied lorsque la distance à parcourir est grande.

Une des premières exigences du consommateur haïtien, et cela pour tous les tubercules, est la dimension de ces derniers. En général l'attrait pour les gros tubercules augment les prix, même si dans certains cas le vendeur est obligé de les morceler. Par ailleurs, le consommateur haïtien apprécie les produits sains et secs en général.

On préfère la patate douce sucrée et une texture fine chez l'igname. Cependant il n'y a aucune préférence particulière pour le manioc, le malanga ou le mazombelle.

Le faible pouvoir d'achat de presque 90% de la population favorise l'auto-consommation et la consommation de tubercules de seconde qualité (patate douce, manioc) qui ont aussi un faible rendement à l'hectare. L'igname et les aracées son consommés par la classe moyenne et la pomme de terre reste en gros le tubercule de choix de la classe la plus aisée (Tableau 14).

Les prix versés correspondant à la perception du consommateur: produit inférieur: US$150/t et moins; produit supérieur: US$300/t et plus. Le gros igname peut atteindre des prix élevés; étant perçu comme symbole de fertilité il est donné lors de mariages et des cérémonies vaudous.

La Demande Extérieure

Toute la production est consommée localement. La quantité produite est probablement insuffisante pour songer au marché extérieur. Un des débouchés pour un éventuel surplus serait les marchés européens de l'alimentation du bétail.

Tableau 14. **Composition approximative de quelques tubercules et fruits amylacés avec référence aux céréales.**

	Eau (%)	Glucides %		Proteines %	
		a	b	a	b
Patate douce	70	27[c]	90	1.3	4.3
Igname[d]	72	24	86	2.4	8.6
Mazombelle (madère)	72	24	86	1.9	6.8
Malanga	65	31	88	2.0	5.7
Pomme de terre	78	19	86	2.0	9.0
Fruit à pain (lam)	76	21	87	1.3	5.4
Banane plantain	63	34	92	1.6	4.3
Riz blanc	13	80	92	6.2	7.1
Grains de maïs	13	69	80	9.5	10.9

a. Par rapport au poids frais
b. Par rapport au poids sec
c. Dont 2 à 4% de sucres
d. En fait très variable selon les espèces.

SOURCE: Messiaen, C.M., Le potager tropical.

Importations

En 1980, Haïti a importé pour environ 50 millions de dollars US de produits alimentaires. En 1984, ce chiffre est passé à 75 millions dont l'essentiel (75%) est constitué de céréales. La mise en place d'une politique rationnelle en matière de tubercules pourrait viser la réduction de ces importations. L'une des voies possibles est l'industrie de transformation qui faciliterait la récupération des surplus découlant d'une augmentation de la production des tubercules.

On pourrait qualifier la politique nationale en matière de tubercules d'élitiste dans le sens où elle favorise la satisfaction de la demande en tubercules de luxe (pomme de terre, igname) sans essayer de répondre aux besoins de la population. Il y a une possibilité de débouchés par la transformation des espèces cultivées à plus grande échelle.

On ne peut pas dire non plus qu'il y ait une stratégie susceptible de réduire les importations à moyen terme en encourageant la production de tubercules comme substituts aux céréales. Seulement en 1985, au titre de l'aide PL 480 près de 45 millions de dollars de céréales provenant des Etats-Unis arriveront sur le marché haïtien.

Sans ajouter l'aide alimentaire française (10 millions) et d'autres organismes philantropiques (Mission Adventiste, Secours Catholique,

Service Chrétien, Caritas, etc,). Ces produits obtenus de l'aide sont gratuits et exempts de taxes. La conséquence à court et à moyen terme est de faire chuter davantage le prix des tubercules sur le marché (principalement pour la patate et le manioc).

L'ideal serait de taxer les aliments importés, de réduire au fur et à mesure l'aide alimentaire afin de provoquer une augmentation relative du prix de tubercules vivriers. Ceci encouragerait le producteur à investir davantage dans la production de tubercules. Malhereusement, ce n'est pas encore la tendance actuelle.

Depuis 1979, les deux institutions de crédit du pays commencent à manifester un certain intérêt pour les tubercules. Ainsi l'Institut de Développement Agricole et Industriel (IDAI) accorde un crédit de 75,000 dollars US aux producteurs et la Banque de Crédit Agricole (BCA), le double. Pour l'IDAI ce chiffre représentait, en 1979, 6% de son crédit à la production agricole.

Jusqu'à récement, le MARNDR subventionnait à 50% le prix de la caisse de semences de pommes de terre importée. On ne peut qu'espérer que cet effort ira en s'accroissant.

La Recherche sur les Tubercules Vivriers

En matière de recherche sur les tubercules, les organismes et institutions qui mènent des actions sont (Tableau 15):

La Faculté d'Agronomie et de Médecine Vétérinaire (FAMV);
L'Organisme de Développement du Nord (ODN);
Le Projet de Développement Agricole Intégré (PDAI);
Le Projet d'Intensification des Cultures Vivrières (PICV); et
Le Centre de Recherche-Développement de La Vallée de Jacmel (CRD-La Vallée).

Tableau 15. **Personnel affecté à la recherche sur les tubercules, Haïti.**

Organisme	Nombre	Niveau (études)
FAMV, CRDA, et	1 personne temps plein	Diplome d'Agronomie
CRD-La Vallée	1 professeur chargé recherche	Approfondie (DAA)
	1 agronome résident T.P.	Licence (FAMV)
ODN	1 personne 1/4 temps	DAA
PDAI	3 personnes (1983)	1 docteur (étranger) 2 licences
PIVC	1 personne 1/4 temps	Licence en agronomie

Il n'existe pas de budget consacré spécifiquement à la recherche sur les tubercules en Haïti. Par contre, dans les projets et les organismes ci-dessus mentionnés, il y a des rubriques «recherches agricoles» où, en fonction des besoins, il est possible de tirer un peu d'argent pour les tubercules. La durée de vie de ces actions de recherche est directement liée à celle des projets. Dans la majoritée des cas, l'équipe meurt avec le projet dont la durée ne dépasse guère quatre ans.

Depuis deux-trois ans néanmoins, avec la nouvelle orientation de la FAMV, une personne est attachée à plein temps au Département de Phytotechnie et travaille tant pour la recherche que pour l'enseignement. Son travail est concentré d'une part au CRD situé dans le Sud et d'autre part à la Faculté où elle dispense cours et stages pratiques et oriente les étudiants en fin de cours sur des voies de recherche en matière de tubercules.

Les thèmes abordés en matière de recherche sur les tubercules vivriers varient avec le type d'organisme ou de projet. Dans les projets dont la durée de vie est courte, l'accent est surtout mis sur la lutte anti-parasitaire, la comparaison du rendement des variétés, et l'introduction de nouvelles variétés. C'est le cas des projets PDAI, ODN, et PICV. Le but de ces recherches et d'assurer un transfert rapide aux paysans des zones touchées.

D'autres organismes plus ou moins stables, tel le Centre. Madian-Salagnac ou le CRD-La Vallée, la FAMV et le Centre de Recherche et de Documentation Agricole (CRDA) mettent surtout l'accent sur des thèmes plus méthodologiques tels que:

La sélection variétale à partir du matériel génétique local;

La mise en place de méthodes de lutte contre les pestes (vers blancs chez les ignames, variétés résistantes au *Cylas formicarius*);

Variété adaptée à la sécheresse;

Fertilisation minérale dans les associations de cultures;

Influence des techniques culturales sur les rendements; et

Possibilité de faire du pain à base de tubercules, etc.

Existence de Cours Spécifiques en Matière de Tubercules

Seulement au niveau de la FAMV, un cours d'une durée de 2 hr par semaine pendant un semestre est dispensé à une moyenne annuelle de 40 étudiants (3ème année).

Très probablement, des cours assez succints sont dispensés aux étudiants de l'Ecole Moyenne d'Agriculture (EMA) et des quatres écoles vocationnelles du pays.

Période de Quarantine et Approvisionement pour les Tubercules

Sauf dans les cas bien spéciaux d'expérience en milieu contrôlé, l'importation d'espèces végétales est interdite par les loies haïtiennes. Toutefois cinq maisons de commerce spécialisées dans la vente de produits agricoles importent chaque année une grande quantité de pomme de terre.

Conclusions

De cette étude il ressort qu'au niveau global le rendement à l'hectare des tubercules en Haïti n'est pas très élevé. L'amélioration du rendement est conditionnée par tout un ensemble de facteurs liés entre eux, mais parfois spécifiques à l'espèce elle-même ou à un groupe d'espèces.

L'igname et la pomme de terre sont les deux tubercules les plus rémunérateurs sur le marché haïtien mais les problèmes de coût des semences, donc d'investissement de départ, limitent leur développement.

Le malanga et le mazombelle sont limités par des problèmes d'espace écologique favorable. Ce qui explique leur faible importance dans les assolements.

La patate douce et le manioc sont les deux tubercules auxquels les paysans haïtiens consacrent la plus grande partie de leur assolement en raison du faible coût à l'hectare d'investissement initial, et aussi, de leur grande adaptation aux conditions de dégradation du milieu physique. Le prix offert au producteur est trop faible pour penser à un plus grand effort de sa part alors même que la production actuelle suffit pour répondre à la demande.

Pour chacun de ces groupes, l'orientation future de la stratégie politique et de la recherche agronomique doit être différente:

L'igname et la pomme de terre: Améliorer le rendement et la production pour satisfaire la demande potentielle. Pour cela les efforts doivent être concentrés sur la lutte phytosanitaire (marocas, nématodes) et un crédit plus substantiel accordé à la production.

Pour la patate douce et le manioc: Il faudrait penser à des possibilités de transformation artisanale ou industrielle et éventuellement à

l'alimentation du bétail dans le but d'absorber les importations d'aliments de bétail faites actuellement. Telles sont les conditions nécessaires pour une amélioration du rendement. Par ailleurs, il faut penser au niveau de la recherche à des actions spécifiques sur les luttes antiparasitaires (*Cylas formicarius*) et sur la sélection variétale très prometteuse.

De façon plus globale, la réduction progressive de l'aide alimentaire demeure la condition idéale pour encourager les paysans haïtiens à une amélioration du rendement des tubercules en particulier et des cultures vivrières en général.

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English Summary

Root and Tuber Crops in Haiti

The existing data, from production to consumption, for sweet potato (*Ipomoea batatas*), cassava (*Manihot esculenta*), yam (*Dioscorea* spp.), potato (*Solanum tuberosum*), taro (*Colocasia* spp.), and arum crops are

presented in order to provide basic elements with which the problems of these crops in Haiti can be analyzed.

The ecosystems in which they are grown are described as are farm characteristics, labor, cropping systems, production costs, volume, and constraints.

The processing and marketing of the products, the domestic demand for fresh and processed products, and their constraints are also discussed. It should be noted that these crops are consumed only locally.

Government policies are analyzed and the institutions, personnel, training, and budget involved in research are described. Finally, some recommendations on an approach toward research are made.

Resumen en español

Cultivos de Raíces y Tubérculos en Haití

Se presentan los datos existentes, desde la producción hasta el consumo, de la batata (*Ipomoea batatas*), yuca (*Manihot esculenta*), ñame (*Dioscorea* spp.), papa (*Solanum tuberosum*), malangay (*Colocasia esculenta* var. *esculenta*) y mazombelle (*Colocasia esculenta* var. *antiquorum*), para tener elementos básicos que permitan analizar la problemática de estos cultivos en Haïtí.

Se indican los ecosistemas en los cuales se cultivan, las características de las fincas, la mano de obra requerida, los sistemas de cultivo, y los precios, volumen y limitantes de la producción.

Se discuten el procesamiento y mercadeo de los productos, la demanda doméstica por productos frescos y procesados y sus limitaciones; es de anotar que estos cultivos son sólamente consumidos a nivel local.

Se analizan las políticas gubernamentales y se indican las instituciones, personal, capacitación y presupuesto involucrados en la investigación. Finalmente se dan algunas recomendaciones sobre el enfoque que se debe tomar en relación con la investigación.

approximately 40% is cultivated at any given point in time with a higher proportion remaining fallow during the dry season. Thirty-five to 40% of this land is occupied by root crops distributed islandwide with major concentrations in the Central Belham Valley and on the upper slopes of the Soufriere Hills and Centre Hills below the forest line. These areas have an annual rainfall of 1500 to 2000 mm.

Currently, farm land is underutilized and there is land available for root crop expansion if the need arises. At present, there is a potential for 815 ha of arable land to be used in the production of food crops and vegetables. There are also 1136 ha capable of being used in mixed-farming cultivation of food crops and improved pastures, and another 820 ha available for mixed farming of tree crops, food crops, and pastures.

The total production area under root and tuber crops is almost as much as that under vegetables and other food crops. In a recently completed islandwide farm survey, conducted by the Ministry of Agriculture in 1983, it was shown that of the possible 332 ha of land available for vegetable and food crops, nearly 60% was in continuous fallow while root and tuber crops occupied 14% (Table 1).

Sweet potato is the dominant staple and has been since the early sixties. This crop establishes easily, tolerates drought, and has export market potential during certain periods of the year. Aroids and yams are grown primarily for local comsumption and tend to be seasonal. Consequently, there are low supplies of these crops on the market between March and August with supplies increasing toward the year's end.

Cassava *(Manihot esculenta),* as a fresh staple, is almost unknown in Montserrat. Farmers grow cassava specifically for processing into cassava

Table 1. **Land allocation (ha) for vegetable and food crops, Montserrat, 1983.**

Crop type	Area (ha)	Percentage of total area
Vegetables	28	8
Roots and tubers	46	14
Other food crops	48	15
Fallow (1 year or less)	20	6
Fallow (1 year or more)	190	57
Total	332	100

bread (cakes) during the festival season. The crop is rarely grown in pure stands but is planted along field borders and contours, and intercropped with pigeon pea, sweet potato, and aroids.

The aroids—eddoe, dasheen, and tannia—are cultivated at subsistence levels for local consumption and their supply, based on local market indicators, appears to be seasonal. These commodities are most abundant from December to March and their production and supply seem to be conditioned by two factors: production for the winter tourist season; and emphasis on growing cash crops in the prime growing season—October to April. Cash crops are also at a premium during the tourist season in comparison with root and tuber crops.

There have been sporadic attempts, in the past, at producing white potato. In the mid-1970's land area under cultivation reached a peak of 40 ha. Production of the crop was scaled down and eventually halted in 1979 because of disease problems and low productivity as was reflected by farmers not being able to repay loans to the DFMC-operated credit scheme. A program has recently been initiated to reintroduce the crop within a carefully monitored program supervised by a multidisciplinary task force. In 1984 ten farmers cultivated a total of 2 ha of the crop with varying degrees of success (Fletcher and Weekes, 1985).

All production systems, with the exception of white potato and to a lesser extent sweet potato, utilize low-level technology characterized by minimal inputs, suboptimal pest and disease control, and below average yields. Weed control, performed by hoeing, is the greatest cost to the farmer in terms of labor input. The actual cash expended depends on whether farm-family labor or hired labor is employed. Consequently, yields are low, but the farmer prefers the low-risk low-return situation in the current production climate. Table 2 gives the average yield estimates of the major root and tuber crops grown in Montserrat with traditional and improved levels of field technology.

Table 2. **Yield estimates (t/ha) of major root and tuber crops, Montserrat.**

Crop	Subsistence	Commercial	Potential yield
Sweet potato	1.8	8.0	10.0 - 15.0
Dasheen	2.0	6.0	10.0
Eddoe	1.6	5.0	9.0
Tannia	1.8	5.0	10.0
Yam	2.0	4.0	15.0
White potato	—	5.0	12.0 - 15.0

In a CARDI islandwide survey (CARDI, 1982) of 42 farm holdings randomly selected across the island, it was found that 57% of the holdings had sweet potato growing either at a commercial or subsistence level (Table 3). The survey also indicated that 70% of the farmers had sweet potato planted as compared to 30% for dasheen, 55% for yams, 45% for tannia, and 30% for eddoe. Cassava was allocated only 14% of the holdings by 20% of the farmers.

Actual land areas under the primary root crops are difficult to determine accurately because few statistics are available. In 1981 estimates available from the Ministry of Agriculture showed a total of 136 ha of root and tuber crops equally distributed among major types. However, market statistics for the same year show nominal sales of sweet potato only through the DFMC. In 1984 there were projections for 35 ha of sweet potato and 2 ha of white potato, which targets to all intentions and purposes have been achieved. Aroid and yam production have sustained the same level of production as in the previous two or three years.

The major cropping systems in Montserrat are based on: vegetables; cotton; food crops; food crops and livestock; mixed livestock (cattle, sheep, goats); and cattle.

Root and tuber crop production is concentrated almost exclusively in the vegetable, food crop, and livestock systems. These systems collectively command more than 70% of the country's agricultural activity. Priority is shared equally among the three systems, however, and the highest level of commercial activity occurs in the vegetable-based system while there is a significant level of subsistence or 'pot farming' practiced in the 'food crops only' system.

Table 3. **Root and tuber crop frequency on food crop farms, Montserrat.**

Crop	Farmers cultivating crop (%)	Farm holdings[a] (%)
Sweet potato	70	57
Dasheen	30	26
Tannia	45	25
Eddoe	30	14
Yams	55	28
Cassava	20	14

a. Most farmers generally cultivate 2-4 holdings—sometimes widely separated.

The vegetable-based system is primarily practiced by farmers with high to medium levels of onfarm technological inputs. Vegetables are grown primarily for the local market with an export of surplus if markets are available. Major crops are tomato, cabbage, carrot, eggplant, sweet pepper, string bean, cucumber, squash, and sweet potato. The main growing season is from September to March after which the land goes into fallow, or is planted with sweet potato. Few farmers practice continuous vegetable production with irrigation. White potato competes with prime vegetables during the main growing season in the few instances that the crop is grown.

The food-crop-based system is the most widely practiced system and is employed by both subsistence and commercial farmers. Production for home consumption as well as for the local market is equally important. Surpluses over and above local requirements may be sold to middlemen who export to neighboring islands. Major crop combinations of this system are:

Sweet potato/maize/pigeon pea;
Short-term vegetables/aroids;
Banana/yams/aroids;
Yams/dasheen/tannia/onions;
Sweet potato/pigeon pea/peanut/maize/lima bean (drier locations);
Cassava/pigeon pea/lima bean/vegetables; and
Yam/maize/sweet potato.

Sweet potato is by far the most important root crop within this system both in land area and volume of production. It is the only crop exported on a regular basis.

The food crop and livestock system is simpler than the food-crop-based system described above. It includes varying numbers of livestock (cattle, sheep, goat) which the farmer maintains as a source of income for emergency purposes. The general practice is to feed livestock on crop residues and to tether them in fallow fields. Most farmers plant a small plot or establish contour barriers of elephant grass (*Pennisetum* sp.) or cush-cush grass (*Veteveria* sp.) for the dry-season, cut-and-carry feeding of their stock.

Socioeconomic Patterns

The socioeconomic profile of the average root and tuber crop farmer is characterized by:

Onfarm production practices are dictated by normal climatic variances resulting in a strict traditional approach for each enterprise. Farmers accept improved technology and change reluctantly—usually only when circumstances force them to do so such as severe pest or disease infestation;

Farm labor comprises primarily the farmer, his spouse, and other adult family members. Children are generally not involved in onfarm production activities and, in fact, are encouraged to follow more academic pursuits. Hired labor is utilized when the enterprise has a strong or viable commercial component; and

Off-farm part-time employment in other sectors of the national economy to supplement family income is a normal occurrence. Remittances from families overseas are also an important source of family income that offset dependency on the farm output.

Marketing and Constraints

The major root crop imported is white potato which is in demand by both local and expatriate communities. In 1982 Montserrat imported 143 tons (t) of white potato at a cost of EC$180,000[1]. Currently, imports are estimated at 3.6 t per week. In addition, small quantities of other root crops, primarily dasheen and tannia, are imported from Dominica during periods of short supply.

The small local market that is available for root and tuber crops in Montserrat exerts a strong influence on the pricing structure of these commodities. There does not seem to be a relationship between production costs and farmgate or wholesale market prices. The final price of these crops, when they appear at retail outlets, seems to be linked to prices of related imported carbohydrate staples, primarily white potato. Sweet potato is the only member of the group in which a logical trend in pricing can be discerned because of the virtual lack of production seasonality and because of the existence of export market opportunities, albeit unstable.

Eddoe, tannia, and dasheen, whenever they appear on the local market, are sold at prices comparable to the other root and tuber staples. Farmgate marketing and distribution of these commodities among family, friends, and neighbors have a significant influence on the marketplace supply and consequently on the price structure which demonstrates a low level of elasticity. White potato, when produced, is purchased by the DFMC at prices which are derived from available cost of production data. Table 4

1. Exchange rate. EC$1.00 = US$0.38 (1984).

Table 4. **Retail prices (EC$/kg)[a] of root crops, Montserrat, 1980 and 1984.**

Commodity	Year	
	1980	1984
Sweet potato	0.55	0.85
Dasheen and eddoe	1.20	2.00
Tannia	1.20	2.00
Yams	1.20	2.00
White potato	1.30	1.50

a. Exchange rate: EC$1.00 = US$ 0.38 (1984).

sets out estimates of root crop commodity prices at the retail level, which are generally 30 to 40% higher than farmgate prices.

Statistics on root crop demand in Montserrat are not readily available primarily because a large proportion of the locally grown commodities does not flow through the official marketing channels.

Sweet potato, yams, and aroids complement each other as basic carbohydrate staples and are used virtually on a daily basis. There is a greater consumption of locally grown root crops in the rural areas when they are grown on a subsistence or semicommercial level. Consumer preference in order seems to be sweet potato, yam, and tannia. These are the commodities that appear most frequently in the municipal market. Dasheen and eddoe do not store as well as the other root crops and for that reason, among others, are traded less frequently.

The highest demand is for white potato which has an average weekly consumption of 3.6 t. All white potato has been imported in recent years. In the mid-1970's part of this demand was met by local production (CARDI Country Team, 1985) which, although quite significant in some years, is very seasonal (Table 5). Some of the crops were exported to the neighboring islands of Trinidad, Antigua, and the Virgin Islands.

Government Policies

The Montserrat Public Sector Investment Programme's Development Plan 1985 to 1989 (Development Unit, 1985) has specified food import substitution as the primary goal of the agricultural sector. It is anticipated that this goal will be attained through a program of accelerated food

Table 5. **Quantities (t) of sweet potato and white potato purchased by the Development Finance Marketing Corporation (DFMC) from farmers, Montserrat, 1974-1980.**

	Year						
Crop	1974	1975	1976	1977	1978	1979	1980
Sweet potato	2.95	2.05	5.68	1.67	1.83	1.99	6.03
White potato	41.93	190.84	222.65	66.99	2.89	3.70	5.78

production by improving field technology and the strengthening of agricultural support services.

The mechanism of import licencing is already in place to restrict imports of those energy-rich agricultural products that compete directly with local production. All major root crops are protected by this legislation—most recently white potato in March 1985 upon the revival of its local production. Currently, there is no determined policy aimed at substituting the conventional energy-rich imported items such as rice, flour and its derivatives, and processed root crops with local production. Instead, the primary objective is aimed at producing white potato in sufficient quantities to significantly reduce the volume of imports over the next five years. Some consideration is being given to stepping up cassava production with a view to small-scale commercial processing for cassava bread. This process is currently being undertaken at the cottage-industry level.

White potato is the only root crop that can be said to have special incentives and credit arrangements attached to it. As part of the current production drive, the Caribbean Development and Advisory Training Service (CARDATS) is making credit and other facilities available to producers. Sweet potato farmers enjoyed special incentive credit previleges through CARDATS in the early 1980's (Rankine et al. 1980), but these arrangements no longer exist.

Research, Training, and Development

In Montserrat the government has assigned CARDI to be responsible for agricultural research and development. Root and tuber crop research falls within this responsibility. The government has no specific allocation for agricultural research, although there is an annual contribution to CARDI which is paid into the Institute's core budget. International donor agency funding is the major contributor to research and development programs in Montserrat. There are currently two professionals assigned to CARDI's entire research and development program (including root crops) in

presented in order to provide basic elements with which the problems of these crops in Haiti can be analyzed.

The ecosystems in which they are grown are described as are farm characteristics, labor, cropping systems, production costs, volume, and constraints.

The processing and marketing of the products, the domestic demand for fresh and processed products, and their constraints are also discussed. It should be noted that these crops are consumed only locally.

Government policies are analyzed and the institutions, personnel, training, and budget involved in research are described. Finally, some recommendations on an approach toward research are made.

Resumen en español

Cultivos de Raíces y Tubérculos en Haití

Se presentan los datos existentes, desde la producción hasta el consumo, de la batata (*Ipomoea batatas*), yuca (*Manihot esculenta*), ñame (*Dioscorea* spp.), papa (*Solanum tuberosum*), malangay (*Colocasia esculenta* var. *esculenta*) y mazombelle (*Colocasia esculenta* var. *antiquorum*), para tener elementos básicos que permitan analizar la problemática de estos cultivos en Haïtí.

Se indican los ecosistemas en los cuales se cultivan, las características de las fincas, la mano de obra requerida, los sistemas de cultivo, y los precios, volumen y limitantes de la producción.

Se discuten el procesamiento y mercadeo de los productos, la demanda doméstica por productos frescos y procesados y sus limitaciones; es de anotar que estos cultivos son sólamente consumidos a nivel local.

Se analizan las políticas gubernamentales y se indican las instituciones, personal, capacitación y presupuesto involucrados en la investigación. Finalmente se dan algunas recomendaciones sobre el enfoque que se debe tomar en relación con la investigación.

Root and Tuber Crops in Montserrat

*R.E. Fletcher**

Introduction

The total land area of Montserrat is 103 km^2 of which 6140 hectares (ha) are suitable for agriculture. Of this, 372 ha are available for rough grazing and 4000 ha are under forest. Agricultural production, as in many other areas of the Caribbean and third world countries, is almost exclusively small-farm agriculture. A significant proportion of the farmers work part time and earn incomes from a variety of other sources.

The general pattern shows that 90.8% of the farms in Montserrat are less than 2 ha and account for only 19.8% of the total agricultural land. Farms of 2 to 40 ha account for 8.6% of the total and occupy 21.6% of the agricultural lands and farms of 40 to 200 ha account for only 0.8% of the farms but occupy 58.6% of the agricultural lands (Ministry of Agriculture, 1983).

Among the principal commercial crops produced are hot pepper, tomato, sweet potato (*Ipomoea batatas*), carrot, peanut, white potato (*Solanum tuberosum*), and cotton. These crops form the bulk of agricultural commodities bought by the marketing board—the Development Finance Marketing Corporation (DFMC). The major crops on a subsistence or semicommercial level include dasheen (*Colocasia esculenta* var. *esculenta*), eddoe (*Colocasia esculenta* var. *antiquorum*), tannia (*Xanthosoma sagittifolium*), sweet potato, pigeon pea, lima bean, banana, and plantain.

Root and Tuber Crop Production and Constraints

Of the estimated 260 ha of available land currently utilized for food crops,

* Caribbean Agricultural Research and Development Institute (CARDI), Montserrat. (In cooperation with the Ministry of Agriculture, Trade, Land, and Fisheries.)

approximately 40% is cultivated at any given point in time with a higher proportion remaining fallow during the dry season. Thirty-five to 40% of this land is occupied by root crops distributed islandwide with major concentrations in the Central Belham Valley and on the upper slopes of the Soufriere Hills and Centre Hills below the forest line. These areas have an annual rainfall of 1500 to 2000 mm.

Currently, farm land is underutilized and there is land available for root crop expansion if the need arises. At present, there is a potential for 815 ha of arable land to be used in the production of food crops and vegetables. There are also 1136 ha capable of being used in mixed-farming cultivation of food crops and improved pastures, and another 820 ha available for mixed farming of tree crops, food crops, and pastures.

The total production area under root and tuber crops is almost as much as that under vegetables and other food crops. In a recently completed islandwide farm survey, conducted by the Ministry of Agriculture in 1983, it was shown that of the possible 332 ha of land available for vegetable and food crops, nearly 60% was in continuous fallow while root and tuber crops occupied 14% (Table 1).

Sweet potato is the dominant staple and has been since the early sixties. This crop establishes easily, tolerates drought, and has export market potential during certain periods of the year. Aroids and yams are grown primarily for local comsumption and tend to be seasonal. Consequently, there are low supplies of these crops on the market between March and August with supplies increasing toward the year's end.

Cassava *(Manihot esculenta),* as a fresh staple, is almost unknown in Montserrat. Farmers grow cassava specifically for processing into cassava

Table 1. **Land allocation (ha) for vegetable and food crops, Montserrat, 1983.**

Crop type	Area (ha)	Percentage of total area
Vegetables	28	8
Roots and tubers	46	14
Other food crops	48	15
Fallow (1 year or less)	20	6
Fallow (1 year or more)	190	57
Total	332	100

Montserrat. In addition, expertise from core staff and specialists based in Trinidad, St. Lucia, and other islands can be requested whenever the need arises.

Currently, the major research and development thrust in root and tuber crops is concentrated on the reintroduction of white potato into the vegetable production system and to establish sustained crop production at a higher production level than existed in the past. The farming systems approach is being used in this project through a multidisciplinary team combining research and development (CARDI), extension (Ministry of Agriculture), farm credit and technology transfer (CARDATS), and marketing and logistic support (DFMC). CARDI's research and development efforts on white potato are equally divided between field stations and onfarm research. There is also an important element of crop monitoring and farm studies that provides up-to-date information on production practices and constraints thereby establishing the basis for future research development and production planning.

Within the white potato project research and development emphasis is being placed on the following areas (CARDI Country Team 1985): cultivar adaptability and suitability; economy in planting material use; spacing and plant population; soil diseases; and marketing and storage.

Very little attention is currently being paid by CARDI or the Ministry of Agriculture to other root and tuber crops in the sphere of research and development. However, the problem of *Euscepes postfasciatus* and *Cylas formicarius* on sweet potato would seem to warrant some attention if the market for that crop is to develop. It may also be necessary to initiate work on cassava aimed at increasing its production and to introduce small-scale processing.

No specific training opportunities are currently available at the country level for either research personnel (CARDI) or Ministry of Agriculture field personnel. Since the emphasis will remain on white potato in the near future, it would be desirable to have a training component emphasizing field technology written into the program.

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Spanish Summary

Cultivos de Raíces y Tubérculos en Montserrat

Se presenta la situación de los cultivos de raíces y tubérculos en Montserrat. Se discuten los principales cultivos, los sistemas de cultivo, las tierras disponibles, los factores socieconómicos, los niveles de producción, la productividad, las importaciones y la estructura de precios y mercados.

En relación con la demanda de los cultivos arriba mencionados, se analizan la demanda doméstica de alimentos frescos, las políticas de importación y los incentivos y créditos ofrecidos a los productores. Finalmente se hace énfasis en la investigación sobre la disponibilidad y adaptabilidad de cultivares, la economía del uso de material de siembra, el espaciamiento y la población de plantas, las enfermedades transmitidas por el suelo y el mercado y almacenamiento de la papa. Se recomienda adelantar más estudios sobre yuca y establecer un programa de capacitación en la tecnología de campo de la papa.

Root and Tuber Crops in Nevis

*Jennifer E. Lowery**

Introduction

Nevis is approximately 90 km² in area and forms part of the political federation of St. Kitts-Nevis. It is an agriculturally based island with a tradition of peasant farming over most of its area. Large areas once growing sugar cane have ceased operations. The only remaining state crop is coconut which is used in copra production. However, the future of this crop is uncertain.

Sea island cotton (*Gossypium barbadense*) has been a small-farmer cash crop for most of this century with maximum production occurring in the 1950's. The area currently under cotton has declined over the past thirty years from around 1200 hectares (ha) to less than 80 ha. Cultivation of cotton is being encouraged by the government because of excellent market conditions.

Farming in Nevis is carried out by an estimated one thousand farmers and varies from subsistence to semicommercial in nature. Farmers are forced to deal with adverse conditions in terms of the physical environment where unpredictable rainfall and stony, eroded, clay soils reduce production, and of the socioeconomic environment where the lack of markets for produce is a common problem. Not surprisingly, farming is not a popular occupation among young people. The average farmer in Nevis is around 60 years old.

Root and Tuber Crop Production and Constraints

The types of root crops grown in Nevis are: sweet potato (*Ipomoea batatas*) which is by far the most important; yams (mainly *Dioscorea*

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alata); tannia (*Xanthosoma sagittifolium*) and cassava (*Manihot esculenta*). Dasheen (*Colocasia esculenta* var. *esculenta*) and eddoe (*Colocasia esculenta* var. *antiquorum*) are grown sparingly because of water constraints but are commonly imported from St. Kitts or Dominica. Root crop production on small farms is presented in Table 1.

Root crop production is an important part of subsistence farming with sweet potato, yams, and tannia contributing to the cash component to varying extents. Cassava is grown almost totally for home consumption and little reaches the marketplace.

Production figures for the 1980-1981 growing season show the following annual production yields: sweet potato (218,672 kg); yams (74,670 kg); tannia (4350 kg); and cassava (3510 kg).

According to a 1984 Caribbean Agriculture and Research Development Institute (CARDI) Baseline Survey (Lowery and Lauckner 1984) 69.2% of all farmers grew sweet potato, 57% grew yams, 29% grew tannia, and 23.4% grew cassava.

Sweet potato occupies a very important place in the farming systems of Nevis. It is the most commonly grown crop and occupies the largest area. The reasons for sweet potato's popularity are: its traditional place in the diet; its drought tolerance when compared with other popular root crops; the ready availability of planting material; and its use as livestock feed during the dry season.

Table 1. **Annual root crop production data[a] for fifteen farms having land areas of 0.5 to 2.0 ha, Nevis.**

Crop	Farmers planting crop (no.)	Annual average area planted (m^2)	Annual average plantings (no.)	Average planting plot size (m^2)	Farmers harvesting crop (no.)	Average production per farmer (kg)	Calculated average yield (kg/ha)
Sweet potato	12	896	9	100	9	316	3527
Yam	11	181	2	90	7	131	7238
Tannia	5	262	3	87	6	15	573
Cassava	7	94	2	47	3	15	1596

a. These figures were obtained by following farmers' practices over one year using weekly monitoring

SOURCE: CARDI Small Farmers Multiple Cropping Project 1980-1982.

Sweet potato is produced on plots ranging from backyard size (approximately 25 m^2) up to commercial plots of around 200 m^2. Sweet potato is most frequently grown as a monocrop but it may be intercropped with corn or pigeon peas. Usually a mixture of cultivars is grown although some semicommercial farmers favor large plantings of one cultivar which may have a market advantage.

Although sweet potato production is islandwide, the larger production areas are usually at elevations above 150 m in the southern half of the island. This area has an average rainfall of over 1250 mm per year. These areas maintain larger plots throughout the year while at lower elevations major plantings are limited to the rainy season from September to December.

Typically the large plots are on farms producing sweet potato along with other root crops, peanuts, pigeon pea, black-eyed pea, and some vegetables (especially during the later part of the year). These vegetables commonly include cabbage, tomato, carrots, sweet peppers, and eggplant. Of these crops sweet potato might occupy the greatest area but peanuts and vegetables generate the largest income.

Yields are generally quite low, varying from 1500 to 7000 kg/ha. In trials involving sweet potato carried out by CARDI during 1982 and 1983, using farmer's practices, marketable yields of 5190 kg/ha during the wet season and 3150 kg/ha during the dry season were obtained.

The major factors limiting yields are low rainfall, especially at critical times, and infestation with the borer *Euscepes postfasciatus* and the weevil *Cylas formicarius*. These pests cause serious yield reductions, especially during the dry season when up to 25% of the total yield can be infested.

Generally sweet potato cultivation inputs are minimal. A farmer rarely uses any fertilizer or crop protection measures on sweet potato. Cost of production figures calculated by the Caribbean Agricultural Rural Development Advisory Training Service (CARDATS, 1984) gives a total production cost of EC$2618[1] per hectare of which EC$1976 was the labor cost which would normally be supplied by the farm family. Outside labor is used occasionally for land preparation.

Market supplies of sweet potato peak between February and May, usually forming a market glut with farmgate prices falling to around

1. Exchange rate: EC$1.00 = US$0.37 (1984).

EC$1.10/kg. From September to November the crop is in short supply and prices are approximately EC$2.20/kg. The retail price varies from around EC$1.65 to EC$3.30/kg.

During glut periods small amounts of the crop are used for home consumption while some tubers and tops are used for feeding pigs and cattle. The remainder of the crop is left in the ground where it becomes susceptible to insect damage.

Dioscorea alata is the most common yam grown in Nevis, and four cultivars, White Lisbon, Statia, Red yam, and Potato yam, have been identified. *Dioscorea rotundata*, known locally as 'Antigua yam', is becoming more common because of its hardiness to leaf disease and drought. *Dioscorea esculenta* has been identified on one farm only. Farmers report that it used to be common to harvest the Mountain yam *D. cayenensis* from forested areas but now the species is used infrequently.

Yam cultivation is carried out by a large number of farmers on small plots no larger than 0.1 ha. Generally, planting is carried out twice in the year. The first planting season is around late April to early May which often coincides with a secondary annual rainfall peak and the second planting is in July sometimes extending into early August which coincides with the onset of the main rainy season. Some farmers, however, plant Red yam in February to harvest in December. In a CARDI trial performed on eleven farms planting during the mid-May to mid-July period in 1984, it was found that those farmers planting late had consistently higher yields than those farmers planting early (CARDI, 1985).

The system of yam production is to plant on small mounds spaced approximately 1 m x 1 m apart. There is no staking, but when corn is used as an intercrop it often serves this purpose. The other common intercrop of yams is tannia. The yam planting piece is between 50-100 g in weight and may be treated with lime before planting. Organic manure is applied to the mounds which are then usually mulched. Harvesting begins with Red yam in December followed by the main yam crop from the end of January until April.

Nevis does not have optimal conditions for yam growing because of its low rainfall and shallow soils in most areas. Yields are therefore relatively low. An average farmer's yield is around 7000 kg/ha. In CARDI's onfarm trial in 1984-1985, farmers' yields, using their own practices, varied from 1070 kg/ha to 16,800 kg/ha with an average yield of 7000 kg/ha. Another important factor reducing yields is anthracnose leaf disease. Most farmers

are unaware of chemical disease-control methods or do not have the necessary crop protection equipment to implement these measures.

Cost of production data for yams (CARDATS, 1984) gives a figure of EC$9292/ha. This high cost results from the high yam planting cost. The value of yam planting material is 70% of the total cost.

The reduction of yam production as a result of reduced land areas, low rainfall, and leaf disease has resulted in favorable market conditions for the crop. There is sometimes a moderate glut in March during the main harvest period but this is not serious and does not result in a price reduction. The 1985 retail price for yams was fairly constant at EC$5.50/kg and the farmgate price was EC$4.40 kg for *D. alata* and EC$3.30/kg for *D. rotundata*. The Central Market buying price, however, remained at EC$1.65/kg.

Tannia is the only aroid grown on a commercial scale in Nevis. It is a crop which is most frequently intercropped. In a CARDI survey (Lowery and Lauckner, 1984) 19% of farmers grew tannia and 80% of those growing tannia grew it as an intercrop. When intercropped with yams, or yams and corn tannia is planted in a regular arrangement with the yams on mounds and tannia in the hollows. Similarly tannia is often intercropped with vegetables with the vegetables being planted on top of the ridge and tannia at the base with a spacing of anywere between 1.0 m x 0.6 m and 1.0 m x 1.3 m. Tannia can, however, appear in almost any combination of crops, both in the long term and short term, sometimes intentionally and sometimes as a volunteer crop. Only in the high-rainfall areas at altitudes of 300 m in the southern section of the island can it be found as a monocrop.

The planting material used is normally either heads or suckers. The crop may receive some pen manure or may benefit from manure applications to the other crops. Beyond this, the only cultural practice applied is weeding.

Browning of the leaf margin is commonly seen in tannia but whether this is a result of drought or burning disease has yet to be established.

Estimates of tannia yield are hard to determine because of its cultivation as an intercrop. The CARDI data of 1980-1981 show a very low average yield of 573 kg/ha. Similarly the 1975 census data indicate a low yield of 963 kg/ha. No figures on tannia production costs are available.

Much of the tannia produced is for home consumption. However, availability in the market is good with inputs from St. Kitts making up for the shortfalls in local production. Retail prices are around EC$3.30/kg.

Cassava is grown on a small scale and is grown almost exclusively for home use both as a fresh provision and as cassava flour. As described by a farmer, cassava is 'emergency food'. A small amount of bitter cassava is grown but the majority is sweet. The same proportion of farmers plant cassava as those who plant tannia. Total island production has declined in recent years possibly because of the increase in convenience-food consumption. Items such as cassava bread have more or less disappeared from the local diet and the home-produced cassava flour is used chiefly to supplement wheat flour.

Cassava is normally planted on land from which some other crop has just been harvested as an alternative to leaving the land fallow. Thus the most common planting time is between January and March which is the harvesting time for most crops. This results in cassava being grown during the dry season.

In Nevis, cassava is planted in rows on ridges approximately 90 cm apart within a row spacing of 30-60 cm. It is often intercropped with vegetables or peanuts. The planting piece is usually 25 cm in length and is planted at a 45^0 angle with about 5 cm showing above the soil. Cultural operations are limited to the occasional weeding but cassava does not rank as a priority crop for weeding purposes. The main pest encountered is the shoot fly (*Silba pendula*) but no pest control measures are carried out. Harvesting may take place after 8-10 months but this period is variable and the crop may be left in the field for up to 18 months.

As with tannia, there are few estimates of cassava yield under farmers' conditions. The yield level calculated from the CARDI farm study is 1596 kg/ha and for the census data of 1975 it was 974 kg/ha. These are low yields considering the potential yield of cassava. No production cost figures are available.

As mentioned previously, most cassava produced is for home consumption. A rough estimate is that 70% of the production goes into cassava flour which is ground at a government-owned mill at a cost of EC$0.25/kg. Preparation of cassava chips for grinding is done by hand. When cassava roots appear on the fresh market the price is between EC$2.20 and EC$3.30/kg.

Marketing and Constraints

Local root crop marketing is through market vendors, some of whom are

also farmers. There is no central marketing-system in Nevis. Prices are controlled by vendors who rarely cut their prices to compete with each other.

Imports of traditional root crops are chiefly limited to sweet potato and aroids from St. Kitts and occasional aroid imports from Dominica. However, white potato (*Solanum tuberosum*) constitutes one of the major items of food imported. In 1982 372,000 kg of white potato valued at EC$448,000 were imported into St. Kitts and Nevis.

Small quantities of root crops are exported each year. Export statistics made available by the Central Marketing Corporation (CMC) show that those root crops exported originated in St. Kitts. Statistics obtained by CMC show that 14,523 kg of sweet potato valued at EC$14,387 were exported in 1982. Yams exported totaled 682 kg valued at EC$1275, and a total of 182 kg of dasheen valued at EC$372 were exported. A little ad hoc exporting to neighboring islands takes place on the interisland schooner trade from Nevis but no statistics are available.

Government Policies

The agricultural objectives of the Nevis Government as laid out in the Agricultural Development Plan of 1984 are:

The reduction of food imports to create self-sufficiency;

To provide a future for profitable farming in Nevis and a level of full employment in agriculture;

To reduce soil erosion;

To provide farms for lease to or purchase by Nevisians; and

To provide as much of the food requirements of the tourist industry as possible.

The Agricultural Development Programme includes a number of projects to achieve these objectives. Efforts are being made to obtain both underground and surface water for irrigation and to improve the supply of inputs and services to farmers.

At present the government subsidizes tractor services for farmers, operates a supplies depot for inputs at a minimal markup, and rents or leases around 526 ha of agricultural land on government-owned estates. Some credit is available to small farmers through the Department of Agriculture and also through the St. Kitts-Nevis Development Bank.

Of direct relevance to root crop production is the interest taken by the Ministry of Agriculture in the local production of white potato as an import substitute.

Research, Training, and Development

The only institution carrying out agricultural research in Nevis at present is CARDI which has been operating on the island since 1980. The staff consists of one professional agronomist, one technician, and one Nevis counterpart. At present only the post of agronomist is filled. Support staff consists of four field assistants and a secretary. For the current year approximately EC$13,000 has been budgeted for research work on root crops.

CARDI's main activity in Nevis is its Farming Systems Research and Development Project which has carried out research on cotton and peanuts as part of the cash-crop component of the farming system and on sweet potato and yams as part of the subsistence component.

The main problem being addressed at the moment is the control of the sweet potato borer. In the dry season of 1982 a trial was carried out to assess the level of control obtained with carbofuran (Furadan) granules applied at 8 and 12 weeks after planting. There was no evidence of a positive response to the application of the insecticide.

Subsequent to this trial, the emphasis has been on control by cultural means with an overall aim of improving the yield per unit area so that the total area occupied by the crop could be decreased. This would make rotation of sweet potato with other crops feasible.

With this aim, a variety trial was carried out in 1983 to assess a reported high-yielding cultivar from Trinidad (A28/7) against two popular local cultivars (Red Man and Mannie Mannie). The results of the trial showed that the imported cultivar performed poorly under local conditions. Although the total yield of A28/7 was higher, marketable yield was lower than the local types, due to more 'strings'. Borer infestation was also found to be higher than in the local cultivars.

A trial to assess cultural methods of borer control on farmers' fields is expected to begin in July 1985. In this trial, one package of borer control measures will include rotation, selection of planting material from the tips of vines, deep planting, molding up of ridges to prevent soil cracks, and one chemical insecticide application 12-14 days after planting. This trial will be

tested both with and without fertilizer application and compared with farmers' practices.

Experimental work with yams started in 1984 with a trial on eleven farms to control anthracnose disease through fungicide applications. Two different spraying schedules, fortnightly and 'as required', were compared with no control measures. The results indicated that the primary yield-determinant was rainfall during the crop's growth. Those farmers planting early (mid-May to early June) obtained very low yields which showed no response to the fungicide applications. Those who planted late (late June to mid-July) benefited from heavy rains after four months crop growth. Yields were higher and there was a beneficial effect of fungicide application during this period.

As a continuation of this work in 1985, yam farmers in different agroecological zones have been monitored to study the incidence of anthracnose and its association with climatic and cultural conditions.

Also the four local cultivars of *Dioscorea alata* and one of *D. rotundata* are being compared at two planting times to determine whether there is a differential varietal response to planting date. Future trials will compare local varieties with imported varieties reported to show tolerance to anthracnose.

Preliminary work on white potato began in 1984 with the comparison of five varieties from Canada at two sites. Yields were low partly because of poor germination and leaf disease. In the 1985-1986 growing season, varieties which have proved high-yielding in Montserrat will be tested on a small-scale intensive system on farmers' fields. Material stored from the last growing season will also be compared with new material of similar varieties to determine whether seed potatoes can be stored from one season to the next.

Recommendations

Research to increase root crop production in Nevis must be approached carefully with full consideration being given to market conditions. Productivity of sweet potato cultivations can be improved with the objective of reducing the areas devoted to the crop. This would enable a farmer to rotate his crops and to diversify cultivation into other crops.

Improved sweet potato production through the use of higher-yielding varieties may be possible but would not show immediate results. Intro-

duced material must not only compete well with the locally-adapted material but it must also be of acceptable eating and cooking quality—important consideration when sweet potato is part of the staple diet. Losses caused by pests should be the area of most interest to researchers.

Another important area of research with sweet potato is its further development as a livestock feed. This would effectively provide a market for the crop and improve livestock production without resorting to imported feed.

With yams, both productivity and production can be increased substantially before local requirements are fulfilled. This crop can also have a potential for export to the neighboring islands. The current market price is high enough to justify irrigated production thereby avoiding uncertainties in rainfall. To control disease the introduction of cultivars tolerant to anthracnose has more potential than chemical control.

Future research on white potato should concentrate on establishing the yield levels attainable under farmers' conditions and the economics of local production compared with imports. Testing of material from the Centro Internacional de la Papa (CIP) adapted to the lowland tropics is suggested.

Considering the scale of production of the other traditional root crops it is difficult to justify the allocation of scarce resources to these other root crops. With tannia it may be possible to determine whether symptoms noted are actually those of tannia leaf burning disease and if so whether to introduce disease-resistant material. Any cassava research might be directed toward livestock feed rather than human consumption.

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Spanish Summary

Cultivos de Raíces y Tubérculos en Nevis

Los cuatro principales cultivos de raíces amilaceas explotados en Nevis —batata (sweet potato), ñame, ocumo (mafafa, yautía, tania, cocoyam), y yuca —se describen subrayando su producción, sus precios al por mayor y al detal, y su demanda tanto local como externa. Se presenta la iniciativa del gobierno para estimular la producción local de papa blanca y reducir así la importación de este tubérculo. También se comentan las actividades de investigación dedicadas a todos los cultivos de raíz así como las pérdidas infligidas por las enfermedades de estos cultivos y la importancia de desarrollar e introducir material genético resistente a tales enfermedades.

Raíces y Tubérculos en Répública Dominicana

*Magdalena Rodríguez de Paredes**

Principales Especies Cultivadas y Zonas de Producción

Los tubérculos y raíces son un componente importante en la dieta de la población en República Dominicana, y constituyen el 10-15% del total de la producción agrícola nacional. Las principales especies cultivadas son yuca (*Manihot esculenta*), camote o batata (*Ipomoea batatas*), yautía (*Xanthosoma* spp.), ñame (*Dioscorea* spp.) y papa (*Solanum tuberosum*). En el Cuadro 1 se resume la oferta de raíces y tubérculos y en el Cuadro 2 se presentan las superficies cultivadas con cada una de las principales especies.

Todos los años se incorporan nuevas áreas de siembra para los cultivos de raíces y tubérculos. En 1985 se incorporaron 5560.93 ha para la yuca, lo cual representa un 13.6% de incremento con respecto a años anteriores.

Cuadro 1. **Oferta de raíces y tubérculos, 1983, 1984, y estimación para 1985, República Dominicana.**

Especie	Oferta anual (miles t)		
	1983	1984	Metas 1985
Yuca (*Manihot esculenta*)	102.00	129.30	145.00
Batata (*Ipomoea batatas*)	35.35	58.08	59.20
Yautía (*Xanthosoma* spp.)	23.94	24.79	32.79
Ñame (*Dioscorea* spp.)	6.92	5.21	13.01
Papa (*Solanun tuberosum*)	14.98	11.59	16.01

FUENTE: Plan operativo 1985. Secretaría de Estado de Agricultura, República Dominicana.

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Cuadro 2. **Superficie cultivada con raíces y tubérculos en 1983 y 1984 y estimación para 1985 en República Dominicana.**

Cultivo	Area anual (miles ha)		
	1983	1984	Metas 1985
Yuca	16.66	19.79	20.24
Batata	5.48	5.63	8.26
Yautía	4.72	4.75	5.67
Ñame	1.21	1.26	2.24
Papa	1.73	1.13	1.77
Total	29.80	32.56	38.18

Para el cultivo de yautía se incorporaron en ese año 2500 ha, localizadas en los asentamientos de Limón del Yuna y El Aguacate, en la región nordeste del país.

El área de producción prodría aumentarse en un 30 - 50% con respecto a lo cultivado actualmente, si existieran condiciones económicas para hacerlo. El cultivo en el cual se realizarán los mayores esfuerzos para la incorporación de nuevas áreas de siembra es la yautía.

El cultivo de las principales especies se realiza en las regiones que presenta el Cuadro 3, en tierras cuya calidad varía según la especie y sus exigencias. A continuación, se resumen algunas características climáticas y edafológicas de las principales zonas de producción.

Zona norte. Comprende numerosos tipos de asociaciones y series de suelos; éstos presentan, en términos generales, una textura franco arcillosa aunque hay algunos arenosos; son moderadamente bien drenados y libres de sales solubles; en algunos casos son aluviales y friables; los hay de topografía ondulada y por lo tanto susceptibles a la erosión. El color varía desde pardo claro a pardo rojizo.

Cuadro 3. **Zonas más importantes para el cultivo de raíces y tubérculos en República Dominicana.**

Cultivo	Zonas de producción
Yuca	Norte, Norcentral, Suroeste
Batata	Norte, Nordeste, Noroeste Suroeste
Yautía	Este, Nordeste, Central, Norcentral
Ñame	Este, Nordeste, Central
Papa	Central, Este, Zonas montañosas de Constanza y San José de Ocoa

La temperatura media anual que caracteriza a esta zona fluctúa alrededor de los 25°C y la precipitación media anual varía de 1000 a 1800 mm.

Zona norcentral. Los suelos de esta zona son de topografía plana, sin factores limitativos de importancia y, por lo tanto, de alta productividad cuando son bien manejados. Son suelos profundos, calcáreos, planos y de textura más bien arcillosa; también se encuentran suelos con topografía levemente ondulada y en general bien drenados.

La temperatura varía entre 11 y 15°C en las zonas altas de la Vega y Constanza.

Zona suroeste. Se encuentra limitada por la cordillera Central al norte; la provincia de Barahona al sur; el mar Caribe al este y la república de Haití al oeste.

Los suelos son arcillosos no calcáreos, de tipo aluvial, altamente permeables. Son suelos de origen ígneo volcánico, y metamórficos, cuya topografía va desde plana a muy ondulada.

Por su capacidad productiva, estos suelos se pueden clasificar desde la categoría II correspondiente a terrenos cultivables, aptos para el riego, hasta la categoría VI, correspondiente a terrenos no cultivables, aptos solamente para fines de explotación forestal.

La temperatura varía de 21 - 25°C y la precipitación pluvial es de 1400 a 2000 mm.

Nordeste (Delta del Yuna). Posee suelos orgánicos que ocupan más de una tercera parte de la región. También tiene suelos arcillosos con mal drenaje y con riesgos de inundación.

En la península de Samaná los suelos están constituídos esencialmente por zonas montañosas, con suelos poco profundos y topografía ondulada. Existen algunas zonas con suelos friables y profundos, de naturaleza calcárea.

Sistemas de Producción

Las raíces y tubérculos se cultivan generalmente en asociación o en rotación con otras especies; entre los principales arreglos se pueden mencionar: yuca/frijol; maíz/ñame; yuca/ñame; batata/yuca; maíz/batata; batata/frijol; yuca/maíz.

Se estima que entre el 80 y el 90% de los productores de raíces son agricultores de tipo mediano y pequeño, que desarrollan su cultivo con bajo nivel de insumos y usando mano de obra familiar; en general, los cultivadores de yuca poseen fincas un poco mayores y disponen también de mayores ingresos para adquirir insumos. En el Cuadro 4 se presenta una estratificación de las unidades de producción según su tamaño, y la superficie total correspondiente a cada estrato; la producción de raíces y tubérculos se concentra en los estratos de fincas más pequeñas, generalmente en las unidades menores de dos ha.

Se ha calculado que casi el 70% del costo de producción se debe al uso de mano de obra, y que ella se emplea así: 14.3% para la preparación del terreno, 47.6% para la siembra y limpieza del cultivo y 38.1% para la cosecha y acarreo.

Producción y Rendimiento

La producción de los cultivos de raíces y tubérculos varía según los cultivares utilizados y las condiciones climatológicas presentes, ya que la mayoría de estos cultivos se siembran en agricultura de temporal. Los Cuadros 5 y 6 presentan los rendimientos de cada uno de los cultivos en 1983 y 1984 y la producción esperada para 1985, según cálculos oficiales.

Entre los principales factores que impiden el incremento de la superficie cultivada con raíces y tubérculos, y que también limitan la obtención de

Cuadro 4. **Número de fincas y superficie en cada categoría de tamaños, República Dominicana.**

Tamaño de las explotaciones (ha)	Explotaciones (no.)	Superficie (ha)
Menos de 0.5	61,670	1,247
0.50 - 4.9	252,995	31,166
5 - 10	32,543	19,288
10 - 50	30,815	63,648
50 - 99.9	4,081	27,015
100 - 199.9	1,825	24,944
200 - 499.9	786	23,018
500 - 999.9	184	12,057
Más de 1,000	161	59,845
Total	385,060	262,228

FUENTE: Censo Nacional Agropecuario 1981

Cuadro 5. **Principales cultivos de raíces y tubérculos y sus rendimientos en 1983 y 1984 en República Dominicana.**

Cultivo	Rendimiento anual (t/ha)	
	1983	1984
Yuca	5.5	5.9
Batata	5.8	9.3
Ñame	7.5	5.1
Yautía	5.6	5.7
Papa	10.1	10.9

Cuadro 6. **Producción esperada en los diferentes cultivos, según las regiones productoras en 1985 en República Dominicana.**

Regiones	Producción por cultivos (miles t)				
	Yuca	Batata	Yautía	Ñame	Papa
Norte	37.37	12.43	5.46	1.42	0.08
Norcentral	28.90	13.17	4.34	1.57	13.71
Nordeste	9.22	4.46	6.19	3.27	-
Noroeste	17.78	5.18	0.65	0.41	-
Central	12.72	3.38	13.99	3.20	6.75
Sur	7.01	6.06	27.76	2.14	11.75
Suroeste	24.55	11.99	0.70	0.21	0.23
Este	7.57	2.53	8.39	4.05	0.20
Total	145.12	59.20	67.48	16.27	32.72

FUENTE: Unidades Regionales de Planificación y Economía. Secretaría de Estado de Agricultura, República Dominicana.

rendimientos más altos se debe considerar el tamaño de la propiedad que se dedica a la producción de estos rubros.

Por otra parte, a nivel de las zonas de producción no existen adecuadas obras de infraestructura tales como caminos vecinales y vías de penetración a las fincas, lo que dificulta el transporte del producto a los centros de venta. En el caso específico del ñame, la yautía, y la papa, la producción se lleva a cabo en regiones particularmente accidentadas y esta topografía impide la comercialización eficiente por la falta de suficientes vías de penetración.

Los costos de producción a nivel de finca se presentan en el Cuadro 7.

Cuadro 7. **Costos de producción de los principales tubérculos y raíces en 1983-1985 en República Dominicana.**

Cultivo	Costos anuales (RD$ha)[a]		
	1983	1984	1985
Yuca	22.11	44.86	59.39
Batata	31.88	42.78	55.01
Yautía	39.11	40.24	43.24
Ñame	70.04	80.09	87.48
Papa	157.08	207.78	264.55

a. Tasa de cambio en enero de 1985: RD$1.00 = US$1.00.

FUENTE: División de Economía Agrícola. Secretaría de Estado de Agricultura, República Dominicana.

Destino y Mercadeo de los Productos

La producción se comercializa para el consumo fresco en la alimentación humana; una parte se destina a la exportación y otra al mercado local. En general los productos no se transforman; sólo el 2-3% de la producción de yuca se destina a la fabricación de cazabe y sólo en una región del país se siembra yuca con ese único propósito. A los animales se le suministran los rechazos de las cosechas.

En los cultivos de ñame y yautía, el 40% de la producción se comercializa a través de los mercados públicos; el 18% se destina al autoconsumo y como semilla para nuevas siembras, y por último, el 42% se destina a la exportación.

El 95% de la producción de yuca se comercializa para consumo humano fresco y el 5% se exporta. En el caso de la batata, el 16% se destina para exportación y el 84% para el consumo humano.

El mercado de exportación lo constituyen Aruba, Curazao, Puerto Rico, San Martín, Islas Vírgenes y Estados Unidos, principalmente la ciudad de New York.

Los Cuadros 8 y 9 presentan la demanda total de raíces y tubérculos en 1983 y 1984 y las cantidades exportadas en esos años, así como estimaciones, en ambos cuadros, para 1985; las exportaciones se refieren sólo a raíces frescas, y no se dispone hasta el momento de información acerca de una posible demanda externa por los productos transformados (trozos,

Cuadro 8. **Demanda de raíces y tubérculos en 1983 - 1985 en República Dominicana.**

Cultivos	Demanda anual (miles t)		
	1983	1984	1985[a]
Yuca	95.7	122.3	139.1
Batata	26.6	49.0	53.4
Yautía	6.6	6.9	12.6
Ñame	6.4	4.5	12.3
Papa	13.4	8.2	12.3

a. Estimaciones para ese año.

FUENTE: Plan operativo, 1985. Secretaria de Estado de Agricultura, República Dominicana.

Cuadro 9. **Volumen de la exportación de raíces y tubérculos en 1983 y 1984 y estimación para 1985. República Dominicana.**

Cultivo	Exportación anual (miles t)		
	1983	1984	Metas 1985
Yuca	6.3	6.9	5.3
Batata	8.7	9.0	5.7
Yautía	17.3	17.8	20.1
Ñame	0.5	0.7	0.7
Papa	0.3	3.3	-

FUENTE: Plan operativo 1985. Secretaría de Estado de Agricultura, República Dominicana.

harinas, almidón, etc); tampoco se conocen los máximos posibles exportables.

Políticas de Fomento a la Producción

Dentro de sus actividades de apoyo a la producción agrícola, la Secretaría de Estado de Agricultura tiene como meta proporcionar asistencia técnica y fomentar los cultivos de raíces y tubérculos principalmente por medio de la adquisición y distribución de materiales de siembra, y de un plan de mecanización para la preparación de terrenos.

También está apoyando las actividades de extensión y capacitación a los técnicos y productores, y se propone además apoyar el otorgamiento de

crédito para financiar nuevas áreas para la siembra. Es de notar que según datos oficiales, el 80% de la producción actual de raíces se lleva a cabo con financiación oficial a través del Banco Agrícola.

La yautía es, dentro del grupo de raíces y tubérculos, uno de los cultivos en los cuales se concentrarán los mayores esfuerzos de la Secretaría en los próximos años, para lograr el aumento de la producción. Este incremento se logrará mediante la incorporación de nuevas áreas de siembra, la introducción de prácticas culturales mejoradas y la realización de estudios para el mejoramiento genético de las variedades existentes.

Es política general del gobierno reducir al mínimo las importaciones de bienes agrícolas. En el caso de República Dominicana, las raíces tienden a jugar un papel cada vez más importante en la alimentación de animales, como substitutos del sorgo y el maíz importados; en cuanto a la substitución de granos importados para uso humano, se adelantan estudios técnicos para impulsar el reemplazo de parte de la harina de trigo por harina de yuca, en la industria panadera.

Investigación y Capacitación Técnica

En la República Dominicana las investigaciones sobre raíces y tubérculos se realizan en tres centros de investigaciones agrícolas que dependen de la Subsecretaría de Investigación, Extensión y Capacitación Agropecuarias de la Secretaría de Estado de Agricultura. Estos centros abarcan todas las regiones del país y son:

Centro Sur de Desarrollo Agropecuario (CESDA), cuya área de influencia comprende el este, el suroeste, el sur y la parte central.

Centro Norte de Desarrollo Agropecuario (CENDA), que abarca las regiones norte, nordeste, norcentral y noroeste.

Centro de Investigación de Zonas Aridas (CIAZA).

Está además el Centro de Investigaciones Pecuarias (CENIP), donde se realizan trabajos de utilización de raíces y tubérculos para la alimentación animal.

Los recursos para la investigación en raíces y tubérculos abarcan un 15-20% del presupuesto global de los centros de investigaciones, y existe una tendencia a aumentar tales recursos en el futuro.

Objetivos y orientación. El objetivo general de la investigación en raíces

y tubérculos es aumentar la productividad de estos cultivos, mediante diferentes proyectos técnicos. Los objetivos específicos son:

Identificar el material vegetativo con que se cuenta en estos cultivos y establecer bancos de germoplasma que sirvan de apoyo a los trabajos de mejoramiento.

Introducir materiales con alta potencialidad genética, que sirvan como progenitores para el mejoramiento del material nativo.

Seleccionar clones de alto rendimiento y buena calidad dentro de los ya existentes en el país.

Desarrollar métodos apropiados para la preparación de terrenos en función de las características zonales y de la extensión y recursos de los productores.

Estudiar la respuesta de los cultivos de tubérculos y raíces a la fertilización, determinando las dosis óptimas económicas para el nitrógeno, el fósforo y el potasio requeridos en cada caso.

Obtener informaciones que permitan reducir al mínimo las pérdidas ocasionadas por plagas, enfermedades y malezas en estos cultivos.

Determinar las acciones más recomendables para corregir las prácticas no adecuadas que afectan el manejo de los productos.

Recopilar toda la información necesaria sobre el uso y la disponibiliad de los factores de producción con respecto a los tubérculos y raíces, para tratar de generar tecnologías que mejoren el bienestar del pequeño agricultor.

Los trabajos de investigación en el Programa de Raíces y Tubérculos se orientan hacia la ejecución de los proyectos técnicos, así:

En el proyecto **Manejo genético** se trabaja en la introducción, evaluación y selección de nuevos materiales de siembra para los distintos cultivos, en la selección de variedades de alto rendimiento y tolerantes a las plagas y enfermedades que afectan estos cultivos, y en la evaluación de nuevos materiales y la búsqueda de zonas para la producción de papa.

En el proyecto **Manejo del ambiente físico** se continuán probando prácticas culturales tales como marcos o distancias de siembra, sistemas de siembra (en plano, camellones, montículos, etc.) y efecto del tamaño de la semilla en el rendimiento de los cultivos de ñame y

yautía. Se estudia además la respuesta de los diferentes cultivos a la fertilización, determinando las dosis óptimas económicas de aplicación.

En el proyecto **Manejo del ambiente biótico** se realizan diagnósticos para determinar las pérdidas que ocasionan las plagas y las enfermedades en estos cultivos, se prueban diferentes insecticidas y fungicidas y su dosis de aplicación para controlar las enfermedades y plagas que los afectan, y se realizan estudios sobre el control de malezas, probando diferentes herbicidas y su eficiencia, dosis de aplicación y número de aplicaciones.

Recursos humanos y capacitación. El personal técnico que trabaja a nivel de investigación en raíces y tubérculos consta de siete ingenieros agrónomos, quienes han recibido entrenamiento a nivel nacional e internacional. En los centros se cuenta además con divisiones de apoyo tales como: suelos, sanidad vegetal y otras, cuyo personal colabora parcialmente según las necesidades de los técnicos que realizan las actividades de investigación.

Alrededor de 300 técnicos nacionales han recibido entrenamiento en el país en los cultivos de raíces y tubérculos. Con el apoyo técnico de centros internacionales e instituciones de países vecinos, se han realizado las siguientes actividades de capacitación en República Dominicana.

1. Curso nacional de yuca, con el apoyo de técnicos del Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

2. Curso nacional en el cultivo de ñame y curso de adiestramiento en el cultivo de la batata, con el apoyo de técnicos del Instituto de Mayagüez, Puerto Rico.

3. Curso sobre técnicas de laboratorio para la detección de *Erwinia* spp. en tubérculos, con la asistencia de participantes de Costa Rica, Honduras, Guatemala, Panamá y República Dominicana.

4. Curso de adiestramiento en el cultivo de yautía, con el apoyo de técnicos del Instituto de Agricultura Tropical de Mayagüez, Puerto Rico, y de un técnico del Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Costa Rica.

Es importante señalar que el programa de raíces y tubérculos ha mantenido estrecha relación con las universidades en la ejecución de investigaciones que sirven de tesis de grado.

English Summary

Root and Tuber Crops in the Dominican Republic

The supply and demand of cassava (*Manihot esculenta*), yam (*Dioscorea* spp.), cocoyam (*Xanthosoma* spp.), sweet potato (*Ipomoea batatas*), and potato (*Solanum tuberosum*) in the Dominican Republic are analyzed, as well as cultivated land characteristics and availability, farmers' socio-economic profile, cultivation systems, yields, production costs and constraints, and required labor.

Discussed also are the fresh product prices, marketing, and the processing of cassava for the manufacture of cassava bread.

Government policies dealing with production, imports, exports, taxes, subsidies, and credits and incentives, are also reriewed.

Finally, the institutions, personnel, and budget assigned to research, training, and technology development for these crops are mentioned. Research objectives are also given.

Root and Tuber Crops in St. Kitts

*Stafford M.A. Crossman**

Introduction

In St. Kitts sugar is the mainstay of the economy, the major source of foreign exchange, and the chief employer of labor. Sugar cane is grown on 78% of the best lands available for agriculture. These lands are government owned and are under the control of the National Agricultural Corporation (NACO). The lands occupied by sugar cane are, for the most part, flat to gently sloping from the coastal areas to the base of the central mountain range. Because of the mountain range there are many ghats running islandwide. Farms are located in these low-lying ghat areas and on steeper slopes between sugar cane and forested areas.

Root crops are essentially produced by small farmers although aided by NACO during certain periods of the year. In addition to root crops, farmers also grow vegetables and usually devote their best lands to vegetable production where rainfall is adequate or irrigation is available. They also grow their own bananas.

Overall, only 5% of the total agricultural land in St. Kitts is devoted to root crops. The most important regions for the production of these crops are located on the northern to northwestern section of the island in the parishes of St. Mary, Christ Church, St. John's, St. Paul's, and St. Ann. It is in these regions that 75% of all small farmers are located (Singh and Luckner, 1981). Most farms are located in middle zones at altitutes of 75-150 metres (m), and in upper zones at altitutes of more than 150 m. However, any increase in land area allocated to root crop production has to be justified by such economic factors as increased consumer demand and a demonstrable ability to attain a higher profit margin than either sugar cane or vegetable crops.

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Farm Characteristics

The average-sized farm operated by small farmers is approximately 0.3 hectares (ha). A baseline survey conducted by the Caribbean Agricultural Research and Development Institute (CARDI) has identified a total of 900 small farmers who produce root crops in varying quantities, either solely for home consumption or for both home consumption and sale as fresh food.

Most small farmers have two separate areas of land. One is usually on the lowland ghats and ghat sides, and the other on the steep slopes above the sugar cane lands. Vegetables are usually grown in lowland areas with root crops being cultivated in highland areas. Farms producing root crops are also most likely to produce vegetables, although some only during the rainy season. Most farmers have bananas on their farms and some small farmers also tend small quantities of livestock.

Socioeconomic Patterns

Farmers producing root crops are predominantly male, typically 50- to 70-years old, and do their farming mainly on a part-time basis. Their income from farming ranges from EC$1000[1] to EC$5000 per annum. Most farmers are married and live in households of five or fewer persons, using family labor on the farm. Employment in root crop production is limited to the small farmer, family labor, and, to a very small extent, outside labor.

The majority of the small farmers are employed by NACO in the sugar industry and have their household income supplemented by contributions from their children. Farmers have at least a primary level of education but hope that their children will attain a tertiary level of education.

The carbohydrate component of the farmers' diet is headed by bananas, followed by rice, and then root crops.

Root and Tuber Crop Production and Constraints

Root crops are usually grown on ridges and usually in pure stands. Although crops on NACO-controlled lands are always grown in pure stands small farmers on land not controlled by NACO practice some amount of intercropping. The most common intercrop combination is *Xanthosoma* spp. and *Colocasia* spp. Another noteworthy intercrop

1. Exchange rate: EC$1.00 = US$0.37 (1984).

combination is yams *(Dioscorea* spp.) with aroids, mainly tannia *(Xanthosoma sagittifolium)* (Table 1).

Obtaining yield data is difficult because 92% of the small farmers keep no record of production. However, estimates by NACO show the following ranges: sweet potato *(Ipomoea batatas)* 1120-4928 kg/ha, yams *(Dioscorea alata)* 3360-11,200 kg/ha, and aroids 1680-3360 kg/ha. The yam yield of 11,200 kg/ha was obtained prior to the outbreak of antracnose. Yields have since decreased substantially.

NACO is currently not involved to any extent in the commercial production of root crops. When sweet potato was grown commercially by NACO it competed heavily with the small farmers' production and created a glut. The corporation makes approximately 80 ha available annually to sugar estate workers for the planting of sweet potatoes. An equal land area was also made available for the growing of yams, prior to the virtual wipeout of White Lisbon yam *(Dioscorea alata)* by anthracnose disease (causal agent *Glomerella cingulata).* In addition to this disease, yams stored for planting material were also severely affected by the internal brown spot (IBS) virus. Research work is presently being done by both CARDI and NACO to make White Lisbon yam easily available once more. Two approaches are being used:

The use of virus-free material combined with spraying the crop with fungicides to control anthracnose; and

Virus-free material and anthracnose-tolerant *D. alata* cultivars with reduced fungicide applications.

Table 1. **Farmers growing root crops and intercropping in St. Kitts, 1981.**

Crop	Farmers growing crops (%)	Farmers intercropping (% of crop-growing farmers)
Sweet potato	63	5
Yams	43	22
Tannia	38	24
Dasheen	24	31
Eddoe	20	13

SOURCE: CARDI Baseline Survey.

Sweet potato production has remained constant at 300 tons (t) per annum for a number of years. Before the outbreak of anthracnose, yam production was equal to that of sweet potato. The yam cultivar now most produced is white yam *(D. rotundata)* which is not the consumers' first choice. Annual yam production is now at 182 t. Production of the aroids has held constant for a number of years at approximately 32 t per year.

The major factors constraining production expansion are lack of demand, lack of export markets, and pests and diseases. Export markets are not organized although some markets are available in the neighboring islands on an irregular basis. Planting materials are infected with pest and disease and, in addition to the yam diseases mentioned earlier, sweet potato yields are increasingly affected by the sweet potato weevil *(Cylas formicarius)* which is causing a reduction of over 30% of the marketable crop yield. Praedial larceny and damage by monkeys significantly constrain increased root crop production. Other constraints include seasonal gluts of root and tuber crops which discourage farmers from increasing their production. Farmers also face a limited amount of available land and poor rainfall now for the third consecutive year.

Production costs are generally lower at the lower levels of technology (Tables 2 and 3). The small farmer is presently producing about 3.4 t/ha of sweet potato whereas at the commercial level 4.5 t/ha are being produced. Using recommended technology the production of sweet potato could be increased to about 7.4 t/ha. The same could be said for yams where, at present, the small farmer is producing between 3.4 to 5.6 t/ha. At the commercial level 6.7 to 10.1 t/ha are being produced. Using recommended technology 13.4 to 14.6 t/ha could be produced. From these figures it can be determined that the higher cost incurred by the use of recommended technology is compensated for by higher yields per unit area. In aroid production small farmers spend a total of EC$1814 which includes land preparation and planting (EC$790), hand weeding (EC$654), and harvesting (EC$370).

Agricultural crops other than sugar cane account for 8% of the total agricultural products. Root crops contribute 50% of the value of these crops (Statistical Office Planning Unit, 1984).

Marketing and Constraints

Product transformation processes involving root crops are insignificant and involve the limited production of starch and cassava meal from cassava.

Table 2. **Sweet potato production costs (EC$/ha)[a] at different levels of technology, St. Kitts.**

Operation	Small farmer	Commercial producer	Recommended technology
Planting material	0[b]	74	197
Land preparation	672	346	346
Planting[c]	370	370	370
Applying fertilizers	0	0	264
Applying insecticides	0	29	59
Hand weeding	555	741	741
Harvesting	370	370	370
Fertilizer	0	0	296
Insecticides	0	53	165
Total cost	1967	1983	2808

a. Exchange rate: EC$1.00 = US$0.37 (1984).
b. Planting material taken from cuttings.
c. Includes cutting and transporting vines.

Table 3. **Yam production costs (EC$/ha)[a] at different levels of technology, St. Kitts.**

Operation	Small farmers	Commercial production	Recommended technology
Land preparation	642	675	593
Planting[b]	444[c]	4691	4691
Herbicide application	0	189	407
Staking	0	0	963
Fertilizer	0	160	424
Manual weeding	2089	1481	230
Anthracnose control	0	425	1139
Harvesting	0	1661	1284
Transportation to stores	0	589	404
Total	3175	9871	10135

a. Exchange rate: EC$1.00=US$0.37 (1984).
b. Planting includes procuring, cutting, and treating planting material.
c. Does not include cost of planting material as small farmers provide their own planting material, having stored it from the previous harvest.
SOURCES: Recommended technology: BDD (British Development Division). Project control memorandum. Commercial production: NACO.

More than 50% of the root crops grown in St. Kitts are grown by small farmers for their home consumption with the possible exception of sweet potato. Approximately 20 to 30% of the root crops produced reach the local markets through peddlers. A small percentage is sold to the Central Marketing Corporation (CMC) and an even smaller percentage is exported (Table 4).

Table 4. **Import and export quantities (kg/yr) of root crops, St. Kitts.**

Crop	Imports	Exports
White potato	455,000	177
Sweet potato	45	82,000
Yams	0	2,730
Aroids	1,900[a]	1,700[b]

a. Tannia (*Xanthosoma* sp.) usually accounts for over 90% of aroids imported

b. Dasheen (*Colocasia esculenta* var. *esculenta*) usually constitutes approximately 75% of aroids exported.

SOURCE: Statistical Office of Planning Unit, Ministry of Agriculture, Lands, Housing and Development.

Of the produce that reaches the local market, 61% is taken by the farmers or members of their household. In the most important production areas 30% of the farmers have to travel distances of over 16 kilometres (km) to the market. Most of the farms are located within distances of 8 to 16 km from the local market.

Because of disease problems there is at present an underproduction of White Lisbon yams. Local demand for aroids exceeds supply which is irregular because they are produced under rainfed conditions.

Top quality produce is given first preference by consumers during glut and normal supply periods. When supply is low, quality of produce assumes a much lower priority. Ironically, lower quality produce during periods of scarcity commands a higher price than top quality produce under normal or glut situations. Root crops are consumed traditionally by the older generation and primarily in rural areas whereas urban dwellers and the young prefer rice, corn, and white potato *(Solanum tuberosum).*

The existence of markets in neighboring islands results in an external demand for root crops as a fresh food. St. Kitts, with its agriculturally-based economy, is surrounded by islands whose economies are dominated by tourism. This gives St. Kitts the opportunity to supply these islands with good quality root crops. Further abroad potential markets exist in North America, although this means competition with other countries.

The external market is unexploited because of the lack of regular transport and the lack of retailers or wholesalers in neighboring islands. St. Kitts will need to guarantee regular shipments of specified quantities of root crops according to the local demand of each island.

Government Policies

Available statistical material on root crops is scarce and scattered among the agricultural institutions, the Statistical Office of the Planning Unit in the Ministry of Agriculture, Lands, Housing and Development, and the Central Marketing Corporation. The data needs to be collated, centrally located, and updated annually so that the figures can be kept current and readily available.

It is estimated that 67% of the energy-providing foods consumed in St. Kitts is accounted for by imports. These imports are dominated by wheat flour, rice, and maize flour. In recent years the local production of energy-rich agricultural products has either stagnated or decreased slightly. At the same time, however, the import bill for vegetables has increased tremendously. As a result, the thrust of import substitutions is focused upon the local production of vegetables in an effort to cut the import bill for these crops. It does not seem likely that consumer preferences will change drastically enough to favor root crops produced locally. There are, at present, no subsidies to consumers or any taxes applied to competing crops.

The policy toward energy-rich agricultural products will probably remain intact unless consumer preferences (which have a significant impact on policy making) make the unlikely switch back to locally-produced starchy foods. However, credit and other production incentives are equally obtainable for root crops as they are for other food crops.

White potatoes make up a large percentage of the food import bill and consequently are receiving some attention for local production. The government, however, prefers to have the private sector involved in the local production of this crop. The quantities imported annually indicate a sizable local market for this crop if it can be produced locally.

Research, Training, and Development

At present, NACO and CARDI are actively engaged in research involving root crops. There is no staff totally assigned to root crop research, but at least four professionals of these institutions spend part of their time on root crop research.

There is an allocation in the government budget for agricultural research but it is not earmarked for specific crops, although more attention is given to vegetables. Only a very small part of the budget is utilized for root crop research which focuses upon increasing the production of White Lisbon

yams. Production of this cultivar has been severely curtailed by the high incidence of anthracnose. Research has been in an applied form conducted on both experimental stations and farms.

Agricultural institutions have a number of local staff with graduate training in agronomy and whose formal training involved a number of courses related to root crops. However, such training did not qualify them as root crop specialists. There are no specific courses in root crops existing in St. Kitts at the country level. Neither are there national development projects to test recommended technology for increasing root crop production.

Quarantine Regulations

Quarantine regulations exist and are enforced by extension officers of the Department of Agriculture for the import and export of root crops.

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Spanish Summary

Cultivos de Raíces y Tubérculos en San Cristobal

Se analizan la oferta (5% de las fincas agrícolas), la disponibilidad y características de la tierra sembrada, los sistemas de cultivo, los rendimientos, el perfil socioéconomico de los productores, el volumen y costos de producción, y el mercadeo de los productos de los cultivos de raíces y tubérculos en San Cristóbal. También se discuten la demanda interna y externa de productos frescos y sus limitaciones. Finalmente se presentan las políticas gubernamentales relacionadas con la producción de cultivos de raíces.

Root and Tuber Crops in St. Vincent

*Glenroy E. Browne**

Introduction

Root crops are widely grown in St. Vincent. Most of these crops can be found growing on recent volcanic-ash soils and high-level content yellow-earth soils. Sweet potato *(Ipomoea batatas)*, cassava *(Manihot esculenta)*, and eddoe (*Colocasia esculenta* var. *antiquorum*) are grown mainly on low-level content yellow-earth soils.

Production is concentrated in the southern half of the island with the south-central zone being the area of highest growing concentration. Yams *(Dioscorea* spp.) and aroids occupy similar ecozones. These zones are characterized by an annual rainfall of 2159-2540 mm and are located at altitudes of more than 182 m. The main agricultural administrative regions where root crops are grown are shown in Table 1.

The area planted to root crops is estimated at 2600 hectares (ha). This represents an increase of 50% over 1975 when the area cultivated was estimated at 1735 ha. No recent statistics exist on distribution on a regional basis.

The soil type and climate render St. Vincent ideal for the cultivation of a wide range of root crops. Since 1979 there has been an increase in root crop production, particularly aroids, as more lands have become available. An important production element has been the expansion in regional root crop marketing by 'traffickers' which made the production of root crops competitive with other crops. In one area of the country, Vermont Valley, eddoe competed successfully with bananas and is now the main crop produced. The removal of restrictions by the Windward Islands' Banana Association (WINBAN) on the intercropping of bananas with root crops has resulted in an increase in the area available for root crop cultivation, especially aroids.

* Caribbean Agricultural Research and Development Institute (CARDI), St. Vincent, West Indies.

Table 1. **Root crops grown in agricultural administrative regions, St. Vincent.**

Crop	Region
Yams *(Dioscorea* spp.)	
D. alata	Biabou
D. rotundata	Lowmans, South Rivers
Sweet potato	Dorsetshire Hill, Argyle
Cassava	Dorsetshire Hill, Argyle
Tannia	Lowmans, Diamonds, Marriaqua
Dasheen	South Rivers, Perseverance
Eddoe	Vermont Valley, Perseverance, Marriaqua, Kingstown, Spring Village, R/Hall

SOURCE: Compiled by author.

The parceling and sale of several large estates have released more than 800 ha of previously underutilized lands for cultivation. The recent state acquisition of the 1400 ha Orange Hill Estate will also increase cultivation. The decline in arrowroot (*Maranta arundinacea*) production and the threatened demise of the sugar industry may also release large tracts of arable land for root crop cultivation.

Farm Characteristics

Production of root crops is concentrated on farms of less than two ha in size. In fact these crops can be considered to be small-farm crops. No recent data exist on the number of farms producing root crops. The majority of farms are made up of single parcels of land, although farms of two, three, or four parcels can also be found. Because these parcelas are generally fully utilized their potential for increased root crop production lies in their more intensive use rather than in extending land area.

Most farms are freehold while others are rented annually, sharecropped or are family-owned (the smallest number). Most holdings are located within three miles of the farmer's home on terrain ranging from gently sloping to rugged topography. Accessibility varies— some inland parcels are served only by footpaths making transport and production very difficult.

Many types of roads can be found in St. Vincent. The most common are unpaved dry-weather roads, all-weather roads, and trails and footpaths. Roads unfit for motor vehicles present a severe constraint on the quantity, quality, and type of produce reaching the marketplace.

Apart from investment in land, root crop farms are undercapitalized. Farm equipment generally consists of one to five pieces of hand tools—the most common being the hoe, machete, and pitchfork. Root crop producers who cultivate bananas may also possess a portable sprayer carried on the back and plastic field boxes. Over the past three years there has been an increase in the number of farmers owning motor vehicles.

The number of crop enterprises found on root crop farms may be as many as seven. The nature of these enterprises is variable, although generally consists of short-term rather than long-term crops. However, perennial crops such as bananas, plantains, coconuts, mangoes, citrus, and breadfruit are frequently planted in aroid and yam producing areas.

Socioeconomic Patterns

The main producers of root crops in St. Vincent are traditional small farmers, mostly over 50 years of age, literate, who live in stable family units of about six persons, and whose sole incomes come from their farms.

The younger or recent farm operators are involved in both onfarm and off-farm economic activities. These root crop farmers are engaged in trades such as carpentry and masonry, and often work in the public and private sectors. This is particularly true of eddoe and yam producers.

The income of root crop producers, although low, is highly variable and is related to production costs. A second job and a shift from perennial to short-term crops is usually necessary.

Starchy foods, especially root crops and rice, are the main components of the farm family's diet. The main source of meat is poultry, particularly chicken backs, imported from North America. Livestock produced is mainly sold or held as a form of bank account.

Root and Tuber Crop Production and Constraints

Root crops in St. Vincent are planted at the start of the rains in May and June and toward the end of the rainy season in October and November. However, planting is done throughout the year in high-rainfall areas. *D. alata* is planted from April to May and *D. rotundata* in January and

February. Most sweet potato are planted from April to June, and October to November. Aroids are planted throughout the year especially in high-rainfall areas. Sweet and bitter cultivars of cassava are also grown.

Eight cultivars of tannia *(Xanthosoma sagittifolium)*, four of dasheen *(Colocasia esculenta* var. *esculenta)*, and three of eddoe have been found on small farms in St. Vincent (Table 2). More than 90% of the area cultivated

Table 2. **Description of eddoe, dasheen, and tannia cultivars grown in St. Vincent.**

	Characteristics	
Cultivar	Corms/cormels	Petiole
Dasheen		
Common White	see Common White eddoe	Light green
Common Black	see Common Black eddoe	Dark green
Pink	Light-brown skin Yellow flesh	Pink
Eddoe		
Common White	Smooth light-brown skin White flesh	Light green
Common Black	Smooth dark-brown skin White flesh	Dark green
Nat Eddoe	Smooth, light pink to brown skin, very small with no neck	Green with light-pink tinge
Tannia		
Barbados White	Smooth skin White flesh	Light green
John Shott, South Rivers	Rough skin White flesh	Dark green
Rough Red Seed	Rough skin Pink flesh	Dark green with light-purple tinge
Smooth Red Seed	Smooth skin Pink flesh	Dark green with light-purple tinge
Grambe	Rough skin Yellow flesh	Red to purple
Nat Tannia White	White flesh	Light green
Nat Tannia Red	Smooth skin Pink flesh	Light green

SOURCE: Described by author (Caribbean Agricultural Research and Development Institute/ European Development Fund Aroid Project).

to tannia is planted with the cultivar Barbados White. In the case of dasheen and eddoe the common Black and White cultivars predominate.

About 16 different cultivars of sweet potato are found cultivated on small farms. Thirteen of these cultivars are described in Table 3.

All major edible yam species are grown in St. Vincent, the important ones being: *Dioscorea rotundata* cv. Portuguese; *D. cayenensis* cv. Dominic; *D. alata,* several cultivars; *D. trifida,* Cush Cush; *D. bulbifera,* unknown cultivar; and *D. domenturum,* unknown cultivar.

The principal species are *D. rotundata* and *D. alata. D. rotundata* and *D. cayenensis* are mainly grown in high-rainfall zones. *D. alata* cultivars are generally grown in the drier zones although some cultivars are adapted to

Table 3. **Major sweet potato cultivars grown in St. Vincent.**

	Characteristics	
Cultivar	Leaf and stem	Tubers
Red Sauce	Lobed, green lamina Red stem Medium size	Red skin Cream-colored flesh Round shape
Stranger	Lobed, green lamina Green vein Green stem with red streaks	Red skin Cream-colored flesh
Six Weeks White	Lobed Green lamina Green petiole Green stem	White skin White flesh Oblong shape
Black Vine (L)	Slightly lobed Large leaves Green lamina Green main vein	Red skin Red flesh
Mek me Laugh	Lobed Medium size Green lamina and red Green vein Green petiole with red streaks Green stem	Red skin Red flesh
White Vine	Large heart-shaped Green lamina Green vein Green petiole	White skin Cream-colored flesh Oblong shape

(Continues)

Table 3. (Continued).

Cultivar	Characteristics	
	Leaf and stem	Tubers
Six Weeks Red	Lobed Green lamina Red vein Green petiole with red streak	Red skin Red flesh Round shape
Black Vein (G)	Green lamina Red and green vein Red petiole Red stem	Red skin White flesh Round shape Sweet
St. Vincent Black Vine	Entire margin heart-shaped Green lamina Red main vein Red stem	Red skin
Bradshaw	Lobed, green lamina Green vein Green petiole with red streaks Red stem with green streaks	Red skin light-green flesh Oblong shape
Bascombe	Entire margin heart-shaped Medium size Green lamina Red to green vein Green petiole with red streaks Green stem with red streaks	Red skin Light-cream-colored flesh Oblong shape
Cassava Leaf	Lobed Green lamina Green vein Green petiole Green stem with red streaks	Red skin White flesh Round shape
Red Devil	Entire margin heart-shaped Small size Red vein Green petiole with red streaks Green stem with red streaks	Red skin Cream-colored flesh Oblong shape

the wetter inland and forested areas. Yams are costly to produce because of the scarcity and high cost of planting materials and because of the high costs of land preparation and weed control.

Root crops are produced both in monoculture and intercrop systems. On those farms where production is highly commercialized monoculture is practiced. In monoculture it is common to find the same crop planted in the same area for several consecutive seasons. On other farms crop combinations are widespread. Crops are either grown simultaneously on the same plot or they follow one another on the same plot for one year. Typical crop combinations are:

Sweet potato mixes

sweet potato/corn/cowpea
sweet potato/corn/pigeon pea
sweet potato/corn/cassava
sweet potato/cucumber
sweet potato/carrot
sweet potato/cowpea/cassava
sweet potato/cowpea/corn/cassava

Yam mixes

yam/tannia/dasheen/cowpea
yam/tannia/dasheen/cowpea/corn
yam/corn/dasheen/cowpea
yam/cowpea
yam/corn/dasheen/okra

Aroid mixes

tannia/dasheen/banana
tannia/dasheen/banana/coconut/breadfruit
tannia/dasheen/banana/coconut
tannia/banana
tannia/dasheen
tannia/eddoe
tannia/dasheen/okra
tannia/dasheen/corn
dasheen/plantain

For root and tuber crops four methods of land preparation are used: ridge and furrow, mounds (round banks), plowing, and minimum tillage (Table 4).

Table 4. **Summary of agronomic practices used in root crop cultivation in St. Vincent.**

Operation	Crop					
	Tannia	Dasheen	Eddoe	Sweet potato	Yam	Cassava
Land preparation	Mounds Minimum tillage	Mounds No tillage	Mounds Plowing	Long bank Plowing	Mounds	Long bank
Principal cultivars and species	Barbados White Red Seed John Shott Gramble	Common		Mixture of cultivars	*D. rotundata* *D. alata* *D. cayenénsis* *D. esculenta*	Bitter Sweet
Planting material	Tops Cormels Sprouted suckers	Tops Suckers	Tops Cormels	Stem cutting	Head cutting Seeds	Stem cutting
Planting season	Apr.-June Oct.-Nov	All year	All year	Apr.-June Oct.-Nov.	Feb.-June	Apr.-June Oct.-Nov.
Spacing (cm)	80 x 80 90 x 90 100 x 100	60 x 60 90 x 90	80 x 80	30 x 90	90 x 90 80 x 80	60 x 90 90 x 90

(Continues)

Table 4. (Continued).

Weed control	Hand:1-2 months after planting Preemergent paraquat spraying	Hand:1-2 months after planting	Paraquat spraying 1 month after planting followed by hand weeding and molding 1-2 months later	Hand:1-2 months after planting	Hand:1-2 months after planting	Hand:1-2 months after planting
Fertilizer use	50 g of ammonium sulfate or N-P-K-Mg per plant every month	None	Same as tannia but applied after land preparation	None	None	None
Pests and diseases	Some leaf burning Leafhoppers (*Empoasca* sp.)	Whiteflies (no control)	Whiteflies (no control)	*Euscepes postfasciatus* Sweet potato mosaic virus (Control by chemicals, mixing cultivars, crop rotation)	Anthracnose (Control by crop rotation, fungicides)	Mealybug (No control)
Harvesting	Barbados White: 7-8 months Other cultivars: 9-12 months Manual Ratooning	8-12 months Manual	5-7 months Manual	4-5 months Manual	6 months and 11-12 months Manual Ratooning	1 year Manual

Ridges and furrows (long banks) are continuous along the planting contour and spaced 30-60 x 90 cm apart. Weeds are removed and arranged along the contours and covered with soil. In some areas compact soils are forked to loosen them. Loose soils are prepared with a hand hoe. This method of land preparation is used for sweet potato and cassava.

In the preparation of mounds, a trench, locally called a 'foot hole', 20 to 30 cm deep is dug and organic matter, including weeds, are placed in the hole. The hole is then covered with the soil removed from another trench nearby. Each row of mound is prepared along the contour. This method of land preparation is used for planting aroids and yams.

The method of plowing is essentially similar to that of making mounds except that no individual hill is made. The mounds are flattened to give a smooth even finish. This method is used in loose sandy soils for planting sweet potato and eddoe.

Minimum tillage involves first clearing or spraying with paraquat the area to be planted. Holes 20-25 cm deep and 25-30 cm wide are then dug. These holes are spaced 60-100 cm x 60-100 cm. At planting the hole is partly filled with organic matter and soil. This method is used in the cultivation of aroids.

Weed control of root crops is done mainly by hand. Simple hand tools such as a hoe and machete are used. For aroids, particularly eddoe, paraquat is applied after the plants' emergence and this is done without a shield. This is then followed by manual weeding and molding (heaping up). The use of paraquat has led to changes in weed species dominant in aroid producing farms. For example, a hardy weed, corn grass *(Rottboelia exaltata),* once a minor weed problem, is now a major problem and farmers are experiencing difficulty in its control. The use of glyphosate is recommended as a chemical weed control in aroids.

Preemergent weed control is not practiced by root crop farmers. Weed control is a major management activity and may be carried out about two to three times in a single cropping season.

Application of root crop fertilizers is very common in St. Vincent even though the fertilizers imported are blended for the specific use of bananas, sugar, arrowroot, and tobacco, and not specifically for root crops. The

suitability of fertilizers is therefore of major concern. Fertilizers are applied in both single and split applications. Band application is common and most farmers cover the fertilizers. The fertilizers available to root crop producers are the 'banana mixture'—nitrogen-phosphorus-potassium-magnesium (N-P-K-Mg) blended 16:8:24:2—and ammonium sulfate. Their availability is dependent upon whether the farmers are involved in the production of crops such as bananas or have enough money to purchase fertilizer from friends at inflated prices.

Because there are no pests or diseases of economic significance, pest and disease control for aroids is uncommon. The main pest of these crops, *Empoasca* spp. (leafhoppers), is insignificant and insecticidal sprays such as Basudin, Systoate, and Decis are sometimes applied. Recently there has been an increasing number of reports on the occurrence of tannia leaf burning disease (cocoyam root rot). Although no control method is consciously followed by farmers, a system of crop rotation and intercropping is practiced.

The main pest of sweet potato is the sweet potato borer *Euscepes postfasciatus.* Farmers attempt to control this pest by mixing cultivars, crop rotation, and chemical methods. The main chemicals used are Aldrin, Primicid, and Sevin applied during land preparation. One disease of significance is sweet potato mosaic virus.

Up until 1984 no pest or disease control was practiced for yams except crop rotation. However, the recent outbreak of anthracnose has led to the widespread use of fungicides such as Dithane M-45 and Benlate in an effort to control the disease. Despite thousands of dollars spent on national programs chemical control of anthracnose has so far proved ineffective.

Root crops are harvested manually. The pitchfork and machete are the major tools used. Harvesting may be accomplished at once or staggered over one or two months. Ratooning may also be practiced especially with tannia and yams. In this case mature cormels and tubers are carefully removed. Over the following three or four months other cormels or tubers are produced.

Grading and sorting are done in the field during which most of the soil and organic matter are removed from the tubers. Cassava is harvested by buyers while other crops are usually harvested by the farmers. Yam tubers are transported to farmers' homes by the farm family where they are stored. All root crops except yams are sold in the field.

Because root crop production is rainfed and land preparation generally occurs at the onset of the rains production of root crops is labor intensive so much so that some farmers are forced to reduce the area of crop cultivation. Consequently labor expenses represent the major cost factor in the production of these crops. Tables 5 and 6 show labor expenses per hectare for the commercial production of eddoe, tannia, sweet potato, and yams in 1983. It should be noted that material and equipment costs for yams (45.3% of total cost) are approximately equal to the cost of labor while material and equipment costs for eddoe, tannia, and sweet potato are 24.7%, 12.4%, and 19.0% respectively. Expanded production will require additional labor that at present is unavailable despite the 40 to 45% unemployment rate.

Table 5. **Summary of production costs and returns (EC$ ha)[a] for root crops, St. Vincent, 1983.**

Item	Crop			
	Eddoe	Tannia	Sweet potato	Yams
Operating expenses				
Labor	5821	4181	3024	5545
Material and equipment	2224	667	870	5594
Marketing charges	287	158	222	435
Total operating expenses	8332	5006	4116	11574
Fixed expenses				
Land rent	123	138	123	93
Other	546	395	335	676
Total fixed expenses	669	533	458	769
Total expenses (Operating + fixed expenses)	9001	5539	4574	12343
Production costs per ton	760	830	880	1220
Gross return	11935	7386	3892	16679
Net return	2934	1947	(551)[b]	4336
Net return per ton	250	300	(110)	430
Saleable yield (kg)	11794	6486	5053	10109

a. EC$1.00 = US$0.37 (1983).
b. Bracketed figures represent losses.
SOURCE: Compiled by author from statistics of the Ministry of Agriculture.

Table 6. **Cost factors as a percentage of total production costs for root crops, St. Vincent.**

Item	Crop			
	Eddoe	Tannia	Sweet potato	Yams
Operating expenses				
Labor	64.6	75.4	66.1	44.9
Material and equipment	24.7	12.1	19.0	45.3
Marketing charges	3.2	2.9	4.9	3.5
Total operating expenses	92.5	90.4	90.0	93.7
Fixed expenses				
Land rent	1.4	2.5	2.7	0.8
Other	6.1	7.1	7.3	5.5
Total	100.0	100.0	100.0	100.0

SOURCE: Compiled by author from Table 5.

There is also a demand for increased wages. Laborers demand higher wages from small farmers than they do with large-scale farmers and plantation owners. Farmers are therefore turning to labor-saving techniques such as minimum tillage.

Production costs are highest for yams averaging EC$1.22/kg[1] followed by sweet potato, tannia, and eddoe in descending order yet the net return for yams is the highest because of its relatively high price (EC$1.65/kg) and high saleable yield. Production of sweet potato, on the other hand, results in a net loss of EC$0.11/kg which is undoubtedly the reason for its declining production. Eddoe production results in a net return of $0.25/kg and tannia has a net return of EC$0.30/kg.

The lack of a well-developed credit system is a major restriction in the present production systems. The collateral requirement for starting production discourages small farmers as well the delays and red tape involved in processing loans.

Before 1972 root crop yields were generally less than 3000 kg/ha. Yields of aroids and yams have tripled since 1972 while yields of sweet potato have doubled. Nevertheless, root crops continue to yield well below their

1. Exchange rate: EC$1.00 = US$0.37 (1984).

potential. The volume increases in root crop production in general and aroids in particular have resulted more from the expansion of the cultivated area rather than from productivity per unit area.

This production inefficiency is a result of low use of appropriate fertilizers, inadequate pest and disease control, and a lack of specific, high-yielding crop varieties adapted to St. Vincent. Even where improved cultivars have been introduced such as for sweet potato, under the small-farm setting they have not performed well.

Fertilizers available to farmers are not blended for root crops. In St. Vincent only mixed banana fertilizer is available along with ammonium sulfate. The soils in which most root crops are grown are acidic and have medium- to low-phosphate levels and yet no soil amelioration measures have been adopted nor are phosphatic fertilizers available to root crop farmers.

Production statistics for root crops at the national level show nearly a five-fold increase over the 22-year period 1961-1983 (Table 7). However, observation on the performance of the individual types of root crops shows that aroid production has expanded greatly and is the main contributor to this remarkable expansion in production volume. Among the edible aroids the *Colocasia* spp., especially eddoe, have experienced dramatic increases in production.

Production of sweet potato has declined over the twenty-year period

Table 7. **Volume of production (t) of root crops in 1961, 1972, and 1983, St. Vincent.**

Crop	Year			Percentage change
	1961	1972	1983	(1961-1983)
Aroids	663	1038	11039	1165
Sweet potato	1580	847	944	(40)[a]
Yams	401	439	1236	308
Cassava				
Tuber	51	94	—	—
Starch	72	84	—	—
Total	2767	2502	13219	

a. Represents a negative change in percentage.

SOURCE: Compiled by author from Agriculture Census 1961, and 1972/73, and statistics from the Ministry of Agriculture.

while the cultivation of cassava has been insignificant. Apart from aroids, only yams showed an increase in production over the period.

Root crops are second only to bananas in total volume produced and, although they still trail bananas by a substantial amount, the margin is narrowing. Their strong position is attributed to the rapidly rising prominence of aroids, especially eddoe, which expanded from 10.2% of the country's total agricultural production in 1979 to 22.1% in 1982, averaging 15.1% over the period as shown in Table 8.

Marketing and Constraints

There is a general agreement that the process of price formation and the subsequent transmission of price information perform poorly in their role of matching production and consumption both within a given season and from year to year. This is a major source of risk in the production of root and tuber crops.

The principal purchasers of most of the root crops are middlemen, the St. Vincent Marketing Corporation, and a private marketing agency—Eastern Caribbean Agencies. The pricing transactions between farmers and middlemen are done privately and are subject to a great deal of variation over time. However, the farmers show a greater degree of trust toward marketing agencies which offer highly-personalized informal transactions, lower but more stable prices, and commitments on a contractual basis with extraregional markets. The good relationship that exists between farmers and middlemen, however, makes it difficult for institutions to fulfill export commitments.

Table 8. **Estimated production of root crops expressed as a percentage of total agricultural production, 1979 to 1983, St. Vincent.**

Crop	Year					Average
	1979	1980	1981	1982	1983	1979-1983
Aroids	10.2	11.8	14.0	17.0	22.1	15.0
Sweet potato	3.7	6.0	3.2	3.3	2.1	3.7
Yams	1.6	1.6	1.6	2.1	2.4	1.9
Total root crops	15.5	19.4	18.8	22.4	26.6	20.6
Banana	73.2	59.7	76.5	71.1	76.7	71.6

SOURCE: Compiled by author from Ministry of Agriculture statistics.

The physical movement of crops from the farm to the consumer involve many problems of postharvest management such as transport, processing, grading, and packaging and storage. Improvements would require technical inputs and capital investments.

The rugged terrain and existing road systems impose severe restrictions on the movement of crops from farm to market. People and donkeys continue to be the only method of transport on the steep winding tracks that link the farms with the road systems. The problem is compounded by the highly diversified cropping patterns and widely separated parcels of land that characterize the farms. The volume collected at any farm is therefore not only low but scattered resulting in high costs of collection.

The practice of transporting root crops tightly packed in gunny sacks leads to a great deal of abrasion, breakage, and spoilage of tubers, corms, and cormels, further aggravated by piling the sacks upon each other in narrow spaces on minivans. The handling and storage of produce on interisland ships and warehouses also reduces commodity quality.

The lack of grading is particularly evident in commodities handled by middlemen. A grading system with price differentials would provide an incentive to farmers to improve quality and reduce postharvest losses.

The lack of reliable root crop data and other information on current or prospective production make market agents hesitant in seeking export markets where future commitments on delivering quality produce at set prices are risky and difficult.

Prices set under the Agricultural Marketing Protocol have not allowed the Marketing Corporation to pay farmers prices which would provide adequate incentive to produce the quantities needed. In recent years the prices offered by the middlemen have been high (as a result of the oil boom in Trinidad) but unfortunately these high prices are associated with low-quality produce.

Root crops produced in St. Vincent are primarily sold on the export market. Over the four year period 1980-1983 root crops retained for local consumption declined from 35% in 1980 to 3.7% in 1983 (Table 9).

Sweet potato and cassava are mainly grown in areas ranging from 2 to 8 miles from the market. Yams are produced in areas 12 to 25 miles away and the main eddoe-producing areas are located from 2 to 5 miles from the market. Dasheen is grown from 5 to 8 miles and tannia from 8 to 25 miles from the market.

Table 9. **Quantity of total root crop production retained for local consumption, 1980 to 1983, St. Vincent.**

Crop	1980		1981		1982		1983	
	Quantity retained (t)	Percentage of total production	Quantity retained (t)	Percentage of total production	Quantity retained (t)	Percentage of total production	Quantity retained (t)	Percentage of total production
Dasheen and eddoe	1288	39.5	601	13.9	540	9.9	79	0.9
Tannia	335	38.6	342	19.7	348	16.9	267	9.0
Yams	285	50.8	285	41.2	309	33.3	15	1.2
Sweet potato	472	22.4	270	19.8	495	34.2	140	12.9
Total retained	2380	35.0	1498	18.5	1692	17.1	501	3.7

Domestically root crops, with the exception of cassava and sweet potato, are consumed mainly by farm families as starchy staples. Per capita consumption of root crops declined 80.4% from 19.9 kg to 3.9 kg (Table 10) over the 4-year period 1980-1983. This has resulted from the increased demand for root crops in external market, particularly in Trinidad and Tobago, and the high prices that middlemen are offering in the local markets.

The only root crop processed is cassava. The production of cassava starch in St. Vincent was a major industry in the first half of this century when several factories were operational. However, cassava starch production later gave way to arrowroot *(M. arundinacea)* starch production.

Today farine is the major byproduct of cassava. It is produced in a few, home-based, manually-operated production units and often bought by market agents primarily for export. A small quantity reaches the local central market and supermarkets. However, sale from the supermarket is usually very slow since the farine is usually stale. There is no external demand for other root crops as transformed products.

The external root crop market (Tables 11 and 12) has been the Caribbean Community (CARICOM) region, particularly Trinidad and to a lesser extent Barbados. Extraregional markets have been the United Kingdom and Canada. Potential markets exist in the United States of America, Bahamas, Canada and Europe. The principal consumers in most foreign markets are migrant West Indians, Africans, and Indians.

The main constraints on the domestic demand of root crops are the taste and preference of consumers, product quality, shelf life, and their price relative to substitutes.

Table 10. **Per capita consumption (kg) of root crops, 1980-1983, St. Vincent.**

Crop	Year			
	1980	1981	1982	1983
Eddoe and dasheen	10.8	4.9	4.3	0.6
Tannia	2.8	2.8	2.8	2.1
Yams	2.4	2.3	2.5	0.1
Sweet potato	3.9	7.2	3.9	1.1
Total root crops	19.9	17.2	13.5	3.9

Table 11. **Export volume (t) and value (EC$)[a] of root crops to major importing countries from 1980 to 1983, St. Vincent.**

Importing country	Year							
	1980		1981		1982		1983	
	Volume (t)	Value (EC$)	Volume (t)	Value (EC$)	Volume (t)	Value (EC$)	Volume (t)	Value (EC$)
Barbados	45.3	172,952	61.4	202,982	38.6	127,406	22.1	76,074
Canada	1.0	2,913	21.5	74,809	30.5	105,020	34.3	117,051
United Kingdom	111.6	345,821	126.0	454,078	44.0	147,471	58.2	191,498
Trinidad	1,806.7	4,712,692	2,800.3	8,431,935	3,617.6	11,416,691	5,894.0	18,562,197

a. Exchange rate: EC$1.00 = US$0.37 (1984).

Table 12. **Destination of exported root crops (%), 1980 to 1983, St. Vincent.**

	Year			
Destination	1980	1981	1982	1983
Barbados	2.31	2.04	1.04	0.37
Canada	0.05	0.71	0.82	0.57
United Kingdom	5.68	4.19	1.18	0.97
Trinidad	91.96	93.06	96.96	98.09

SOURCE: Statistics Unit, Ministry of Agriculture.

The vast majority of St. Vincentian consumers have acquired the taste and preference for foreign foods. Several factors are responsible for this preference including such ideas as root crops being a poor man's food, as a heavy food not suitable for intellectual development, as social climbing being incompatible with the consumption of root crops, and foreign product superiority (augmented by the impact of tourism, foreign films and TV, and visits of St. Vincentians to foreign metropolitan centers). Root crops are not advertised and their positive qualities remain unknown to most consumers. Utilization of root crops as primary products is further associated with the messy and time-consuming task of peeling. St. Vincentians are therefore eating more semi- or fully-processed food products.

Little effort is given by farmers and market agents alike to improve the presentation of root crops in the marketplace. Washing and curing of the commodities are more often the exception than the rule. Urban consumers are becoming more aware of product quality but product presentation has not improved with this increased awareness. In both supermarkets and central markets root crops appear in unsightly heaps. In some cases soil, dead leaves, and petiole residue are present. Grading, if practiced, is restricted to size only. Often broken, lacerated, and bruised tubers are mixed in with those of perfect condition. There has been no effort to improve the packaging of root crops.

Many consumers complain of the short shelf life of sweet potato now produced in St. Vincent. In contrast, this commodity 15 to 20 years ago could be kept under most conditions for 3 to 4 weeks. Sweet potato today rots after 1 or 2 weeks. The unsupported view that fertilizers applied to the crop are responsible for this poor storage is widely believed. It is also believed that the varieties presently grown and their maturity rates also determine spoilage. Studies on these aspects are urgently needed.

Root crops need to be transformed into more concentrated, easy to use, and more storable products. At present consumers buy only limited quantities that can be stored for short periods and consumed readily. They cannot take advantage of seasonal gluts when prices are low to purchase large quantities. Considerable losses are therefore suffered by farmers and market agents since large quantities are dumped or allowed to rot in the fields.

Farmers and market agents also face the problem that substitute foods are price competitive in the marketplace.

The main problems constraining external demand for root crops relate to postharvest handling, price, phytosanitary requirements, and a guaranteed year-round supply in volume acceptable to the foreign purchaser.

Since most root crops are marketed in their fresh state, maintaining acceptable quality during their transport to the marketplace is very important. The high moisture content and rapid rate of deterioration after harvesting are serious problems affecting the export of these crops in their fresh form without controlled environmental conditions. The bulk of root crops exported are subjected only to minimal postharvest treatment. At best, grading and removal of soil and organic matter are performed, but no curing or chemical treatment of any kind is carried out. In addition, most crops are exported in sacks which allow pathogens to flourish and therefore reduce shelf life.

Another important factor that affects shelf life and product quality is the degree of maturity of the harvested product. Many farmers have been forced to harvest some root crops prematurely when pressured by middlemen and high prices. Such premature harvesting leads not only to losses in volume and returns but also in an inferior product.

In extraregional markets all root crops passing through ports of the United States of America, whether bound for the U.S.A. or not, are subject to quarantine regulations. All produce must be fumigated, whether treated locally or not. In view of this inconvenience and cost, market agents make efforts, where possible, to bypass U.S. ports.

The high cost of root crop production combined with the high cost of commodities generally encourage high market-prices at the farm. Fluctuations in supply and demand in the regional market have led to excessively high prices at certain times of the year. Consequently exporters filling contracts to extraregional markets find their offer of fixed annual-prices a major constraint.

Because of the low prices offered for root crops in the metropolitan markets high returns must be based on exporting large quantities of commodities throughout the year. Moreover, they need to be shipped in quantities of not less than 20 t. Such volumes, with the noted exception of eddoe, are often impossible to attain because of low productivity at the farm level and seasonality. It is perhaps the most serious constraint to expanding the sale of root crops in the market place.

The available statistical data consist of quarterly, national, export figures for all root crops except cassava. These data are compiled from invoices from which the actual volumes exported are estimated. Production statistics are of an even cruder nature, being based on estimates of land area.

There are no recent systematic land area assessments. The last such assessment was done in 1972-1973 when the Agricultural Census was conducted. In 1982 a survey of aroid crop cultivation was carried out by the Aroid Improvement Project of CARDI. Data on market prices and quantities sold at the various markets have been available on a weekly basis since 1985.

Recommendations

Future market strategy should aim at expanding into the North American and Bahamian markets. This requires aggressive lobbying, the establishment of proper and acceptable quarantine arrangements, and good postharvest management. In addition efforts must be made to maintain positive growth in the Trinidad market. With the decline in oil revenues and increasing agricultural production in Trinidad the demand for imported root crops may decrease.

Government Policies

There is no document outlining government policies on root crops. Production is mainly determined by demand in the regional and extra-regional markets. Discussions with government officials revealed, however, that the promotion of root crops as a foreign exchange earner will continue. Special efforts are to be undertaken to increase the production of 'red' tannia and to introduce special cultivars of both *D. alata* and *D. cayenensis.*

The testing of sweet potato cultivars to obtain cultivars with promising yields, good storage, and tolerance to the sweet potato weevil is also

expected. Good postharvest management is also regarded as vital and is currently being addressed.

A wide range of energy-rich agricultural products is imported into St. Vincent. No restrictions of any kind are imposed—in fact, the approach is to allow the import of these commodities and to obtain revenues through import and consumption taxes. As a result, no effort has been made to practice import substitution with root crops and their derivatives. No domestic subsidies are offered to encourage production, local consumption, or export of root crops.

The milling of wheat flour in St. Vincent has been granted 'pioneer' status and enjoys special concessionary privileges including tax exemption which makes its price competitive (although controlled) relative to root crops. Rice is imported by the government and sold at controlled prices. A pilot project to produce hill rice is presently underway. The production of rice is seen as an alternative to sugar.

Audiovisual media, especially foreign, is now widespread and its impact is tremendous. Its content contributes to increasing the preference for imported foods which, with the government's stated commitment to an open-market economy, are easily imported.

Food crops, such as bananas and arrowroot *(M. Arundinacea),* receive production incentives. These crops enjoy the support of long-standing commodity organizations jointly managed by the government and producers. These institutions are also responsible for extension and marketing activities.

Research, Training, and Development

There are two institutions conducting root crop research. They are the Research Unit of the Ministry of Trade, Industry and Agriculture, and the country team of CARDI. In the Ministry two staff members are assigned to root crops research and in CARDI five staff members are involved.

There is no specific budgetary allocation to root crops or any other crop. In fact, no record of root crop research is available for the period 1969-1984. An overall allocation of approximately EC$100,000 is set for research including technical assistance. This amount is then divided according to research priorities. In the government's 1984-1985 Research Programme priority was given to the evaluation of sweet potato cultivars. An estimated 10% of the research budget was allocated to this work. For this upcoming fiscal year research on root crops is expected to increase and thus its budgetary allocation.

Research emphasis in St. Vincent has traditionally been on export crops such as arrowroot, banana, and cotton. Research became more diversified with the involvement of the Regional Research Centre. The Research Programme was expanded to include many crops that were traditionally grown for local consumption by small farmers. Studies on legumes, root crops, and cereals were conducted. Investigations on soil fertility and response to fertilizers were carried out for several crops.

In those earlier periods much of the research was conducted at the Campden Park Experiment Station. At that stage trials were conducted on farmers' holdings but under the full control of the researcher. With the transformation of the Regional Research Centre into CARDI, research emphasis was shifted to farming-systems research. Commodity oriented research was also continued. The efforts were directed at obtaining technological packages for the improved production of particular crops. In the earlier stages, farming-systems research was concerned mainly with data gathering as a basis for improving small-farm technology.

All root crop research in St. Vincent has been conducted onfarm. The most outstanding efforts include fertilizer trials in the 1970's, evaluation of sweet potato cultivars, collection and evaluation of aroid cultivars, development of postharvest management techniques for sweet potato, chemical control of the sweet potato weevil, and evaluation of production costs for some root crops.

Current studies include description of *D. alata* cultivars in St. Vincent, evaluation of sweet potato cultivars including cultivars from the International Institute of Tropical Agriculture (IITA) and the University of the West Indies (UWI), rapid production of disease-free planting material for red tannia, evaluation of improved technological packages for tannia production, improved packaging and treatment, and simple storage of eddoe and tannia. Maturity studies on aroids are currently being undertaken.

St. Vincent has only one person with some formal training in root crop production. The person holds a B.Sc. degree in agriculture from UWI and was a participant in an intensive course in root and tuber crop technology conducted by IITA in 1983. No specific training courses in root crops exist in St. Vincent.

A United States Agency for International Development (USAID)-funded Farming Systems Research Project being undertaken by CARDI exists at the national level. This project includes the evaluation of sweet potato cultivars developed for superior yield and pest tolerance.

The CARDI/European Development Fund (EDF) Arrowroot Improvement Project, operating subregionally, is a good example of a project with the specific objective of technology development for the improved production of aroids—particularly tannia. The project focuses on the identification and control of pathogens causing tannia leaf burning disease (cocoyam root disease). Work has been undertaken to describe cultivars of aroids in this subregion, evaluation of locally-introduced hybrid tannia cultivars, rapid production of disease-free tannia planting material, development and testing of technological packages for improved tannia production, and some aspects of aroid postharvest management techniques.

Quarantine Regulations

There are no specific quarantine regulations or quarantine facilities for root crops. Facilities for quarantine inspection, treatment, and disposal do not exist at any port. The quarantine regulations require that all produce be free from soil, organic matter, diseases, and pests.

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Spanish Summary

Cultivos de Raíces y Tubérculos en St. Vincent

Se hace una descripción detallada de las variedades de tiquisque (eddoe), taro (malanga, bore dasheen), ocumo (mafafa, yautía, tannia, cocuyam), y

batata (sweet potato) que se cultivan en este país. Se indica la disponibilidad de tierras y el potencial de expansión de la superficie cultivable, y se hace un pronóstico del incremento de tierra disponible por el descenso en la producción de arruruz (maranta, arrowroot) y deficiencias en la industria azucarera. Se describen también las características de las fincas productoras y de los sistemas de cultivo empleados. Se analizan además la demanda tanto interna como externa y sus propios sistemas de mercado. Se indica el empleo que se hace de los productos agroquímicos y de otros métodos para controlar malezas, insectos y enfermedades. También se presenta un estudio extenso de los costos de producción de los cultivos mencionados. Finalmente, se discuten las limitaciones de la producción y la orientación de la investigación futura. Se señala así mismo la importancia que tienen instituciones de investigación para la producción y desarrollo de los cultivos de raíces feculentas.

Root and Tuber Crops in Trinidad and Tobago

*Anthony Seesahai**

Introduction

Approximately 1563 hectares of land are under root crop production in Trinidad and Tobago. This production area is expected to increase to 2542 ha in 1986 with most of the increased land resulting from a significant increase in cassava (*Manihot esculenta*) cultivation. Most of the root crops are grown in Nariva and Mayaro, followed by St. Patrick, Caroni, Victoria, and to a lesser extent, St. Andrew, St. David, and St. George. The root crops which occupy the majority of the land areas are cassava and dasheen (*Colocasia esculenta* var. *esculenta*) (Table 1).

Table 1. **Area under root crop cultivation (ha) in different counties, Trinidad, 1984.**

County	Cassava	Yams	Sweet potato	Dasheen	Eddoe	Tannia	Total
St. Patrick	139	35	36	35	31	13	289
Nariva, Mayaro	36	28	10	300	8	7	389
Caroni	130	60	60	15	40	44	349
Victoria	90	67	44	22	63	22	308
St. Andrew, St. David	43	10	46	11	4	6	120
St. George	45	10	20	21	6	6	108
Total	483	210	216	404	152	98	1563

SOURCE: MALFP, Extension Division Survey.

* Ministry of Agriculture, Land and Food Production, Crop Research Division, Centeno, Trinidad and Tobago.

Sugar cane lands, abandoned croplands, and some areas of cultivated croplands are all available for root crop expansion. The government-owned sugar companies intend to plant 500 ha to root crops over the next 10 years.

Farm Characteristics

Data obtained from the Food and Agriculture Organization of the United Nations (FAO) indicate that the size of farms producing specific root crops varies among counties. Generally, average farm sizes are: cassava 2-6 ha; yams (*Dioscorea* spp.) 2-5 ha; sweet potato (*Ipomoea batatas*) 2-4 ha; dasheen 2-4 ha; eddoe (*Colocasia esculenta* var. *antiquorum*) 1-2 ha; and tannia (*Xanthosoma sagittifolium*) 0.05-1 ha. Average farm size in the County of Caroni for cassava is 2.2 ha, sweet potato 1.4 ha, dasheen 0.9 ha, and eddoe 0.8 ha. The total number of farms producing root crops was 70.

The 1982 Agricultural Census indicated that the number of holdings in Trinidad and Tobago cultivating root crops was 5045 occupying 2124 ha of which 4381 holdings (1874 ha) were in Trinidad and 664 holdings (250 ha) were in Tobago.

Many root crop farmers cultivate tree crops and vegetable crops and raise livestock such as goats, sheep, poultry, cattle, and pigs. Some areas are specialized in the production of a single root crop, e.g., dasheen production in the Rio Claro, Nariva/Mayaro, and Navet areas. On these root crop farms a number of other enterprises may exist but to a lesser extent than on other food crop farms.

The major cropping system in which root crops are grown is mixed cropping which includes the simultaneous cultivation of fruit trees, bananas, plantains, grain legumes, and vegetables. In lowland areas wherever dasheen is planted, it is grown in monoculture. There are a few farmers in each county who have large holdings and practice monoculture for cassava, eddoe, and sweet potato.

Socioeconomic Patterns

The percentage of the labor force involved in root crop production is very low in relation to the percentage of the labor force involved in agriculture because of low wages paid and low prices paid by retailers for imported root crops from other Caribbean islands.

Most farmers producing root crops are either in the low or middle income brackets. Data on 162 farmers who were willing to enter

contractual arrangements for growing cassava with the Food and Agriculture Corporation (FAC) show that: 154 were male; 94 were part-time farmers; 30 were renting land; 27 had leased land; 92 had freehold land; and 13 had other types of tenure. Seventeen farmers were 30 years old or under; 85 were 30-49 years old; 60 were more than 50 years old; and the average farmer's age was 40 years. In an interview sample of root crop farmers not growing cassava 24% were under 30 years old; 53% were 30-50 years old; and 23% were over 50 years old. Ninety-two percent were males of whom 67% were full-time farmers.

Root and Tuber Crop Production and Constraints

Domestic root crop production in Trinidad and Tobago for the period 1978 to 1982 indicates a decrease of more than 50% in total domestic production for all root crops (Table 2). Table 3 presents data on hectare yields of individual root crops in Trinidad and Tobago.

The production of individual root crops at regional (county) and country levels is presented in Table 4. At the country level more dasheen was produced than any other root crop while dasheen and cassava accounted for 63.7% of the total root crop production. The three counties which produced the most root crops were Caroni, Victoria, Nariva, and Mayaro.

A survey conducted by the Extension Division of the Ministry of Agriculture, Lands and Food Production (MALFP) in 1982 identified the following major constraints affecting root crop expansion:

Praedial larceny and scarcity of farm labor;

Marketing and storage problems;

Poor transportation from field to market, pests and diseases, and inadequate land preparation; and

Poor planting material (particularly important for cassava and sweet potato).

The Food and Agricultural Corporation (FAC) is currently offering an attractive price of TT$1.75-$1.87/kg[1] for cassava. In addition, it is also purchasing dasheen with future possibilities of yam, eddoe, tannia, and

1. Exchange rate: TT$1.00 = US$0.42 (1984).

Table 2. **Domestic production (t) of root crops, Trinidad and Tobago, 1978 to 1982.**

Crop	Year				
	1978	1979	1980	1981	1982
Cassava	4600	4500	4300	4100	2662
Yams	3682	3846	3682	3518	1274
Sweet potato	2586	2227	2168	2068	966
Dasheen	5625	5114	4659	4545	4092
Eddoe	2940	2991	2889	2813	1233
Tannia	1591	1364	1250	1136	375
Total	21024	20042	18948	18180	10602

SOURCE: Ministry of Agriculture, Lands and Food Production. Trinidad and Tobago.

Table 3. **Average yields (kg/ha) by county, Trinidad and Tobago, 1982.**

County	Cassava	Yams	Sweet potato	Dasheen	Eddoe	Tannia
St. Patrick	5000	4500	3000	5000	4000	4500
Nariva, Mayaro	2000	5000	5000	8000	4000	3000
Caroni	11000	8000	6000	10000	12000	4000
Victoria	10545	10366	8234	10560	9333	8500
St. Andrew, St. David	1300	1000	1100	1200	1200	2500
St. George	3200	2000	2400	3500	2100	2600
Average yield	5508	5144	4289	6377	5439	4183

SOURCE: Ministry of Agriculture, Lands and Food Production. Trinidad and Tobago.

Table 4. **Production (t) of root crops by county, Trinidad and Tobago, 1982.**

County	Cassava	Yams	Sweet potato	Dasheen	Eddoe	Tannia	Total
St. Patrick	545	103	78	167	124	59	1076
Nariva, Mayaro	25	46	13	2208	29	5	2326
Caroni	1056	400	360	1500	480	160	3956
Victoria	875	695	494	169	588	128	2949
St. Andrew, St. David	49	10	6	13	1	10	89
St. George	112	20	15	35	11	13	206
Total	2662	1274	966	4092	1233	375	10602

SOURCE: Ministry of Agriculture, Lands and Food Production. Trinidad and Tobago.

sweet potato purchases. These FAC activities should remove the marketing constraints as well as provide transport for the produce to the market.

Credit is not difficult to obtain especially from the contractual arrangements offered by FAC. The Agricultural Development Bank (ADB) considers root crops to rank second in importance to rice as a commodity for obtaining credit (Table 5).

The production costs for most root crops on a commerical scale are very high because of the high wage rates and chemical costs. Data on production costs for recommended technologies are presented in Table 6. Only one set of production costs was obtained for small farmers and is presented in Table 7 which lists the production costs for yams.

Marketing and Constraints

Wholesale and retail prices of most root crops as presented in Table 8 and 9 indicate increasing prices up to 1982 and slowly declining thereafter.

Most of the root crops produced locally are sold on the fresh market. At the local community level a small quantity of cassava is processed into farine.

Table 5. **Priority ranking[a] of commodities for national food security, Trinidad and Tobago.**

Commodity group	Year	
	1984	1985
Meat and meat products	4	7
Rice	2	1
Milk products	3	8
Roots and starches	1	2
Fish and byproducts	5	3
Vegetables	6	4
Fruits	7	6
Pulses	8	5
Coffee	9	10
Sugar and syrups	10	9
Table eggs	11	11

a. Highest priority ranking (1); lowest priority ranking (11).

SOURCE: Personal communications with Agricultural Development Bank.

Table 6. **Production costs (TT$ ha)[a] of root crops at recommended technologies, Trinidad and Tobago.**

Operation	Cassava	Yams	Sweet potato	Dasheen	Tannia
Land operation	1,163	623	723	880	623
Planting, propagation (and staking for yams)	638	6,240	1,568	4,287	3,593
Fertilizing	865	849	1,155	1,000	543
Weed control	493	338	779	569	644
Pest and disease control	210	335	1,391	0	0
Harvesting	978	2,480	1,200	600	1,000
Cleaning, packaging, bagging	480	974	647	1,960	647
Transportation	180	1,000	840	816	840
Land rental	100	100	100	100	100
Total working-capital investment	5,107	12,939	8,403	10,212	7,990
Interest on working capital	153	389	249	259	226
Total production costs	5,260	13,328	8,652	10,471	8,216

a. Exchange rate: TT$1.00 = US$0.42 (1984).

Table 7. **Production costs (TT$ ha)[a] for a small yam-farmer, Trinidad and Tobago.**

Operation	Cost
Land clearing	25
Plowing	35
Rotary hoeing	25
Banking	20
Labor for planting	60
Chemicals and their application	64
Planting materials	175
Labor for harvest	200
Transportation	25
Cleaning and grading	100
Total	729

a. Exchange rate: TT$1.00 = US$0.42 (1984).

Table 8. **Wholesale prices (TT$/kg)[a] of selected root crops, Trinidad and Tobago, 1977 to 1985.**

Crop	Year								
	1977	1978	1979	1980	1981	1982	1983	1984	1985[b]
Cassava	0.73	0.87	1.06	1.64	1.95	3.01	2.74	2.14	1.97
Lisbon yams	0.82	1.14	1.16	1.09	1.46	3.00	2.17	1.17	1.14
Other yams	0.97	1.13	1.15	1.78	3.31	—	2.24	2.34	2.64
Sweet potato	1.15	1.19	1.75	1.85	1.88	2.06	1.61	1.72	0.99
Dasheen	0.77	0.95	1.26	1.66	2.04	1.83	2.22	2.04	1.64
Eddoe	0.86	0.87	0.97	1.24	1.32	2.13	1.87	1.77	1.00
Tannia	1.01	0.93	1.06	1.40	1.84	1.99	2.56	2.81	2.29

a. Exchange rate: TT$1.00 = US$0.42 (1984).
b. Data for January to March 1985.
SOURCE: Ministry of Agriculture, Lands and Food Production. Trinidad and Tobago.

Table 9. **Retail prices (TT$/kg)[a] of selected root crops, Trinidad and Tobago, 1977 to 1985.**

Crop	Year								
	1977	1978	1979	1980	1981	1982	1983	1984	1985[b]
Cassava	1.08	1.33	1.70	2.24	2.43	3.92	3.83	3.31	3.06
Lisbon yams	1.15	1.65	1.87	2.31	2.58	3.84	2.76	2.62	2.20
Other yams	1.37	1.60	1.98	2.43	3.52	—	2.55	2.40	2.41
Sweet potato	1.63	1.68	2.26	2.14	2.58	2.85	2.41	2.70	2.05
Dasheen	1.26	1.39	1.98	2.56	2.56	2.56	3.22	2.52	2.27
Eddoe	1.39	1.50	1.86	2.41	2.68	2.92	2.77	2.77	2.06
Tannia	1.46	1.45	2.08	2.49	3.23	2.68	3.56	3.89	3.67

a. Exchange rate: TT$1.00 = US$0.42 (1984).
b. Data for January to March 1985.
SOURCE: Ministry of Agriculture, Lands and Food Production. Trinidad and Tobago.

The FAC is presently setting up a plant to produce frozen cassava. The processes involve washing, trimming, peeling, cropping, dipping, bagging, sealing, blast freezing, and frozen storage. There is one other entrepreneur located at Trincity, North Trinidad, who is also setting up a factory for producing frozen cassava.

More than 80% of local root crop production reaches the local market as cleaned fresh tubers. Discussion with FAC revealed that there is a high consumer demand for the frozen peeled cassava product and the local

market should be able to consume all of the frozen product that FAC can produce. The rated capacity of the FAC plant is 4000 kg/hr or 32,000 kg/day. Assuming a loss of 75%, the output of frozen product per day is 8000 kg/day.

Major marketing areas are located close to all root crop farms. Distances may range from 2 to 180 km depending on which market the producer prefers. However, the distance from the main root crop producing areas in the southern part of the country to the Port-of-Spain Central Market, where most wholesale transactions occur, is approximately 161 km.

The domestic demand for root crops in Trinidad and Tobago is given in Table 10. Large quantities of sweet potato, dasheen, and eddoe are consumed in the fresh state. The total demand for roots appears to fluctuate: in 1980 the demand was over 8414 tons decreasing to 2566 tons in 1982, and increasing again in 1983 to 5512 tons. The demand for fresh cassava is low because of its perishability.

Factors serving as constraints on the domestic demand of root crops are:

Lack of adequate processing facilities to produce and market products acceptable to the consumer in both taste and cost;

Lack of varieties amenable for processing into desired products;

Erratic supply of root and tuber crops throughout the year; and

Inadequate price and import controls, especially for white potato, that restrict markets for local root and tuber crops products.

Table 10. **Domestic demand (t) of root crops as a fresh product, Trinidad and Tobago, 1978 to 1983.**

	Year					
Crop	1978	1979	1980	1981	1982	1983
Cassava	4	4	4	5	39	58
Yams	556	669	814	638	167	1118
Sweet potato	1327	1027	2389	1164	463	1435
Dasheen and eddoe	1430	1959	4037	1647	1430	623
Tannia	734	623	1170	1100	467	2278
Total	4051	4382	8414	4554	2566	5512

Government Policies

The White Paper on Agriculture is the basic policy framework for the development of agriculture in Trinidad and Tobago. The agricultural sector is now at its crossroads. This is reflected in the rationalization or diversification of sugar cane croplands, a receding oil economy, and increased levels of unemployment. Emphasis is now being placed on agricultural development, reducing the food import bill by import restrictions, and increasing domestic production.

Considerable quantities of energy-rich agricultural products are imported into Trinidad and Tobago (Table 11). Indeed, the largest components of the food import bill in descending order of importance are cereals and cereal preparations, fruits and vegetables, meat and meat preparations, and dairy products and eggs. White potato is one of the major staples imported and competes directly with root crops because of its low price, adaptability to various preparations, year-round availability, and taste.

Although root crop, pulse, and vegetable production are the largest industries in domestic agriculture, substitution of some of the energy-rich imported products, especially the white potato, by local root and tuber crops depends on restricting imports of the white potato (which the government will not at present consider); making available processed root crops which are easy for the housewife to prepare and use, and selecting varieties with characteristics which can easily replace other products, e.g., fried dasheen chips instead of fried potato chips.

Table 11. **Imports (kg) of energy-rich agricultural products, Trinidad and Tobago, 1983.**

Product	Quantity
Durum wheat	23,844,000
Other wheat and meslin	44,634,559
Barley	14,290
Oats	484,826
Maize	30,770,073
Other cereals	223,893
Rice in retail pkts.	30,744,807
Rice in bulk	33,068,042
Wheat flour	1,054,525
Maize flour	483,479
Flour of other cereals	481,119

In 1985 domestic subsidies were removed from nearly all agricultural products. In 1981 the agricultural program had allocated 64% of its budget to the export crops of sugar, cocoa, and coffee. Sugar received a subsidy of TT$300 million on a total budgetary amount of TT$502 million. Items such as rice, flour, cooking oil, milk, and poultry meat received 13% of the subsidy funds.

Domestic agriculture, i.e., poultry, vegetables, pulses, and root crops, received only 25% of the government's subsidy on food and agriculture of which poultry received 70%. In earlier years there was little impact of government subsidies on domestic agricultural production especially on roots and tubers.

Recently, reports on new marketing arrangements for primary agricultural products and livestock have led to the meeting of the Standing Committee of Ministers responsible for agriculture within the Caribbean Community (CARICOM) systems. From this meeting appropriate tariffs were set for specified agricultural commodities. Root crops fell into a list of commodities that will be subject to free intraregional trade and for which, it is hoped, rates of external tariffs will be increased as from June 1985. The agreed duty rate for root and tuber crops is between 30 and 35%.

The future direction of government policy for the importation of energy-rich agricultural products must be considered under the broader umbrella of the domestic agricultural sector transformation objectives, namely:

Increasing self-sufficiency in food;

Improved resource allocation to agricultural production;

Reduction of price and income stability; and

Increased average level of farm prices and income.

The nutritional and food security approach implies the selection of agricultural enterprises for development and the allocation of promotional incentives for the product. Subsequently, the government may decrease the importation of energy-rich agricultural products as the domestic food sector is rejuvenated. The recommendation, in fact, is to establish one or two government institutions charged with the responsibility of developing large-scale commercial enterprises in the areas of cereals, oil seeds, pulses, and livestock feeds. The trend toward the diversification of sugar cane lands into traditional crops and the need for reducing the food import bill are strong indicators of the government's positive approach to self-sufficiency. However, it is not easy to quantify the government's policy,

and the future direction of such policies will depend greatly on the present level of output in agriculture, the world marketing-system, and the world oil prices.

Credit for root crops ranks very high in priority when compared with other crops—second to rice by the Agricultural Development Bank. Production incentives center mainly on cassava where farmers can enter into a contractual arrangement with FAC at a guaranteed price for fresh cassava tubers. Other production incentives operate for various other root and tuber crops but the price offered to farmers will depend on the current market prices. FAC and the MALFP extension personnel will monitor prices closely and advise freely on the agronomic requirements of these agricultural crops.

Research, Training and Development

See Table 12 for the institutes involved in root and tuber crop research.

The government, in recent years, has tended to allocate smaller proportions of funds to root and tuber crop research in comparison to high-priority crops such as grains (rice) and legumes. Wages and salaries account for a high proportion of funds allocated to root crop research.

In 1985 UWI allocated TT$89,363 (salaries included) to root crops, and TT$700,000 to other crops. MALFP at the Central Experiment Station allocated TT$10,000 (not including salaries) to root crops and TT$12,910,557 to other crops. CARDI had an allocation of TT$290,000 for root crops which included the salaries of various professionals, field workers, and supplies and equipment, and had no fixed allocation for other crops.

For cassava, research emphasis will be placed on the collection, multiplication, and selection of local and foreign germplasm and the introduction and agronomic evaluation of local and CIAT cultivars. Cassava intercropping studies and studies on cassava bacterial blight will be undertaken along with preliminary investigations on storage systems, physiological factors controlling yield, and the mechanization of cassava harvesting.

Research on sweet potato will emphasize the bulking of improved sweet potato cultivars and their evaluation for nematode susceptibility, the collection and screening of germplasm, and agronomic evaluation studies of promising cultivars.

Table 12. **Institutes and research staff in root crop research. Trinidad and Tobago.**

Institute[a]	Function	Full time	Part time	Total
MALFP				
CES	Research organization	3	13	16
El Carmen	Developmental research		1	
CADP	Developmental research	1	1	2
Extension Division	Developmental research		1	1
CARDI	Research organization	1	2	3
Caroni	Research organization	3	2	5
FAC	Research and development, and marketing research	6	1	7
CIBC	Biological control		1	1
CARIRI	Research and development		2	2
UWI	Research and development, teaching, postgraduate training		12	12[b]
Total		14[c]	36[d]	49

a. Acronyms of the following institutes are: MALFP, Central Experiment Station, Centeno (CES); MALFP, Chaguaramas Agricultural Development Project (CADP); Commonwealth Institute of Biological Control (CIBC), St. Augustine; Caribbean Research and Development Institute (CARDI), Caribbean Industrial Research Institute (CARIRI).

b. Excludes graduate students.

c. They have the following qualifications: Ph.D. (1); M.Sc. (1); B.Sc. (6); Diplomas (6).

d. They have the folowing qualifications: Ph.D. (19), M.Sc. (12); B.Sc. (3); Diplomas (2).

Yam research will include the agronomic evaluation of growth and yield performance of selected cultivars, and the establishment of virus-free, White Lisbon yam planting-material using tissue culture techniques. The collection of local Cush Cush cultivar germplasm and identification of varietal characteristics will be performed and virus-free planting material will be introduced to farmers. Dormancy studies and attempts to extend the shelf life of yams will also be undertaken.

Aroid research will be centered on the collection and evaluation of aroid germplasm for increased yields and on the determination of levels of bacterial, nematodal, and viral diseases found in aroids. Trials to extend the storage life of selected aroids will also be undertaken.

Two farmer-training courses on root crops are normally offered. Courses are usually one week long and briefly cover the agronomy of cassava, yams, sweet potato, and the aroids, and aspects of marketing, disease control, harvesting, grading, and storage of root crops.

The Extension Department also offered one-day courses in different counties during different months in 1985. The courses covered the topics mentioned in the farmer-training courses above.

A new single-crop training course dealing with specific areas only is now being drawn up for county extension officers. These courses will last for two days and are scheduled for June 1985. Subject areas include the identification and control of cassava bacterial blight, agronomy of cassava, and the mechanization of cassava production.

Developmental Projects

National developmental projects can be divided into three main categories: research; state enterprise; and farmer education.

The research development projects have a policy and review committee responsible for monitoring the projects to avoid wasting funds and duplicating projects.

State enterprise projects are mainly under the control of the Caroni and Orange Grove companies who adopt recommended technologies for large-scale plantations, particularly for cassava production.

The farmer education project is mainly under the control of FAC which advises contracted farmers of their agronomic requirements and marketing arrangements. FAC is assisted by research personnel and extension staff who conduct training programs and onfield visits. Extension stations are also required to conduct small-plot demonstrations and assist farmers in obtaining clean planting material.

Quarantine Regulations

Quarantine regulations for root crops are the general regulations which require that imported planting material must be:

Free from pests and diseases;

Free from soil;

Accompanied by a phytosanitary certificate; and

Inspected by a qualified officer on arrival.

Part III of these regulations stipulates that root crops "from the British West Indies shall not be imported into the colony unless they are accompanied by a certificate delivered by an official of the plant inspection service of the country of origin stating that they have been examined at the port or place of shipment and that they and their containers are reasonably free from trash and soil" (MALFP).

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Spanish Summary

Cultivos de Raíces y Tubérculos en Trinidad y Tobago

Se analizan la oferta y demanda de cultivos de raíces y tubérculos y sus productos en Trinidad y Tobago abarcando características de la tierra sembrada, sistemas de cultivo, rendimientos, perfil socioeconómico de los productores, volumen, costos y limitaciones de la producción, y mercadeo.

Se presentan las políticas gubernamentales relacionadas con la producción de cultivos de raíces incluyendo las pertinentes a la importación de productos agrícolas con un alto contenido energético, los subsidios domésticos para los consumidores, los impuestos de importación y exportación, y los créditos e incentivos para la producción de cultivos de raíces y tubérculos.

En relación con la investigación sobre cultivos de raíces y tubérculos se indican el número y tipo de instituciones involucradas, el personal, el presupuesto, la capacitación a nivel nacional, los proyectos para el desarrollo nacional y regional (usando la tecnología recomendada), y las medidas de cuarentena.

Root and Tuber Crop Programs at the University of the West Indies

*Theodore U. Ferguson and L.A. Wilson**

Introduction

The Faculty of Agriculture of the University of the West Indies has been involved in research, development, and training activities on tropical crops from its inception in 1960 when it succeeded the Imperial College of Tropical Agriculture. The Faculty's Root Crop Program was launched in 1967 as a multidisciplinary research effort and marked the beginning of a new phase of research on root crops not only in the Caribbean, but worldwide.

Prior to 1967 research was conducted at the Imperial College of Tropical Agriculture. Research projects undertaken during the period 1955 to 1960 by H. G. Gooding and T. Chapman included the selection of sweet potato (*Ipomoea batatas*) cultivars 049 and C9 (049 is still an important cultivar) and improved cultivars of yams (*Dioscorea alata*) and tannia (*Xanthosoma sagittifolium*). These two workers were also responsible for pioneering the use of growth analysis as a tool for investigating yield mechanisms in tropical root crops. Investigations on yam storage and the mechanism of tuber dormancy were also initiated during this period.

During 1960 to 1967 work was conducted on the incompatibility problem in sweet potato hybridization by B. Williams and F. Cope. The use of growth analysis for studying the yield mechanism was extended by P.H. Haynes, J. A. Spence, and C. Walter and the agronomy of root crops received considerable attention from P. H. Haynes and S. Thomas.

Research activity and interest shown by Faculty staff during the 1960's

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resulted in the establishment of the First International Symposium on Tropical Root Crops in April 1967 in Trinidad. Since then there have been six further triennial symposia—the most recent of which was held in Guadeloupe. It should also be noted that following the First International Symposium a considerable level of interest in root crop development was generated on an international level. This interest was responsible, in part, for the development of three international centers and the realized need for root crop research in the tropics.

From 1967 until now research on root crops in the Faculty of Agriculture has been conducted under the supervision of the Root Crop Program. This program is multidisciplinary in nature and is included within the traditional departmental structure of the Faculty. A research staff known as the Regional Research Center (RRC) and teaching staff were included within the Faculty during 1967 and 1975. In 1975 the RRC separated from the Faculty to form the Caribbean Research and Development Institute (CARDI).

Research, Training, and Development

The Root Crop Program has undertaken major research for yams, sweet potato, cassava (*Manihot esculenta*), potato (*Solanum tuberosum*), and the aroids (particularly tannia). The major disciplinary areas of research have been agronomy, physiology, biochemistry, mechanized cultivation, economics of production, postharvest storage, and processing.

The Program has received significant funding from the Rockefeller Foundation (1967 to 1970), the International Development Research Centre (IDRC), (1970 to 1974), and the Government of Trinidad and Tobago (1979 to 1985).

The major achievements of the Program have been:

Agronomic reviews of root crop production in the Commonwealth Caribbean region. These studies described and quantified the major factors limiting the development of root crops in the region;

Understanding the mechanisms of growth, development, and yield of yams, sweet potato, cassava, and tannia, including absorption of nutrients, effects of mineral nutrition on tuberization, physical soil factors, and flowering;

Selection or development or both of improved cultivars of yams, sweet potato, and cassava and their release, and the identification of improved tannia germplasm;

Development of improved systems for the mechanization of root crop production, e.g., soil preparation, planting techniques and equipment, harvesting equipment, and staking in yams;

Studies of tuber growth against soil resistance in yams and quantification of cassava yield performance on soil types with different physical properties;

Development of packages of cultural practices for the cultivation of yams, sweet potato, and cassava;

Studies on the dormancy mechanism in yams, cassava, and sweet potato;

Development of improved yam storage methods. The most recent development involves the use of gibberellic acid (GA_3) to suppress sprouting and extend the dormancy period;

Development of new processed products from root crops, e.g., instant yam flakes and sweet potato flour for bread making and breakfast foods; and

Development of unit process technologies, e.g., lye peeling of yams for instant yam-flake manufacture.

In addition to the above achievements in research and development, the Faculty of Agriculture is involved in significant training activities on tropical root crops. In fact, postgraduate training forms an integral part of the research program and a large number of students have conducted their thesis research in areas listed in the above section. Since 1967 a total of ten students have received the degree Ph.D. and a combined total of 16 students have received M.Sc. or M. Phil. degrees in the area of tropical root crops. These graduates are now widely dispersed in the Caribbean (13) and internationally (13). A large number of our B.Sc. undergraduate students also pursue their final-year research projects on tropical root crops.

The Faculty has been actively involved in organizing regional workshops and conferences aimed at highlighting the problems of root crop production and utilization in the region. The First Caribbean Regional Workshop on Tropical Root Crops was held in Jamaica in 1983 and the proceedings

were published. This workshop was cosponsored by the Food and Agriculture Organization of the United Nations (FAO), the International Institute of Tropical Agriculture (IITA), and the Government of Jamaica.

The Faculty is also engaged in the publication of extension bulletins on various aspects of root crop production and utilization. Staff of the Root Crop Program have contributed to the annual inservice extension training courses and to the Caribbean Agriculture Extension Project activities in the Windward Islands, Leeward Islands, and Belize.

Scientists in the Root Crop Program have served on the boards of international institutions as consultants and as officers of the International Society for Tropical Root Crops. The Faculty is developing links with international centers—recently an agreement was signed with IITA and a work program has been developed for Jamaica.

Constraining factors in the areas of research, training, and development include the unavailability of funds for essential capital equipment. This has resulted in deteriorating conditions of existing laboratory, greenhouse, and field facilities for experimentation in the Faculty. In fact, intermittent operational funding for research and training has led to the abandonment of projects at critical stages of development. There is a limited capacity for locating specific research within the region and a limited number of support personnel for the editing and preparation of outreach material.

Current and future research activities will be centered on germplasm collection and cultivar evaluation of yams, sweet potato, cassava, dasheen (*Colocasia esculenta*), and potato. Studies have already started for yams, sweet potato, and cassava. Recent additions to the germplasm collections have come from IITA and the Centro Internacional de Agricultura Tropical (CIAT). The programs for potato and dasheen are now in their initial stages and the Faculty proposes to increase its germplasm collections significantly in the near future.

The project for improved propagation systems for *D. rotundata* and *D. cayenensis* is being developed in association with IITA, the Jamaican Ministry of Agriculture, and the Christiana Potato Growers Association of Jamaica.

Other future research areas will include:

Rapid propagation and seed production in potato;

Physiological studies on the growth, development, and yield of root crops;

Selection for resistance to *Megastes grandalis* in sweet potato;

Control of anthracnose in yams;

Mechanization studies in root crops;

Minimum-tillage studies for the production of root crops;

Agroeconomic studies on root crops in the Caribbean;

Selection of sweet potato cultivars for intercropping systems;

Studies on dormancy mechanisms in yams, cassava, and sweet potato;

Extension of storage life of yams and cassava tubers by preharvest and postharvest treatments; and

Improvement and development of commercially-feasible processed root crop products.

Spanish Summary

Programas de Cultivos de Raíces y Tubérculos en la Universidad de West Indies

Se describen el trabajo llevado a cabo sobre cultivos de raíces por la Facultad de Agricultura de la Universidad de West Indies y la creación en 1967 del programa de cultivos de raíces de la misma facultad. Los principales cultivos investigados son el ñame, la batata, la yuca, la papa y los aroides (particularmente el ocumo).

Los mayores logros del programa han sido la definición de las limitaciones al desarrollo de los cultivos de raíces en la región, el entendimiento de los mecanismos de crecimiento de ñame, batata, yuca y ocumo; la selección, desarrollo y vulgarización de cultivares; la creación de sistemas mejorados para la mecanización de la producción de cultivos de raíces; estudios del crecimiento del tubérculo y raíz en diferentes tipos de suelo y del letargo en los cultivos de raíces tropicales; y el desarrollo de paquetes de prácticas culturales, métodos mejorados para el almacenamiento del ñame, nuevos productos procesados a partir de cultivos de raíces y unidades de tecnologías de procesamiento.

Se mencionan las actividades de cooperación internacional y de capacitación, se indican las limitaciones de la investigación, capacitación y desarrollo, y se presentan las propuestas para las actividades de investigación sobre cultivos de raíces.

Root and Tuber Crops in the Caribbean

*Theodore U. Ferguson**

Introduction

The countries covered by this study are highly heterogeneous and consist of a number of densely populated Caribbean islands and sparsely populated mainland countries. The island countries are Antigua and Barbuda, the Bahamas, Barbados, Cuba, Dominica, the Dominican Republic, Grenada, Haiti, Jamaica, Montserrat, St. Christopher-Nevis, St. Lucia, St. Vincent and the Grenadines, and Trinidad and Tobago. The mainland countries are Belize, Guyana, and Suriname.

Table 1 gives some basic physical and economic data for these countries. The 17 countries have a combined population of 27.8 million inhabitants. Cuba has the largest population (9.9 million) followed by the Dominican Republic (6.2 million) and Haiti (6.1 million). The only other countries with populations of over one million are Jamaica (2.1 million) and Trinidad and Tobago (1.1 million). Among the smaller countries are Montserrat (12,000), St. Christopher-Nevis (44,000), Dominica (75,000), and Antigua and Barbuda (77,000).

The total land area of all 17 countries is 622,000 square kilometres (km^2) with Guyana being the largest with an area of 214,970 km^2 and Montserrat the smallest with an area of 104 km^2. The countries contrast sharply in population density. Barbados is the most densely populated with 574 persons/km^2, Grenada has 344/km^2, followed by St. Vincent and the Grenadines (329), Haiti (220), Trinidad and Tobago (220), St. Lucia (204), and Jamaica (190). At the other extreme are Suriname with 2 persons/km^2 and Guyana, Bahamas, and Belize with 4, 6, and 7 persons/km^2 respectively.

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Table 1. **Physical and economic data on root crop producing countries in the Caribbean, 1982-1983.**

Country	Population (thousands)	Area (km^2)	Population density (no./km^2)	Agricultural area (ha in thousands)	Active population in agriculture (% of pop.)	Agricultural contribution (% of GDP)[a]
Antigua and Barbuda	77	440	175	11	9.0	7.3
Bahamas	227	13,935	6	17	4.5	4.0[b]
Barbados	247	430	574	37	16.4	7.6
Belize	158	22,963	7	125	35.9	31.4
Cuba	9,846	110,860	89	4,992	21.9	15.7
Dominica	75	750	100	19	30.8	30.7
Dominican Republic	6,247	48,734	128	2,730	55.0	18.4
Grenada	107	311	344	16	25.0	26.2
Guyana	797	214,970	4	1,378	43.1	22.2
Haiti	6,103	27,750	220	1,395	64.9	31.9
Jamaica	2,091	10,992	190	475	24.9	7.5
Montserrat	12	104	115	2	10.0	4.7
St. Christopher-Nevis	44	264	164	15	35.7	15.6
St. Lucia	126	616	204	20	29.5	13.8
St. Vincent and the Grenadines	128	389	329	19	—	17.8
Suriname	368	163,265	2	59	11.6	11.1
Trinidad and Tobago	1,129	5,128	220	169	8.6	2.5

a. Data presented for the year 1981.
b. Data based on author's estimate.
SOURCE: UNECLAC. 1984. Agricultural Statistics. Vol. 4.

The contribution of agriculture to the Gross Domestic Product (GDP) is variable among the countries. For example, agriculture accounts for over 25% of GDP in Belize, Dominica, Grenada, and Haiti and for less than 5% in the Bahamas, Montserrat, and Trinidad and Tobago.

Agriculture is a major source of employment among the active population in most of the countries. More than 30% of the active population is employed in agriculture in Haiti (65%), Dominican Republic (55%), Guyana (43%), and St. Christopher-Nevis (36%). Ten percent or less of the active population is engaged in agricultural pursuits in Antigua and Barbuda (9%), Bahamas (4%), Montserrat (10%), and Trinidad and Tobago (8.6%).

Root and Tuber Crop Production in the Caribbean

The production of root crops in the Caribbean is estimated at over 2 million tons (t) giving an average of about 72 kilograms (kg) produced per person. All of the major tropical root crops are produced within the region. These are yams (*Dioscorea* spp.), cassava (*Manihot esculenta*), sweet potato (*Ipomoea batatas*), and amongst the aroids, dasheen (*Colocasia esculenta* var. *esculenta*), eddoe (*Colocasia esculenta* var. *antiquorum*), tannia (*Xanthosoma sagittifolium*), and potato (*Solanum tuberosum*). The estimated production of these root crops is in Table 2.

Cassava and sweet potato are the major root crops produced, followed by yams and potato. The aroids are relatively minor crops, but, as will be

Table 2. **Production of the major root crops in the Caribbean, 1982-1983.**

Crop	Production (t in thousands)	Production per capita (kg)
Cassava	734	26.4
Sweet potato	551	19.8
Yams	279	10.1
Potato	267	9.6
Tannia	125	4.5
Dasheen	36	1.3
Eddoe	13	0.5
Total	2005	72.2

SOURCE: Compiled by author.

discussed, of localized production. Data on the total production of all root crops by country are presented in Table 3. The countries can be grouped on the basis of total production:

Very large producers 500,000 t or more	Cuba, Haiti
Large producers 100,000 - 499,999 t	Jamaica, Dominican Republic
Small producers 10,000 - 99,999 t	St. Vincent and the Grenadines, Dominica, Trinidad and Tobago
Very small producers 10,000 t or less	Guyana, Barbados, Grenada, St. Lucia, Suriname, St. Christopher-Nevis, Antigua and Barbuda, Bahamas, Belize, Montserrat

Table 3. **Production of root crops according to country, Caribbean region, 1982-1983.**

Country	Total root crop production (t)	Production per capita (kg)
Antigua and Barbuda	689	8.9
Bahamas	240	0.9
Barbados	8,982	36.3
Belize	200	1.3
Cuba	845,000	85.8
Dominica	25,705	342.8
Dominican Republic	183,000	29.2
Grenada	6,249	58.3
Guyana	9,100	11.4
Haiti	674,000	110.5
Jamaica	204,830	97.9
Montserrat	250	20.8
St. Christopher-Nevis	869	19.7
St. Lucia	6,010	47.7
St. Vincent and the Grenadines	26,182	204.5
Suriname	3,205	8.6
Trinidad and Tobago	10,602	9.2
Total/average	2,005,113	72.2

SOURCE: Compiled by the author.

The intensity of crop cultivation and the total production in relation to the country's population are also indicators of the crop's relative importance. Data on per capita production were therefore developed and are also presented in Table 3. The data indicate that the countries can be grouped as:

Very large per capita producers 200 kg or more	Dominica, St. Vincent and the Grenadines
Large per capita producers 50 - 199 kg	Jamaica, Cuba, Grenada
Small per capita producers 10 - 49 kg	Montserrat, St. Lucia, Barbados Dominican Republic, St. Christopher-Nevis, Guyana
Very small per capita producers 10 kg or less	Trinidad and Tobago, Antigua and Barbuda, Suriname, Belize, Bahamas

Production figures do not accurately reflect the importance of the root crops' total contribution to the economies of Dominica and St. Vincent because of the small surface area of these two countries. Jamaica, Cuba, and Grenada are other significant, large, per capita producers of root crops.

Root and Tuber Crop Production by Country

Production of root crops in the Caribbean will next be examined briefly on a country basis (Tables 4 and 5).

Antigua and Barbuda

The production of root crops in this country is of minor importance. The total production and per capita production are estimated at 689 t and 8.9 kg respectively. The yam *D. alata* and sweet potato are regarded as being important root crops.

A limited four- to six-month rainfall period restricts the growing season in Antigua and only sweet potato is seen as having an increased production potential. Antigua is interested in developing an export market for sweet potato.

Table 4. **The production of root crops (t) in the Caribbean, 1982-1983.**

Country	Yams	Cassava	Sweet potato	Dasheen	Eddoe	Tannia	Potato	Total
Antigua and Barbuda	273	44	352			20[a]		689[a]
Bahamas	6	19	166		29		20	240
Barbados	4,500	60	4,300			122		8,982
Belize	70[a]	100[a]	10[a]	10[a]		10[a]		200[a]
Cuba	5,400	330,000	200,000			75,000[a]	235,000	845,000[a]
Dominica	5,000	775	1,480	11,000		7,400	50	25,705
Dominican Republic	7,000	102,000	35,000			24,000	15,000	183,000
Grenada	448	4,500	271	850	40	140		6,249
Guyana	1,000	5,000	250	250	2,500	50	50[a]	9,100[a]
Haiti	120,000	265,000	280,000				9,000	674,000
Jamaica	130,607	17,145	24,084	13,220		11,764	8,010	204,830
Montserrat	38		64	58		90		250
St. Christopher-Nevis	257	30	518	20	8	36		869
St. Lucia	713	1,000[a]	297	3,000		1,000		6,010[a]
St. Vincent and the Grenadines	1,750	3,000	3,197	4,000	9,500	4,735		26,182
Suriname	370	2,660	75	50[a]		50[a]		3,205[a]
Trinidad and Tobago	1,274	2,662	966	4,092	1,233	375		10,602
Total	278,706	733.995	551,030	36,550	13,310	124,792	267,130	2,005,113

a. Author's estimated figures.

SOURCES: Author's estimates.
Country papers. Proceedings of the workshop on tropical root crops held by the Caribbean Collaborative Agricultural Research Network in Guadeloupe, 9-10 July 1985.
FAO (Food and Agriculture Organization of the United Nations). 1983. Production yearbook. Vol.37.
UNECLAC (United Nations Economic Commission for Latin America and the Caribbean). 1984. Agricultural Statistic. Vol. 4.

Table 5. **Per capita production (kg) of root crops in the Caribbean, 1982-1983.**

Country	Yams	Cassava	Sweet potato	Dasheen	Eddoe	Tannia	Potato	Total
Antigua and Barbuda	3.5	0.6	4.6			0.2[a]		8.9[a]
Bahamas			0.7		0.1		0.1	0.9
Barbados	18.2	0.2	17.4			0.5		36.3
Belize	0.4[a]	0.6	0.1[a]	0.1[a]		0.1[a]		1.3[a]
Cuba	0.5	33.5	20.3			7.6	23.9	85.8[a]
Dominica	66.7	10.3	19.7	146.7		98.7	0.7	342.8
Dominican Republic	1.1	16.3	5.6			3.8	2.4	29.2
Grenada	4.2	42.0	2.5	7.9	0.4	1.3		58.3
Guyana	1.2	6.3	0.3	0.3	3.1	0.1	0.1[a]	11.4
Haiti	19.7	43.4	45.9				1.5	110.5
Jamaica	62.5	8.2	11.5	6.3		5.6	3.8	97.9
Montserrat	3.2		5.3	4.8		7.5		20.8
St. Christopher-Nevis	5.8	0.7	11.8	0.4	0.2	0.8		19.7
St. Lucia	5.7	7.9	2.4	23.8		7.9		47.7[a]
St. Vincent and the Grenadines	13.7	23.4	25.0	31.2	74.2	37.0		204.5
Suriname	1.0	7.2	0.2	0.1[a]		0.1[a]		8.6[a]
Trinidad and Tobago	1.1	2.3	0.8	3.6	1.1	0.3		9.2
Mean	10.1	26.4	19.8	1.3	0.5	4.5	9.6	72.2

a. Author's estimated figures.

SOURCE Calculated from data in Tables 1 and 4

Bahamas

Agriculture in the Bahamas is severely limited by its small agricultural land area. Production of root crops is currently very low (240 t), 69 % of which is sweet potato. Some potential exists for the expansion of sweet potato area and cultivation.

Barbados

Yams and sweet potato are the two important root crops grown in Barbados and together in 1983 they accounted for 98% of the 8982 t of root crops grown in that country. The 4500-t yam yield is practically all *D. alata* and is produced on relatively large farms utilizing a certain degree of mechanization. Similarly, large farms are the main producers of sweet potato.

The level of technology used in the production of root crops in the Barbados is generally higher than that of the other producer countries and if given suitable markets the production of these crops could be increased significantly.

Belize

This country is currently a very small producer of root crops with the total annual production currently estimated at less than 200 t. Production is confined to only two districts, Stan Creek and Cayo. Belize has the potential for significantly increasing the production of root crops for industrial use and export.

Cuba

Cuba is the largest producer, in the Caribbean, of cassava, potato, and tannia, and the second largest producer of sweet potato. There is a large national program aimed at extending and improving cassava production for its use as a food energy source.

Dominica

Dominica, although a relatively small root crop producer in terms of the total quantity produced, has the highest per capita production among all of the Caribbean producer countries (342.7 kg). It is the second-largest producer of dasheen, which is the most important root crop produced in the country. Significant quantities of yams and tannia are also produced.

Dominican Republic

This country produced 183,000 t of root crops during 1982 to 1983. In terms of volume, cassava (102,000 t) was the most important crop followed by sweet potato (35,000 t), tannia (24,000 t), and potato (15,000 t). Yams were also grown in relatively large quantities (7000 t).

Grenada

Grenada produced only 6249 t of root crops in 1982 to 1983 with cassava and yams being the major crops. These crops are produced on farms less than one hectare (ha) in size.

Guyana

Cassava and eddoe are the important root crops produced in Guyana. Cassava was once processed through government-controlled cassava flour mills. Small quantities of yams are produced and sweet potato is of growing importance.

Root crops, which play an important part in the economy of the country, are cultivated on plots of less than 0.5 ha by a large number of small farmers with a large percentage of the crop being consumed by the farming family.

Haiti

Crops of sweet potato, cassava, and yams are generally grown on steep hillsides with little or no erosion-control measures. As a result soil erosion is a major problem in root crop producing areas. Traditional systems of cultivation are used and chemical fertilizers are generally not applied. There is practically no land for root crop expansion and any increase in production must come through an increase in productivity.

Jamaica

Root crops play an important role in the country's economy, particularly yams which in 1982-1983 had a total production of 130,607 t and premium market prices. The potato industry, which is totally dependent on imported seeds, is an important contribution to the area's economy.

Montserrat

This country is a very small producer of root crops in terms of total quantity produced. Tannia, sweet potato, and dasheen are the most important root crops produced.

St. Christopher-Nevis

The production of root crops is mainly confined to yam (*D. alata*) and sweet potato. These crops are mainly produced by small farmers.

St. Lucia

Root crops, particularly dasheen, are important to the economy of St. Lucia. Significant quantities of cassava, tannia, and yams are also grown.

St. Vincent and the Grenadines

The per capita production of root crops in St. Vincent is the second highest in the Caribbean. The data show relatively high per capita production of cassava, sweet potato, dasheen, eddoe, and tannia. St. Vincent, with a per capita eddoe production of 74.2 kg, is the largest Caribbean producer of eddoe. Trinidad and Tobago is an important export market for root crops from St. Vincent. Most of the root crops produced are exported.

Suriname

Root crops are of minor importance in this country.

Trinidad and Tobago

Root crops are currently produced in relatively small quantities (10,602 t). Dasheen is produced in the largest quantity, followed by cassava. There are plans for significantly expanding the root crop acreage for domestic consumption in both the fresh and processed states.

Root and Tuber Crop Production by Crop

Yams

Yams are grown in most countries within the region. Total production is estimated at 278,706 t with Jamaica (130,607 t) and Haiti (120,000 t) being the two largest producers. Other important producers are the Dominican Republic, Cuba, Dominica, the Barbados, and St. Vincent and the Grenadines. Production per capita for the crops is highest in Dominica (66.7 kg) and Jamaica (62.5 kg).

Most of the yams produced are consumed within the region and therefore, the per capita production in most countries equals the per capita consumption. In Jamaica the export of yams is estimated to be at less than 2% of the total production with major markets being in the United

Table 6. **Species of yams** *(Dioscorea* **spp.) grown in the Caribbean countries.**

Country	Major species			
	D. alata	*D. cayenensis*	*D. rotundata*	*D. trifida*
Antigua and Barbuda	X			
Barbados	X			
Cuba	X	X	X	
Dominica	X	X	X	X
Dominican Republic	X	X	X	
Grenada	X	X		
Guyana	X			X
Haiti	X	X	X	
Jamaica	X	X	X	
Montserrat	X			
St. Christopher-Nevis	X			
St. Lucia	X	X	X	X
St. Vincent and the Grenadines	X		X	
Suriname	X			
Trinidad and Tobago	X			

Kingdom and North America. Other exporting countries of significance are the Dominican Republic and St. Vincent.

The main species of yams grown are *Dioscorea rotundata, D. alata,* and *D. cayenensis* (Table 6) *D. rotundata* and *D. cayenensis* are particularly important in Jamaica, Haiti, the Dominican Republic, Cuba, St. Lucia, Dominica, and St. Vincent. In addition to the previously listed countries, *D. alata* is the major yam produced in the Barbados, St. Christopher-Nevis, and Antigua and Barbuda. Although cultivation is restricted mainly to the North West District *D. trifida* is the most important yam produced in Guyana and is of lesser commercial interest in St. Lucia, St. Vincent, Dominica, Jamaica, and Trinidad and Tobago.

Systems of producing yams are mainly traditional and involve the following:

Use of traditional cultivars;

Use of relatively large planting pieces that are disease and pest infected. Nematode infection is a particularly serious problem on *D. rotundata* and *D. cayenensis* in Jamaica;

Land preparation through the use of labor intensive and erosion-enhancing methods;

Late planting;

Use of expensive and labor-consuming staking methods;

Inefficient and disease-prone systems of producing planting material through the use of the double-harvesting technique in *D. rotundata* and *D. cayenensis;*

Generally poor practices in terms of fertilizer use, weed and disease control, and intercropping; and

Poor harvesting and storage methods.

Although the above will apply to most countries, Barbados is a notable exception in that the system of production involves a relatively high level of technology and no staking. This is reflected by the relatively high yields obtained for yams in Barbados (Table 7).

Table 7. **The yield (t/ha) of root crops in the Caribbean, 1980-1983.**

Country	Yams	Cassava	Sweet potato	Dasheen	Eddoe	Tannia	Potato
Antigua and Barbuda	4.5	3.1	7.3			4.0	
Bahamas			1.1				
Barbados	18.0	25.0	17.2		3.4		
Belize	4.5						
Cuba		4.5	4.6				19.3
Dominica	13.8	13.8	13.8	12.3		10.3	10.4
Dominican Republic	6.4	5.6	5.8			7.8	12.5
Grenada	2.5	4.0	2.8				
Guyana							
Haiti	3.3	4.1	4.0				15.0
Jamaica	12.4	8.6	10.0				11.4
Montserrat		2.5					2.5
St. Christopher-Nevis	7.8	2.0	4.0			2.5	8.4
St. Lucia	4.0	3.5	5.5	5.0			
St. Vincent and the Grenadines	10.3	11.7	2.1	9.5	15.9	5.0	
Suriname		6.5	3.7				
Trinidad and Tobago	5.1	5.5	4.3	6.4	5.4	4.2	

SOURCES: CIP (Centro Internacional de la Papa). 1982. World potato facts.

Country papers. Proceedings of the workshop on tropical root crops held by the Caribbean Collaborative Agricultural Research Network in Guadeloupe, 9-10 July 1985.

FAO (Food and Agriculture Organization of the United Nations). 1983. Production yearbook. Vol. 37.

UNECLAC (United Nations Economic Commission for Latin America and the Caribbean). 1984. Agricultural statistics. Vol. 4.

Cassava

Cassava, like yams, is grown in most countries. Total production is estimated at 733,995 t, with Cuba, Haiti, and the Dominican Republic being the three largest producers—640,000 t or 88% of the region's total production. Among the small producing countries, the high per capita production in Grenada and St. Vincent should be noted.

Most of the cassava produced is used for human consumption either in the fresh state or processed using traditional methods. However, there is considerable interest in the region to use cassava in the production of composite flours, livestock feeds, and starch, although both Guyana and Jamaica have been unsuccessful in coordinating cassava production with wheat production for bread-making.

Guyana has established three processing plants and Jamaica one. The failure of these attempts was because of reasons such as the poor choice of equipment (especially in Guyana), poor location of plants in relation to supply, low prices offered for fresh cassava, and high processing costs.

With the possible exception of Cuba, levels of technology are low in the production of cassava. Production tends to be confined to the more marginal lands that are restricted by both soil fertility and irregular rainfall. Yields are therefore low—generally less than 8 t/ha. The yield potential of cultivars grown is rarely known.

Sweet potato

Sweet potato, as noted earlier, is the second most important root crop in the region, with Haiti, Cuba, and the Dominican Republic being the largest producers. Countries with a high per capita production are Haiti, St. Vincent, Cuba, Dominica, and the Barbados. Sweet potato is a very important crop in Haiti where most of the crop is consumed at a subsistence level by a large number of small producers.

A large number of cultivars, generally carrying local names, are grown. Yields are variable with the lowest yields of less 3 t/ha occurring in St. Vincent and in Haiti. Relatively good yields of about 17 t/ha are obtained in Barbados. In many countries cultivation is on steep hillsides and erosion is a major problem. This is particularly evident in Haiti where many areas have had to abandon production or are producing at very low levels.

Sweet potato is often intercropped. Corn is an important intercrop in many countries (e.g., Haiti and St. Vincent).

Aroids

Aroid production is estimated at about 174,652 t of which tannia accounts for 124,792 t, dasheen 36,550 t, and eddoe 13,310 t.

The production of tannia is confined mainly to Cuba which produces over 50% of the total regional production. Other significant producers of tannia are the Dominican Republic, Jamaica, and St. Vincent. Per capita production is highest in Dominica (98.7 kg) and St. Vincent (37.0 kg).

The largest producer of eddoe in the region is St. Vincent (9500 t). Guyana produces 2500 t and Trinidad and Tobago 1233 t annually.

St. Vincent exports over 90% of the eddoe and tannia it produces mainly to Trinidad and Tobago. The cultivation of tannia and eddoe is generally restricted to areas of moderate and seasonal rainfall and to soils with good internal drainage. Tannia and eddoe are often intercropped with bananas.

Most of the dasheen produced is consumed in the producing countries. Its production is relatively low with the major producers being Jamaica and Dominica. The per capita production of dasheen in Dominica is 146.7 kg. This is the highest per capita production of any single root crop in the region. Significant per capita production can also be found in St. Vincent and St. Lucia. The cultivation of dasheen is limited to high rainfall and low-lying areas, ravines, and small streams, and, in wet areas with good internal drainage, bananas can be found intercropping with dasheen.

Potato

The production of potato is confined to only a few countries, with Cuba being the largest producer—235,000 t out of a total regional production of 267,130 t. Nonproducing countries are, however, major consumers of potato (over 20 kg per capita per year) and there is a readily available market for this crop. Production technology is generally of a much higher level than that used in the production of other root crops. Seeds are often imported and generally are of good quality. Domestic seed production programs are being developed in Cuba and the Dominican Republic. The potato crop is usually fertilized and sprayed for the control of pests and diseases. Pure stand planting is most often practiced. Yields are generally higher than those obtained for other root crops.

Constraints to Root and Tuber Crop Production in the Caribbean

The use of unimproved cultivars for all root crops. In general, most of the

cultivars grown are traditional and have been in cultivation for a long period of time. These cultivars are generally low-yielding, suited to production under a low level of technology, and are not responsive to improved agronomic practices. It should be noted, however, that although there have been some cultivar evaluation studies the results have had only a limited impact on the production of root crops among traditional producers.

The use of poor planting materials as a result of poor propagation techniques—particularly in yams. Yams are propagated vegetatively through the use of whole tubers or tuber pieces. In some species, for example, *D. rotundata* and *D. cayenensis,* the traditional systems of producing planting material is both labor and land intensive. These systems generally require that farmers keep their fields in yams for eleven months or more to allow for the production of planting material. In addition, yams are usually planted in the same field for a number of years thus leading to a buildup of pests and diseases, particularly nematodes. Anthracnose and viruses are other serious diseases transmitted in the planting material. There exists the need for the development of suitable systems for the production of clean yam planting material that is less labor intensive. The work of CARDI in the propagation of *D. alata* for the production of virus-tested planting material should be noted.

High cost of imported planting material of white potato. Most Caribbean countries have limited foreign exchange and the need to import expensive seed material from North America or European countries restricts potato production. Indigenous seed production is the obvious solution but unfortunately the production of potato seed in the humid tropics is associated with a number of problems. Where successful, production is generally confined to climatically cooler areas. Cuba and the Dominican Republic have successful seed programs. CIP has developed some interesting approaches to solving the seed production problem through the use of micropropagation techniques and high-temperature tolerant germplasm.

Serious pest problems. There are two particularly serious pest problems. To control the pest problem of nematodes in yams further studies in the field control of nematodes are needed in addition to the production of nematode-free planting material. Secondly, sweet potato weevils (*Cylas* spp.) and borers (*Euscepes* spp.) are serious pests which adversely affect the marketability of tubers. It is a particularly serious problem in St. Vincent where many farmers sometimes suffer total crop loss. Weevil-resistant germplasm from IITA needs to be introduced and evaluated under

Caribbean conditions. The sweet potato stemborer (*Megastes grandalis*) is the single most important limiting factor in sweet potato production in Trinidad and Tobago.

Serious disease problems. Three problems are of particular importance—anthracnose and viruses in yams and tannia burning disease in tannia. Anthracnose is the major limiting factor to the expanded cultivation of *D. alata* but other species such as *D. rotundata, D. cayenensis,* and *D. trifida* are also being threatened. In recent years the disease has been particularly serious on the Windward and Leeward Islands. Viruses are present in most yam cultivars and yield reduction is estimated to be in the order of 30% or more.

The tannia burning disease (cocoyam root rot/blight complex) has, in recent years, seriously affected the cultivation of tannia on the Windward Islands including Martinique and Guadeloupe. Although there has been some concerted research effort by CARDI and French researchers, effective and economical control of the disease is still to be attained. In particular there is the need to identify resistant *Xanthosoma* germplasm.

Bacterial wilt of cassava is not yet a major disease in the region. It was recently found in Trinidad and Tobago and every effort should be made to restrict its spread in the region. Potato is affected by a wide range of diseases and this, along with germplasm invariability, is a major limiting factor in the production of this crop.

Labor-intensive methods of production. Most of the root crops produced in the region are grown through the use of labor-intensive systems of cultivation. Within the small-farm setting farmers, who are the main producers, are often limited in production by labor. In these situations the introduction of improved technologies, which involve increased labor utilization, is unlikely to be adopted by farmers. So, although there is a need to implement improved systems of production, such systems will have a better opportunity for adoption if they involve reduced labor input.

Seasonality of production. Specific root crops are often available for only a limited time during the year resulting in periods of gluts and shortages. This is particularly true for yams but also applies to most other root crops. There is the need to improve the availability and marketability of these crops by off-season production and improved storage methods.

Constraints to Marketing Root and Tuber Crops in the Caribbean

Limited storage life of most root crops. Root crops store for only a limited

period of time. Fresh cassava and dasheen will keep for only a few days; sweet potato, eddoe, and tannia for one to three weeks; and yams for one week to three months, depending on the cultivar. Techniques are available for extending the storage life for all of these root crops but these techniques generally require further developmental work under Caribbean conditions before widespread adoption can be expected.

High level of variability in size, shape, and quality of tubers. Tuber variability severely restricts the marketability of all root crops with the exception of potato. Export markets are particularly demanding with regard to physical appearance and quality. There is a need, therefore, to develop cultivars that can produce uniform tubers of acceptable size and quality. The marketability of sweet potato and yams is, in particular, affected by high tuber variability.

Poor handling and packaging techniques. Very little attention is generally paid to the proper handling and packaging of root crops. Postharvest losses are therefore high and the produce is often in a poor state when it reaches the consumer. Most countries identified this as an area for future improvement.

High labor requirements and energy-consuming methods of processing. This is particularly true for cassava. In the preparation of farine and starch traditional cassava processing methods consume high quantities of fuel in the heating and baking stages and consist of many labor-intensive steps. Fuel (wood) is expensive or scarce in many countries (e.g., Haiti and St. Lucia) and many farmers have abandoned the production of cassava because of difficulties in processing the raw material.

Limited forms of consumption. Many root crops are consumed in limited forms—sometimes only by boiling. Potato is an exception, but yams, dasheen, tannia, eddoe, and sweet potato are generally available to the consumer in only the fresh state. There is a need to further explore the possibility of improving the marketability of these crops by improved processing methods and a greater choice of options for consumption.

Imports of Root and Tuber Crops in the Caribbean

The only root crop imported in large quantities in the region is potato. Over 100,000 t are imported annually. Cuba (59,000 t), Trinidad and Tobago (28,000 t), and Barbados (10,000 t) are the largest potato importers. The Barbados has the highest per capita potato import of 40 kg while Trinidad and Tobago import 25.3 kg per capita of potato (Table 8).

Table 8. **Annual imports of potato into the Caribbean, 1980-1983.**

Country	Total imports (t)	Imports per capita (t)
Antigua and Barbados	600	7.8
Bahamas	1,500	6.6
Barbados	9,922	40.2
Belize	1,815	11.5
Cuba	59,000	6.0
Dominica	—	—
Dominican Republic	—	—
Grenada	400	3.7
Guyana	—	—
Haiti	—	—
Jamaica	1,400	0.7
Montserrat	—	—
St. Christopher-Nevis	600	13.6
St. Lucia	795	6.3
St. Vincent and the Grenadines	576	4.5
Suriname	—	—
Trinidad and Tobago	28,567	25.3
Total imports	105,175	

SOURCES: CIP (Centro International de la Papa). 1982. World potato facts.
Country papers. Proceedings of the workshop on tropical root crops held by the Caribbean Collaborative Agricultural Research Network in Guadeloupe, 9-10 July 1985.

Potato imports are all supplied by extraregional North American and European countries.

Trinidad and Tobago is the only country importing significant quantities of the other crops (Table 9). The 1983 statistics indicate that the country imported 5582 t of yams, cassava, sweet potato, dasheen, eddoe, and tannia. Actual importations may, however, be much higher. St. Vincent was the main supplier of yams, sweet potato, and tannia. The Barbados is also a significant exporter of sweet potato to Trinidad and Tobago. The importation of cassava is a relatively recent development which began in 1981 with imports of about one ton. Most of this cassava is imported in the frozen form with the main suppliers being Costa Rica and the Dominican Republic. Small quantities of frozen yams and dasheen are also imported.

Research in the Caribbean

Research on root crops in the Caribbean is conducted on both the national and regional level. The following summarizes research in each individual country.

Table 9. **Imports (t) of root crops into Trinidad and Tobago, 1983.**

Crop	Quantity
Yam	1,172
Cassava	58
Sweet potato	1,435
Dasheen and eddoe	639
Tannia	2,278
Potato	28,567
Total	34,149

Antigua and Barbuda

Little or no research is conducted by the Ministry of Agriculture and this country is dependent on the Caribbean Agricultural Research and Development Institute (CARDI) for research on root crops.

Bahamas

Research on root crops is conducted by the Ministry of Agriculture at the Central Agricultural Station and the Bahamas Agricultural Research Centre. The major research emphasis is on germplasm collection and selection for improved agronomic and nutritional characteristics. There is one scientist assigned to root crop research on a full-time basis supported by three other professionals who work part time on root crops.

Barbados

The Ministry of Agriculture has three graduate agronomists and three nongraduate agricultural assistants assigned to root crop research. Projects include: the cultivar evaluation for sweet potato, yams, and potato; control of the sweet potato weevil; and general agronomic studies on sweet potato, yams, and potato. CARDI has active research programs on the propagation of virus-tested planting materials and on the possibility of using cassava for animal feed.

Belize

No root crop research is being undertaken in this country.

Dominica

Active research programs are in progress under the direction of CARDI, the Ministry of Agriculture, and the French Technical Cooperation (FTC). For aroids research includes cultivar selection, disease control, postharvest

studies, and techniques for rapid propagation. Yam research will center on the introduction of clean planting material and the identification and screening of cultivars. Studies will also be conducted on propagation, anthracnose control, and general agronomic practices. For both cassava and sweet potato research will be conducted on the introduction and testing of new cultivars. Research is conducted both on farms and experiment stations.

Dominican Republic

Research on root crops is being conducted by two national programs—Centro Sur de Desarrollo Agropecuario (CESDA) in San Cristobal and Centro Norte de Desarrollo Agropecuario (CENDA) in Santiago. Experimental work includes germplasm adaptation studies and regional yield trials with cassava, sweet potato, yams, and tannia. In addition to general agronomic studies such as the use of corn as a support for yam and weed control in tannia, studies of pest control in cassava and sweet potato are also being undertaken. There are two full-time research scientists in these programs.

Potato research is being conducted through a project funded by the Federal Republic of Germany and concentrates on the development of a national seed program and on *Phytopthora* and *Alternaria* control.

Three universities—Autonomous University of Santo Domingo (UASD), National University "Pedro Enriquez Ureña" (UNPEU), and Madre y Maestra Catholic University (UCAMAYMA)—are also conducting research on root crops but these efforts do not appear to be coordinated with other national efforts.

Grenada

Little research is currently being conducted by the Ministry of Agriculture. CARDI has active research programs in their Farming Systems and Aroid Projects.

Guyana

Research is currently being undertaken by the National Agricultural Research Institute on sweet potato, cassava, and yams. Two research officers are assigned part time to root crop research. Most of the research is centered around germplasm introduction and evaluation.

Haiti

Research on root crops in Haiti is limited but there are plans to conduct

comprehensive research programs on yams, sweet potato, and cassava through the Center for Research and Documentation in Agriculture (CRDA) of the Faculty of Agriculture and Veterinary Sciences of the State University. The programs have one full-time research scientist and one resident graduate. Other research organizations involved in root crop research are: the Center for Research and Development (CRD la Vallée); Organization for Development of the North (ODN); and the Department of Agriculture, Natural Resources, and Rural Development (DARNDR).

Jamaica

Very little research is currently being conducted on root crops in Jamaica. The Ministry of Agriculture is understaffed and has assigned only a few persons on a part-time basis to root crop activities.

The University of the West Indies (UWI), Faculty of Agriculture, has a research program based on the introduction and screening of sweet potato and yam germplasm. A joint research program by the UWI, Ministry of Agriculture, and the International Institute of Tropical Agriculture (IITA) is expected to begin activities on yams, sweet potato, and cocoyam improvement in the near future. The Christiana Potato Growers Association is doing limited research on the storage of yams (with the UWI) and on the screening of potato cultivars.

Montserrat

Some research is being undertaken by CARDI through the Farming Systems Project. The major research effort is on the reintroduction of potato into the farming systems. This involves cultivar evaluation and general agronomic and postharvest studies. Two CARDI scientists devote part of their time to root crop research.

St. Christopher-Nevis

In St. Christopher the major current research effort is directed toward improving the production of White Lisbon yam which has been, in recent years, seriously affected by anthracnose disease. In Nevis crop improvement work is in progress on sweet potato (mainly borer control), yams (anthracnose control and cultivar evaluation), and potato (cultivar evaluation). All research is being conducted by CARDI staff.

St. Lucia

St. Lucia has, within the Ministry of Agriculture, a research officer who devotes less than 20% of his time to research on root crops—mainly

agronomic studies. Most of the root crop research is done by the CARDI Farming Systems and Aroid Projects. The Windward Islands' Banana Association (WINBAN) recently conducted intercropping studies with root crops (sweet potato and aroids) and bananas.

St. Vincent and the Grenadines

Research in the Ministry of Agriculture is limited to sweet potato cultivar trials. CARDI conducts research on sweet potato, cassava, yams, and aroids within the Farming Systems and Aroid Projects.

Trinidad and Tobago

Research on root crops in Trinidad and Tobago is currently being undertaken by the Crops Research Division of the Ministry of Agriculture, the Faculty of Agriculture of the UWI, and CARDI. Current activities by these three institutions include comprehensive studies on yams, cassava, sweet potato, and dasheen. Caroni (1975) Limited is conducting studies on the large-scale cultivation of cassava and potato.

Regional institutions and personnel

Two regional institutions, CARDI and UWI Faculty of Agriculture, are involved in research on root crops in the region. Most of the work of the UWI Faculty of Agriculture is done on its Trinidad campus and to a lesser extent in Jamaica. The Faculty maintains germplasm collections of sweet potato, yams, cassava, and tannia and has ongoing, comprehensive, multidisciplinary studies on these crops. CARDI conducts agronomic research at its headquarters in Trinidad and has localized activities in its member countries. In many of the smaller countries, CARDI is the only institution conducting research or capable of conducting research on root crops. The propagation of virus-tested yams in Barbados, the Aroid Project based in Dominica, and the Farming Systems Project are three of the important root crop research activities being undertaken by CARDI.

The number of scientists working on tropical root crops in the region is generally very limited. The precise number of research workers is difficult to determine because in most countries scientists are also involved in other research activities. Table 10 summarizes the available information. Root crop scientists are defined as those devoting more than 30% of their work time to root crop research. It should be noted that a large number of the scientists involved in tropical root crop research are located in two regional institutions—CARDI and UWI. In addition, scientists are also working on projects in a number of national development institutions such as the Caribbean Industrial Research Institute (CARIRI), the Food and Agricul-

Table 10. **Number of active root crop scientists in Caribbean countries.**

Country	Institution[a]	Scientists (no.)
Antigua and Barbuda	Ministry of Agriculture	1
	CARDI	0
Bahamas	Ministry of Agriculture	4
Barbados	Ministry of Agriculture	2
	CARDI	1
Belize	Ministry of Agriculture	0
	CARDI	0
Dominica	Ministry of Agriculture	1
	CARDI	3
	FTC	1
Dominican Republic	CESDA	0
	CENDA	4
Grenada	Ministry of Agriculture	0
	CARDI	1
Guyana	Ministry of Agriculture/NARI	2
	CARDI	0
Haiti	FAMV	0
	CRDA	0
	CRD La Vallée	6
	ODN	0
	DARNDR	
	DARNDR	
Jamaica	Ministry of Agriculture	2
	CARDI	1
	UWI	3
Montserrat	Ministry of Agriculture	0
	CARDI	2
St. Christopher-Nevis	Ministry of Agriculture	1
	NACO	1
	CARDI	2
St. Lucia	Ministry of Agriculture	1
	CARDI	3
St. Vincent and the Grenadines	Ministry of Agriculture	0
	CARDI	2
Trinidad and Tobago	Ministry of Agriculture	6
	CARDI	3
	UWI	15
	Caroni (1975) Ltd.	1
	CIBC	1

a. CARDI Caribbean Agricultural Research and Development Institute, various locations.
CENDA Centro Norte de Desarrollo Agropecuario, Dominican Republic.
CESDA Centro Sur de Desarrollo Agropecuario, Dominican Republic.
CIBC Commonwealth Institute of Biological Control, Trinidad.
CRD Center for Research and Development, Haiti.
CRDA Centre de Recherche et Documentation de L'Agriculture, Haiti.
DARNDR Département de L'Agriculture de Ressources Naturelles et de Développement Rural, Haiti.
FAMV Faculté d' Agronomie et Médecine Vétérinaire, Haiti.
FTC French Technical Cooperation, Haiti.
NACO National Agricultural Corporation, Basseterre, St. Kitts.
NARI National Agricultural Research Institute, Guyana.
ODN L'Organisme de Développement du Nord, Haiti.
UWI University of the West Indies, various branches.

ture Corporation of Trinidad and Tobago Limited (FAC), and Caroni (1975) Limited in Trinidad, as well as scientific research councils in Jamaica and Guyana.

Training in the Caribbean

Training opportunities for personnel in regional root crop production are somewhat limited. For the Commonwealth Caribbean training opportunities for farmers, extension officers, and research scientists can be described as:

Farmers. Periodic in-country courses are sometimes offered to farmers in the production of specific crops or in dealing with specific problems. These courses are generally organized by the extension division of the ministries of agriculture. In Trinidad and Tobago these courses are organized on a regular basis and are sometimes offered as residential courses.

Extension officers. Root crops are often included in the annual UWI Agricultural Extension In-Service Training Course which serves as a periodic refresher course for extension officers of the Commonwealth Caribbean. In Jamaica and Trinidad and Tobago, special training courses or seminars on the production of root crops are sometimes held by the ministries of agriculture. Schools offering diplomas in agriculture in Jamaica, Trinidad and Tobago, and Guyana all provide training in root crop production for extension officers in these and other English-speaking Caribbean countries.

Research scientists. Scientists from most of the region are trained primarily at the University of the West Indies, Faculty of Agriculture, Trinidad. Training in root crops at the B.Sc. level is limited but at the M.Sc. and Ph.D. levels students can pursue full-time studies on most aspects of root crop production. The University is now considering offering occasional courses on root crop production targeted for research scientists and extension officers in the region. University training at the B.Sc. level is also available in Cuba, the Dominican Republic, Haiti, and Suriname.

In Haiti training on tropical root crop production is conducted primarily by the university and is included in the agricultural programs at three levels—superior, intermediate, and vocational. There is a need for more specific production training courses for all major root crops grown in Haiti.

Production training courses are offered by the Centro Internacional de Agricultura Tropical (CIAT), Centro Internacional de la Papa (CIP), and IITA. A limited number of regional personnel have participated in these courses.

Constraints to Research, Training, and Development in the Caribbean

Inadequate dissemination of information. Although there is much development and research activity on root crops in the region the information generated is often not readily available particularly between countries whose languages differ. For example, the English-speaking Caribbean region is generally poorly informed on developments in Haiti, the Dominican Republic, and Cuba. The problem also exists among countries with the same language because of inadequate documentation. Although there is the occasional gathering of scientists or workers in root crops, these meetings are sporadic and infrequent. More frequent direct dialogue and exchange of written reports would facilitate the sharing of experiences and findings among root crop workers in the Caribbean.

Insufficient regional training programs. The limited number of trained research personnel in root crops is, to some extent, a result of the limited training opportunities available. There is clearly a great need for regular training programs.

Lack of adequate research funds and facilities. The major national research activities on root crops in the region are in Cuba, Trinidad and Tobago, and the Dominican Republic. The two regional institutions, UWI and CARDI, have important research activities but these activities are greatly affected by the limited and discontinuous funding of research projects. It should be noted that in many of the smaller countries all national research is undertaken by CARDI. The strengthening of indigenous research institutions is considered to be essential for the development of the root crop industry in the region.

Limited trained research personnel in national programs. This applies to most countries and greatly affects the capacity of the national programs to undertake research and developmental work on root crops.

The Development of a Regional Research Network

Most of the constraints identified as limiting the development of the root crop industry are clearly of a regional nature. The establishment of a regional network is seen as a mechanism to help remove some of these constraints.

The basic philosophy of the network would involve the utilization of a mechanism for promoting and coordinating cooperation among national and regional programs and in conducting and stimulating research and development activities on tropical root crops (Table 11). The strengthening of indigenous programs (national and regional) is a fundamental part of this philosophy.

Network objectives could include:

Strengthening the capacity of regional root crop research and implementing development and training programs in order to more fully support national programs;

Stimulating of collaborative research and development on common root crop production and utilization problems;

Stimulating of collaborative training activities on all aspects of root crop production and utilization;

Stimulating greater research and developmental interest on root crops (research activities must bear some relationship to the importance or potential importance of root crops in national economies);

Facilitating more effective participation of CIAT, CIP, IITA, and other relevant international institutions in national and regional programs; and

Improving technical cooperation between Caribbean countries in agricultural research.

Table 11. **Possible project activities and their objective which could be undertaken by the proposed network.**

Activity	Objective
Collect and maintain elite germplasm	To collect and maintain elite germplasm of yams, cassava, sweet potato, tannia, dasheen, eddoe, and potato for evaluation, propagation, and distribution in the region.
Development of improved yam propagation systems	To develop improved systems of propagation and to distribute and produce clean planting material of *Dioscorea rotundata, D. cayenensis,* and *D. alata.*

Continues

Table 11. **Continued.**

Activity	Objective
Yam cultivar evaluation	To evaluate elite yam cultivars in specific ecological zones in the region for agronomic, storage, and processing characteristics.
Sweet potato cultivar evaluation	To evaluate sweet potato cultivars in specific ecological zones for agronomic, disease, and processing characteristics.
Cassava cultivar evaluation	To evaluate elite cassava cultivars in specific ecological zones for agronomic, disease resistance, storage, and processing characteristics.
Potato germplasm evaluation	To evaluate elite potato germplasm for adaptability in regional conditions.
Control of sweet potato borer	To develop control methods of sweet potato stemborer *(Megastes grandalis)* through the selection of resistant cultivars and chemical or biological control.
Control of sweet potato weevil	To develop control methods of sweet potato borer *(Euscepes)* and weevil *(Cylas)* through the selection of resistant cultivars and chemical or biological control.
Potato seed production	To develop or adapt, for regional use, methods of producing cheap and clean planting material of adapted germplasm.
Control of nematodes in yams	To control nematodes in yams through the use of clean seed by the development of cultural and chemical means.
Control of anthracnose in yams	To develop suitable methods for anthracnose control through an intensive selection program for resistance and improved methods of chemical control.
Studies on the characterization and control of yam virus	To characterize the viruses of economic importance on yams in the Caribbean and to devise suitable methods of control.

Continues

Table 11. Continued.

Activity	Objective
Control of tannia leaf burning disease	To identify resistant germplasm and to develop chemical and cultural methods of control.
Integrated pest and disease control in potato	To develop suitable methods to minimize the effect of pests and disease in potato production in the lowland tropics.
Development of improved cultural methods for root crop production	To develop more efficient systems of root crop production by reducing labor inputs and increasing yields.
Evaluation of storage methods for cassava, sweet potato, and dasheen	To develop methods for increasing the storage life of yams, cassava, sweet potato, and dasheen.
Handling and packaging techniques for root crops	To develop commercially feasible methods for handling and packaging tropical root crops.
Root crop processing	To develop improved methods of processing selected products using traditional and nontraditional methods.
Training of research scientists	To increase the number of qualified personnel in the region through increased training at the M.Sc. and Ph.D. levels.
Training of production personnel	To increase the number of trained extension and production personnel in the region.
Information dissemination and exchange	To promote the dissemination and exchange of information through regional seminars, exchange visits, exchange of written reports, scientific papers, etc.

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Spanish Summary

Cultivos de Raíces y Tubérculos en el Caribe

Se analizan la importancia y producción de los cultivos de raíces en Antigua y Barbuda, Bahamas, Barbados, Belize, Cuba, Dominica, República Dominicana, Granada, Guyana, Haití, Jamaica, Montserrat, San Cristóbal y Nevis, Santa Lucía, San Vicente y las Granadinas, Trinidad y Tobago, y Suriname. La producción de cultivosde raíces se estima en más de dos millones de toneladas y los principales cultivos son ñame, yuca, batata, aroides (malangay y ocumo), y papa, siendo los mayores países productores Cuba y Haití.

En relación con la población de los países (producción per capita), los mayores productores son Dominica y San Vicente. Se discuten también la producción y los sistemas de producción por cultivo. El único cultivo de raíz importado en grandes cantidades (más de 100.000 toneladas por año) en la región, es la papa. De los otros cultivos de raíces, sólo Trinidad y Tobago importa cantidades significativas. A nivel regional la investigación sobre cultivos de raíces es realizada por el Caribbean Agricultural Research and Development Institute y la Universidad de West Indies; se resume brevemente la investigación llevada a cabo en cada país y se indica el personal involucrado en la investigación y en la capacitación. Se discuten las limitaciones a la investigación, capacitación, producción y utilización de los cultivos de raíces. Finalmente, se resalta la importancia de una red regional de investigación sobre cultivos de raíces tropicales, se indican sus objetivos y se presentan los proyectos de actividad propuestos para la misma.

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Acronyms of Regional Organizations and Projects in the Caribbean Mentioned in the proceedings of the Workshop

		Location
CARDI	Caribbean Agricultural Research and Development Institute	Trin. and Tob.
CARICOM	Caribbean Community	Guyana
CARIRI	Caribbean Industrial Research Institute	Trin. and Tob.
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza	Costa Rica
CDCC	Caribbean Development and Cooperation Committee	Dominican Rep.
CENDA	Centro Norte de Desarrollo Agropecuario	Dominican Rep.
CESDA	Centro Sur de Desarrollo Agropecuario	Dominican Rep.
CRD	Centre de Recherche et de Développement	Haiti
CRDA	Centre de Recherche et Documentation de l'Agriculture	Haiti
DARNDR	Département de l'Agriculture des Ressources Naturelles et de Développement Rural	Haiti
FAC	Food and Agriculture Corporation	Trin. and Tob.
FAMV	Faculté d'Agronomie et Médecine Vétérinaire	Haiti
FTC	French Technical Cooperation	Dominica
INRA	Institut National de Recherches Agronomiques	Guadeloupe
MALFP	Ministry of Agriculture, Lands and Food Production	Trin. and Tob.
NACO	National Agricultural Corporation	St. Kitts

NARI	National Agricultural Research Institute	Guyana
ODN	L'Organisme de Développement du Nord	Haiti
UASD	Universidad Autónoma de Santo Domingo	Dominican Rep.
UCAMAYMA	Universidad Católica Madre y Maestra	Dominican Rep.
UNPHU	Universidad Nacional 'Pedro Henríquez Ureña'	Dominican Rep.
UWI	University of the West Indies	Trinidad
WINBAN	Windward Islands' Banana Association	

Acronyms of International Organizations and Projects Mentioned in the Proceedings of the Workshop

		Location
CIAT	Centro Internacional de Agricultura Tropical	Colombia
CIDA	Canadian International Development Agency	Canada
CIP	Centro Internacional de la Papa	Peru
CIBC	Commonwealth Institute of Biological Control	Trinidad
EEC	European Economic Community	Belgium
FAO	Food and Agriculture Organization of the United Nations	Italy
IDRC	International Development Research Centre	Canada
IITA	International Institute of Tropical Agriculture	Nigeria
UNECLAC	United Nations Economic Commission for Latin America and the Caribbean	Chile

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