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Introduction of Clean *Dioscorea Alata* Planting Material into Small Farm Systems of Dominica

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Resulting from baseline surveys of small farm systems in Dominica, the Caribbean Agricultural Research and Development Institute (CARDI) and the French Technical Cooperation (FTC) recognized the unavailability of clean yam planting material as a major production constraint.

Institut National de la Recherche Agronomique (INRA), Guadeloupe and CARDI, Barbardos have developed anthracnose resistant (Bilep and SEA 189) and virus tested (White Lisbon) *Dioscorea alata* cultivars respectively during the last decade. In 1981 to 1982 samples of the above material were introduced into Dominica in order to alleviate the problem of lack of clean planting material.

This paper describes the farming systems' methodologies utilized by CARDI and FTC to introduce this clean yam planting material into the small farm systems of Dominica. Results to date are discussed herein.

The paper describes the collaborative efforts of the Ministry of Agriculture, Lands, Fisheries and Cooperatives (MOA), the Caribbean Agricultural Research and Development Institute (CARDI) and the French Technical Cooperation (FTC) to alleviate the problem of unavailability of clean yam planting material in the small farm systems of Dominica. CARDI is a regional organization, which serves twelve member states of the Caribbean Community by providing research and development needs of the agricultural sector as identified in national plans and policies. FTC is a unit of the Ambassade de France Cooperation Technique, funded by the Delegation General a la Recherche Scientifique et Technique.

These organizations have chosen a farming systems approach to address the principal agronomic and organizational constraints to increased production in Dominica. Available evidence suggests it to be the most cost effective means of technology generation and diffusion in the complex milieu of the Dominican small farmer. The FTC has directed attention in its "Agrarian Systems in the Caribbean with Alternatives for Development Project" to defining the on-farm decision-making processes and rationalization of farmers' practices in a given location with a view to utilizing the framework for planning information flow to farmers. This would be achieved by farming systems research and an extension methodology based on an intimate knowledge of the farming systems gained whilst living in a rural community. CARDI, initially through the "Small Farm Multiple Cropping Systems Research Project," and currently through the "Farming Systems Research and Development Project," both funded by USAID, has moved away from traditional commodity and discipline-oriented agricultural research which proved time-consuming and elusive in producing transferable results. Efforts represent a comprehensive agricultural strategy encompassing marketing, extension, production, input distribution and policy dialogue to address the principal constraints.

The above organizations, through various surveys and farm characterizations, have identified the shortage of adequate quantities of clean, certified planting material of good quality as a principal constraint to agricultural production of root crops, tuber crops, legumes and fruit crops. Initially, attention was directed to yam, *Dioscorea* spp., since CARDI's Barbados unit had developed virus-tested White Lisbon yam, *D. alata*, and anthracnose tolerant cultivars were available from INRA, Guadeloupe. The objective was to introduce certified, healthy planting material to the small farm systems of Dominica and to provide an appropriate technological package consistent with the farming system. The alternative to this approach would have been to upgrade the quality of local planting material. However, this was not regarded as a viable alternative at that stage because of its long term nature.

This activity commenced in 1981 and is still in progress. Results to date are presented and discussed herein.

Overview of Small Farm Systems in Dominica

The terrain of Dominica is rugged and mountainous, and the inaccessible central forested mountain ranges make about 60% of the island unsuitable for agriculture. The remaining 40%, with better edaphic and topographic characteristics, is occupied by a small number of large plantations. Most small farms are located on the fringes of these plantations going inland on steep mountain slopes. Recently there has been a trend towards fragmentation of some of the larger plantations, making such land available to small farmers.

A common feature of the small farms is the very complex, mixed farming systems. A number of crops and livestock species are simultaneously kept on the same parcels of land.

The tropical climate (mean temperature of 28°C, 15° N. Latitude and 61° W. Longitude), heavy rainfall (1250mm to 8750mm average), volcanic soils, and various agro-socio-economic factors have led to the following major constraints to small farm systems:

1. limited and disorganized markets,
2. limited accessibility of farms,
3. expensive farm labour and an extremely low level of mechanisation,
4. unavailability of agricultural inputs (feeds, seeds, livestock, tools, fertilizers, agri-chemicals, containers and drugs),
5. endo- and ecto-parasites in livestock,

6. scarce investment funds, and
7. crop protection problems including abundant weeds.

Consequently, the prevailing complex and mixed farming systems are regarded as mechanisms of risk reduction. Crops such as banana, citrus, coconut and to a lesser extent bay, which have relatively more organized markets, constitute the dominant enterprises in the farming systems (Table I). In addition, small livestock, a few beef and milk cattle, root crops, tuber crops, vegetables and fruit crops are present in the farming systems to provide on-farm food. Small surpluses are sold at the local markets and small quantities to regional and extra-regional markets. Green bananas and dasheen, which are ubiquitous, form the main staple foods and are augmented by other staples such as tannia, yams, plantains, sweet potatoes, cassava and arrowroot starch.

The most commonly cultivated crops, as shown on the survey of 120 farms by Henderson and Gomes (1979), are shown in Table 1.

Table 1. and the results of our survey indicate that banana-based farming systems are the single most important factor influencing the income and production of Dominican small farmers.

Yams in the Small Farm Systems of Dominica

Traditionally, on the majority (80%) of small farms, about a dozen yams are grown for home consumption. In addition some farmers harvest "Babaoule" yam from roadsides and forested areas. However, the farms which grow yams commercially are fewer in number and possibly less than reflected by the data in Table 1. Of the 29% of the small farms which produce yams for the local and export markets, most of them plant on sloping terrain, on elaborately formed mounds 38 - 60cm high, 90 - 150cm apart, and invariably intercropped with one or more of the following: cucurbits, dasheen, tannia, pigeon peas, banana, plantains or corn (CARDI Annual Report, 1981). In some instances the intercrops are harvested before the yam vines cover the ground, thus leaving the yams to remain in pure stands.

Yam production technology is generally low; the "overworked" soil is formed into mounds. Stakes 1m - 2m high are used and the mixed "banana" fertilizer (NPK + 4MgO) is usally banded on the surface, around the plant, and left exposed to the heavy rains. Liberal use is made of wood ashes with some farmers using pen manure where available. Limited use is made of straw and other coarse organic matter as a soil ameliorant. Few farmers specialise in a single cultivar, thus many cultivars and different species are found in a single plot. The four main species are *D. alata, D. rotundata, D. cayenensis* (Ladies yam), and *D. trifida* (Cush-cush), with the latter two the most popular species. Nematodes, viruses and anthracnose were observed as serious diseases and pests on yam farms (Fergusson, 1981). No measures to combat them were observed. Planting material was carried over from crop to crop, and this, coupled with limited crop rotation, permitted a steady build-up of pests. This is especially so for viruses and nematodes.

Planting of yams is usually spread from January to as late as June, peaking in March, April and May, with harvesting from October through February. Incomplete and repeated harvests ("castrations") are practised for home consumption; complete harvests are usually done only for the market. Storage is practised mainly in cool, well ventilated spaces, and to a lesser extent in the mounds on the vines.

The estimated volume of production of root crops in 1983 is given in Table 2.

The local market prices of yams for 1983 ranged from $1.20/kg - $2.86/kg, fluctuating with the cultivar and season. (Market Intelligence Unit, Ministry of Agriculture, 1984). For dasheen and tannia the range over the same period was $0.84/kg - $1.44/kg and $1.50/kg - $2.50/kg, respectively.

A Case Study of a Commercial Yam Farm

This farm, located in the southeast of the Island, was primarily a banana-based farming system (1.4ha of banana providing 70% of the farm income). Yams, dasheen, cinnamon and mixed vegetables were also produced on a commercial scale. Yams were grown on 0.1ha (¼ acre) with about 1000 mounds providing 20% of the total farm income and 10% of the total quantity of

TABLE 1. The most commonly cultivated crops and their frequency of occurrence on 120 small farms in Dominica.*

Crops	Farms on which grown	
	Number	Per Cent
Banana	102	85.0
Plantain	46	38.3
Root Crops		
Dasheen	96	80.0
Tannia	77	64.2
Sweet Potato	16	13.3
Cassava	12	10.0
Yam	**35**	**29.2**
Ginger	5	4.2
Tree Crops		
Coconuts	52	43.3
Cocoa	30	25.0
Coffee	20	16.7
Avocado	7	5.8
Bay	18	15.0
Citrus	34	28.3
Breadfruit	17	14.2
Mangoes	11	9.2
Vegetables		
Cucurbits	11	9.2
Tomatoes	6	5.0
Cabbage	4	3.3
Carrots	7	5.8
Pigeon Peas	5	4.2

*Henderson & Gomes (1979)

TABLE 2. Estimated production of tuber and root crops in Dominica for 1983 (Thomas, [1984] MINAG/CARDI/EDF - Roseau, Dominica).

Crop	1983 Production (tons)
Dasheen	**10,700**
Tannia	**6,250**
Yam	**3,600**
Sweet Potato	1,300
Cassava	700

root and tuber crops consumed by the farm family. The species grown was Cush-cush (*D. trifida*), which was planted in March-April 1983 and harvested in December 1983-February 1984. Operations during the crop were two hand-weedings, one fertilizing (57g NPK/plant) and one staking, using only family labour.

The role of the yam in that farm system was to diversify production, to provide food, to avoid total dependence on the bananas and to utilise farm labour at a time when the bananas could not employ the available labour. The latter was during the drier parts of the year when the banana harvesrs are less frequent and weed growth slower.

Table 3, based on the data from an annual longitudinal survey of the farm, shows a partial economic analysis of yam production. Attention was directed to the cash flow into and out of the system.

On this farm a total of 2,600 man-hours were spent on the bananas which brought in $12,000 during that year. The productivity of labour on the bananas was calculated at $4.60/man hour, which was less than that of the yams.

On Station Tests

Consistent with the farming system research methodology, (Fig. 1), the initial planting material introduced into Dominica was evaluated largely at La Plaine Agricultural Station, a southeast coastal area. This material included anthracnose resistant cultivars from INRA, Guadeloupe, and virus tested material from CARDI, Barbados (Table 4.) At La Plaine, total annual precipitation, mean monthly maximum temperature, mean monthly minimum temperature and monthly wind run ranged

TABLE 3. A summary cash analysis of commercial yam production on 0.1 ha of a small farm in Dominica.

CASH INPUTS	VALUE	
	EC$ ¢	
Fertilizers	40.00	
transportation	40.00	
labour	no cash paid (family labour) 740 m/h	
Total	80.00	
OUTPUT Total	Unit Value	Total Value
yield 2273	-	-
sold 2136	1,76	3,760.00
home use 137	-	-
TOTAL CASH INCOME		3,760.00
TOTAL CASH SPENT		80.00
NET CASH INCOME		$3,680.00

Productivity of labour:

Total yield = $5.41 per man/hr

Total labour 740 m/hr

FIGURE 1. Process for introduction of yam into Dominican farm systems.

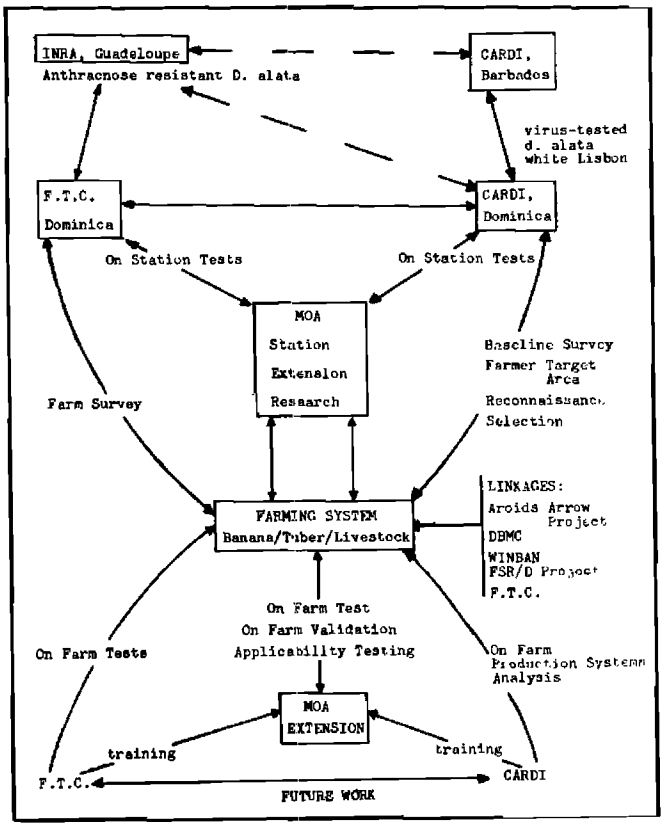
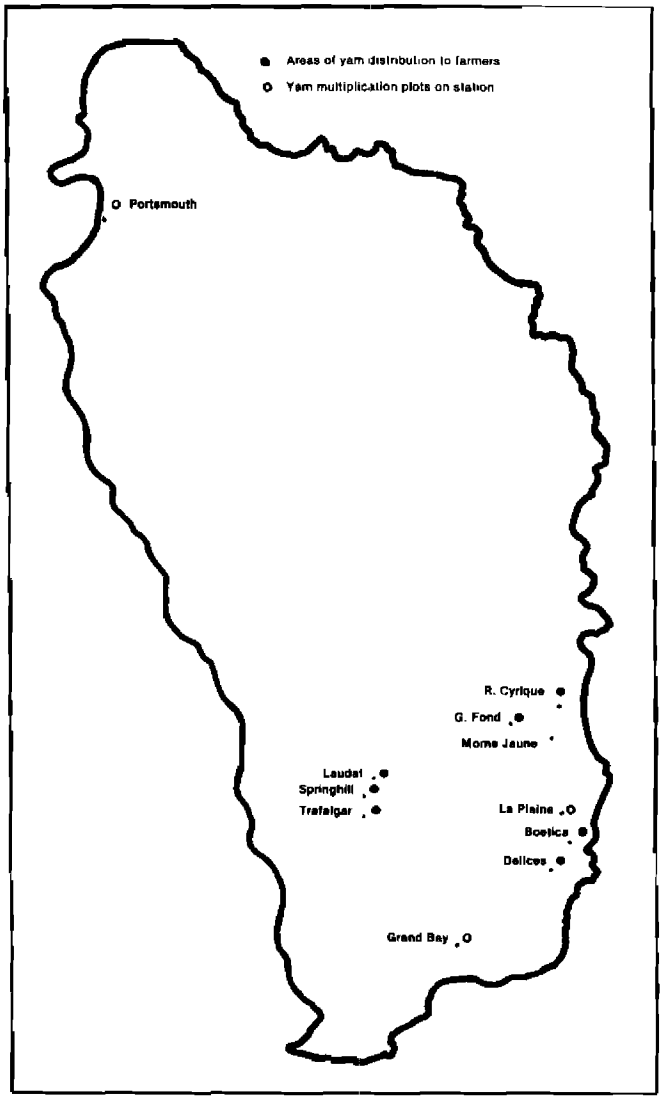


TABLE 4. Description of yam planting material introduced to Dominica 1981-84.

Cultivar	Species	Source	Character	Year	Origin	Quantity
White Lisbon A	*D. alata*	CARDI Barbados	VT	1981	Barbados	12 kgs
Belep	*D. alata*	INRA Guadeloupe	AT	1982	New Caledonia	25 kgs
SEA 189	*D. alata*	INRA Guadeloupe	AT	1982	Phillipines	
V 1712	*D. cayenensis*	INRA Guadeloupe	AT	1982	N.A.	
White Lisbon B	*D. alata*	CARDI Barbados	VT	1982	Barbados	75 kgs
White Lisbon C	*D. alata*	CARDI Barbados	VT	1982	Barbados	25 kgs
Oriental B	*D. alata*	CARDI Barbados	VTAT	1984	Barbados	46 kgs
Coconut Lisbon B	*D. alata*	CARDI Barbados	VT	1984	Barbados	46 kgs
White cush-cush	*D. trifida*	INRA Guadeloupe		1984	N.A.	5.0 kgs
Crop	Lisbon *D. alata*	CARDI Barbados	VT	1984	N.A.	46 kgs

VT = virus tested; AT = anthracnose tolerant; N.A. = not applicable;
A, B, and C = 1st, 2nd and 3rd crop harvested by certified farmer after initial green house source.

FIG. 2. Distribution of major yam activity sites in Dominica, 1981-1984



from 2,500mm to 3,000mm, 27.0°C to 31.6°C, 16.6°C to 22.5°C, and 502kg to 846kg, respectively, during the report period. Well-drained acid soils of clay loam texture predominate.

Over the report period, either mounds 30cm to 60cm high and 90cm to 150cm apart, or ridges 25cm to 40cm high and 75cm to 150cm apart, were prepared after clean weeding and ploughing. Prior to planting, all tubers were cut into 100g to 150g portions, treated with insecticide and fungicide for 15 minutes and air-dried for 24 hours. Biocides used were benomyl, 1.5g/l, captan 5.5g/l, malathion 3ml/l and sevin 80wp 4g/l, depending on availability. Prior to all plantings, yam holes were treated with 5g to 6g of Furadan 10% granules.

In the first two seasons tubers were divided, allowed to sprout and then planted; in the latter two seasons, sprouts were removed, tubers cut and the desprouted setts planted. Yam setts were planted May to June in all seasons, 70cm apart along the ridges and 5cm to 10cm beneath the surface, at an angle with the cut face away from the surface.

Branched stakes, 1.0m to 2.5m in height, were established after crop emergence. Yam vines were trained at regular intervals by loosely tied string. All plots were hand weeded at 6 and 16 weeks after planting. Immediately after the first weeding 60g of NPK MgO (12:12:17:2) fertilizer was handed 15cm away from each plant. Total harvest of tubers was conducted after 8-9 months in all seasons. Total tuber yields were the only data recorded for the 1981 planting whereas in 1982, time to emergence, anthracnose presence (scale 0 - 5), insect damage (scale 0 - 5), apparent virus symptoms (scale 0 - 5), as well as tuber yield were recorded. For 1983 and 1984 emphasis was placed on multiplication of planting material and monitoring of anthracnose. Some of the yams produced in on-station tests were distributed to farmers.

In support of the above, the station foreman at La Plaine Agricultural Station was trained in management of virus-tested yam at the Tissue Culture Facility, CARDI, Barbados. In addition the Agricultural Assistant/Extension Supervisor and the Extension Officer for the La Plaine area assisted in observation of yam cultivation at the Station. Technical support was provided by the MOA Crop Protection Division.

Distribution and Monitoring

In 1983, after results of the previous season were assessed, 40 farmers were selected by MOA personnel to whom White Lisbon clean material would be distributed. At a seminar organized by MOA, at which CARDI, FTC and MOA Crop Protection were the resource personnel, each farmer was provided with 3 - 5kg of planting material. Preparation of setts for planting was demonstrated and other production practices were discussed. Similar exercises, where extension officers played a greater role in farmer selection, were conducted in 1984 for 30 farmers of Grand Fond, Riviere Cyrique, Morne Jaune, La Ronde and Boerica in the South East Extension District and 19 farmers of Trafalgar, Laudat and Springhill in the Roseau Valley area, (Fig. 2). In all instances, after harvest, farmers were mandated to return to MOA the same quantity received for possible redistribution in the ensuing season. FTC and MOA personnel organized to monitor a few of these farmers to see how the newly distributed yams fit into the farming system. In order to provide additional planting material, yam multiplication centres were also established at Portsmouth and Grand Bay Agricultural Stations in the North West and South Central Districts in the 1983 season. These locations are similar to La Plaine in edaphic and climatic parameters except for Portsmouth, where, because of its more sheltered location, the windrun is less and the temperatures marginally higher. Portsmouth also differs topographically from the other locations as the area has less steep slopes.

Discussion

Results to date are shown in Table 5. Data on time to emergence was not collected. In 1981, yield data for White Lisbon, A grade, averaged only 1.6kg of tuber per plant, though tubers were of good quality.

In 1982, data was recorded for White Lisbon B and C grades, Belep SEA 189, all *D. alata*, and V 1712, *D. cayenensis*. Tuber yields of White Lisbon were 300% and 175% greater than those of 1981 for grades B and C respectively. This could be attributed to improved crop management as a result of the Station Foreman's training in Barbados. In 1982, White Lisbon also yielded more than the other cultivars planted. The lowest yields were recorded for cv. V 1712 (0.5kg/plant), and the highest yield from White Lisbon B of 4.8kg per plant. There was a small difference between Belep and SEA 189; however, both had greater yields than V 1712. In addition, White Lisbon B and C differed by 2kg per plant. The above yields compare favourably with those in the small farm systems in Dominica, where yields range from 1.8kg to 2.7kg/plant. Furthermore, in the 1982 cultivation, a group of 14 plants was inadvertently planted in an area which was previously a pen manure patch. Yields ranged from 2.7 to 15.5kg/plant with a mean of 7.4kg/plant. This, coupled with noted interveinal chlorosis symptoms, indicative of nutritional disorders in other areas, suggests that further yield improvements can be achieved by augmenting plant nutrition.

TABLE 5. Results of on station observations on introduced yam cultivars.

Location	Year	Species/Cultivar	No. of Plants	Anthracnose damage (0-5)	Insect damage (0-5)	Virus symptoms leaf (0-5)	Virus symptoms tuber (0-5)	Average Yield/ plant (kg)
La Plaine	1981	W. Lisbon (A)	50	data	not	collected		1.6
La Plaine	1982	W. Lisbon (B)	238	0.7	0	0	0	4.8
La Plaine	1982	W. Lisbon (C)	197	1.2	0	0	0	2.8
La Plaine	1982	Belep	35	2.0	0	0.2	0	1.4
La Plaine	1982	SEA 189	23	0	0	0	0	1.7
La Plaine	1982	V 1712	28	0.8	0	0	0	0.5
La Plaine	1983	W. Lisbon	483	3.5	0	0	0	1.0
La Plaine	1983	Belep	180	2.0	0	0	0	1.2
La Plaine	1983	SEA 189	80	2.0	0	0	0	0.5
La Plaine	1983	V 1712	14	2.0	0	0	0	1.1
Grand Bay	1983	W. Lisbon	264	3.0	0	0	0	1.1
Portsmouth	1983	W. Lisbon	179	2.0	0	0	0	1.4

Variation in tuber yield per plant could be attributed to the intensity of anthracnose in White Lisbon yam. However, genetic variations could have contributed to the lower yields of V 1712 (*D. cayenensis*) and SEA 189. Anthracnose levels of 0.8 and 0.0 were recorded for these respectively. The highest anthracnose level was evident in Belep. Ninety-five percent emergence was recorded in all cultivars except V 1712 which gave only 10%. Since this cultivar is *D. cayenensis*, only a larger sett size from head and tail portions of the tuber should be used as planting material.

Negligible insect damage was noticed on the foliage of all plants. Though some boring insects were observed in the tubers at harvest, these resulted in superficial damage only.

The foliage of all plants was examined for virus symptoms. Mottling occurred in a few plants of Belep and these were immediately discarded. Symptoms were not observed on other plants. When 2% of all harvested tubers of each cultivar were sliced and examined, internal brown spots were noted in a single tuber of Belep. Table 4 shows that only the planting material from CARDI, Barbados had been virus-tested.

Data for 1983 showed increased levels of anthracnose except for Belep which remained the same, 2.0. These increases ranged from 2.5 in White Lisbon to 1.2 in V 1712 grown at La Plaine. Similar results were recorded in all those locations in which White Lisbon was grown. This is associated with the similar climatic characteristics. Generally, depression in yield was observed in White Lisbon subjected to the virus-free process indicated in data recorded in 1982. Apparently Belep and SEA 189 can tolerate higher levels of anthracnose than White Lisbon.

The expression of anthracnose in virus-tested White Lisbon with increasing generations has also been reported in St. Lucia, St. Vincent, and Grenada. In all cases the levels noted were greater than those observed in Barbados which has a much drier environment, so that results reported herein may be attributed to either the greater precipitation in Dominica or the virus-tested process predisposing the planting material to more pronounced expression of anthracnose. Further work is necessary to elucidate the incidence of anthracnose in the introduced material in Dominica, and to identify appropriate technology to control this disease. Thus it may be more appropriate at this stage to accept the lower yields of SEA 189 concomittant with virus-testing the same, rather than persisting with White Lisbon. Nevertheless, in the interim, two additional cultivars, Coconut Lisbon and Oriental, both virus-tested and *D. alata*, have been brought in to Dominica and planted in 1984. Preliminary observations indicate that Oriental, grown at the Corona Station (precipitation 6,250 to 7,500), shows very little anthracnose incidence. This confirms observations in Barbados.

Differences in approach between 1983 and 1984 are attributed to the adoption of CARDI's Farming Systems Research and Development Methodology, in which emphasis is placed not only on technology generation but technology transfer. The farmer will maintain much closer contact with the researcher through participation with extension agents and the researchers on the farm. Closer examination of the farmer's resources, objectives and decision making processes is achieved by the FTC who reside in a rural area. This facilitates evaluation of the impact of the new technology. In addition to evaluation in 1984, generation of new technologies has been initiated. A yam collection of 22 local accessions has commenced on a farm in La Plaine in order to ascertain the characteristics of indigenous material. Well-adapted material with disease tolerance could be identified and virus-tested at the CARDI, Barbados facility for introduction into the farming system.

The association of high yam yields with pen manure, alluded to earlier, will lead to on-farm tests on this topic, since pen manure is present on most small farms.

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