CAYO DISTRICT, BELIZE

Coco Yam Commodity Profile

University of Vermont (UVM)
Inter-American Institute for Cooperation on Agriculture (IICA)
Ministry of Agriculture, Fisheries and Cooperatives (MAFC)
Belize College of Agriculture (BCA)

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This document is one of fourteen commodity profiles resulting from the University of Vermont (UVM), the Inter-American Institute for Cooperation on Agriculture (IICA), the Ministry of Agriculture, Fisheries and Cooperatives (MAFC), and the Belize College of Agriculture cooperation over the last two years. Under the supervision of Dr. J.R. Deep Ford (International Agriculture Development, UVM) and Ms. Amy Damon (Graduate Student, Michigan State University) this document was prepared by UVM students Mark Kohout and Sara Ceppetelli. Professionals from the MAFC reviewed the document from a technical standpoint. The document is intended to serve as an input into the Agriculture and Policy Unit of the Ministry of Agriculture, Fisheries and Cooperatives.

1.0 Historical Background and Importance

Known commonly as 'coco' in English and 'macal' in Spanish, the coco yam, *Xanthosoma sagittifolium,* is a very important traditional root crop cultivated within Belize. It is botanically classified as a monocot with parallel veins. It has a fibrous root structure with nutrient requirements like other monocots in the Poaceae or Gramineae families. The Arawak Indians originally distributed the coco yam throughout the Caribbean; and while it is one of the oldest Central American food crops, there has been relatively little research directed towards its growth and cultivation.

Within Belize, the total acreage of coco yam production has ranged annually from 160 to 250 acres. Within the Cayo district, production of coco yam has increased over the past decade, from twenty-five recorded acres in 1990 to fifty-eight acres in 1996.

2.0 Agronomic and Production System Issues

Coco yam producers utilize both mechanized and milpa production systems. In Belize, milpa is the most commonly practiced system, by both subsistence farmers in the southern and western areas of the country. In this system, tracts of land are cleared by hand and set on fire in preparation for planting. This system is also recognized as "slash and burn". It is a low input system, characterized by manual labor, no-tilling, and few outside inputs.

The mechanized system often uses manual or automatic irrigation, fertilizers, pesticides, and tractors with various implements to plant, cultivate and harvest. Greater total yields are seen with mechanization and the use of inputs, however, both agronomic systems have the potential to be efficient and productive. Coco yam production is an important potential source of income for milpa farmers in the Cayo district. The mechanized system, which is not prevalent in Belize or in Cayo, will be presented throughout this profile as a potential system to increase production and yields to meet the export demand from the United States. However, supporting research is necessary tfor realization if the full potential of the mechanized system.

2.1 Land Selection

Land that has proven suitable for grasses is often suitable for the production of coco yam. Coco yam prefers soils with pH of 5.5-6.5, though it has been grown successfully in both acidic and alkaline soils. Some reduction in soil-borne diseases has been seen when grown in soil with a higher pH.

Evidence from field research conducted in the southern United States suggests that the crop not be planted in fields previously used for coco yam or any other root crops. Crop rotation including a five year hiatus between root crops is highly advised and seen as being optimal in terms of output. If not practiced, the farmer will see reductions in yields due to nutrient loss, pests or diseases.

Coco yam prefers highland areas where there are typically looser soils with good drainage. However, it will grow just about anywhere in Belize, from the wet soils of Toledo to the hillsides in the Cayo district. Extremely tall specimens can often be seen growing in compost heaps and in low spots within coco yam fields.

Ideally, the plant prefers a well-drained but moist soil. The roots do not tolerate saturated conditions. It is recommended that soils be deep enough to allow for raised bed formation as in the field production of potatoes. Depending on the site conditions, coco yams are often grown in raised beds or on hills to assist with water drainage and to allow for better cormel formation.

2.2 Propagation

Coco yam is most widely and easily propagated by stem cuttings. The top of the corm, portions of the main corm, and cormels may be used as propagules. It is recommended that nurseries be established with this method of propagation to ensure even and timely development of coco yam seedlings. This method is currently being used in the research plots at Orange Walk to ensure even sprouting and uniform results.

The coco yam can also be propagated by dividing the bottom portions of the main corm into bits. Each small portion, or bit, will contain lateral buds or eyes that will later develop into new plants under the right growing conditions. Like potato tubers, the corm is divided for use as seed. Bits with only one eye are planted. This method of preparation will ensure that only one strong plant grows in each given area. Sprouting is uneven in coco yam bits because of the inherent dormancy of the buds. The lack of uniformity causes scheduling problems for the crop manager. Cultivation, fertilization and harvesting of field crops become increasingly difficult when plants are at varied developmental stages. Research is being done to determine if the growth hormone gibberillic acid (G.A) can overcome the dormancy in such buds. In other root crops, the use of G.A. has enhanced dormancy and also causes elongation of the cells.

Finally, the coco yam can be propagated using tissue culture. This method is more costly and may not be economically feasible at the current production levels. However, tissue culture is the only method that guarantees high-quality, disease-free seed planting material.

2.3 Planting

Once it is planted, a coco yam propagule needs adequate moisture to germinate. In situations of insufficient rainfall, supplemental irrigation should be applied within two days of planting. With mechanization, seed is planted into a furrow and covered with two inches of soil. In the milpa system, bits are planted by hand and covered with two inches of soil. A spacing of approximately two feet between plants in recommended to limit competition for water and nutrients and to allow for full cormel development. Rows are to be spaced three and a half to four feet apart. Under suitable conditions, it is further recommended that these rows be developed into hills at some point during the cultivation of this field crop. The coco yam is tolerant of some shade, perhaps making it an ideal crop for companion planting, intercropping or agroforestry practices. These planting recommendations are largely based on experiments conducted under specific growing conditions and may not necessarily be applicable to all of coco yam growing conditions inBelize.

2.4 Fertilization

The first fertilizer application generally coincides with the emergence of the first leaf of the coco yam plant, which could be one to two months after palanting.

A second application of fertilizer is applied as a side-dressing three to four months after planting. Some researchers recommend a third application at four months in the event of heavy leaching of nutrients. After four months of vegetative growth, no additional fertilizers should be applied. It is necessary to halt fertilizer applications at this point to ensure high quality cormel production. When the nutrients are no longer abundant, the plant concentrates on survival and reproduction, concntrating it's energy on cormel production during later months of growth and development when plants have reached maturity. A common practice in some countries bruising of the leaves to induce this same plant survival mechanism.

2.5 Fertilization Rates

Currently, agronomists recommend applications of 100 pounds of nitrogen per acre, 50 pounds of potassium per acre, and up to 120 pounds per acre of phosphorus during each season. The rate of phosphorus application is currently under debate. There is evidence that the root systems of coco yams exude an acid adequate to release the reserve phosphorus from Belize's calcareous soils, which was previously deemed unavailable. Application of micronutrients is currently not practiced because plant needs have yet to be determined.

In Belize, milpa farmers do not use inorganic fertilizers. Instead, they rely on crop rotation, mulching and fallow periods to increase available nutrients. Commercial farmers apply mineral fertilizers specifically containing the elemental potassium required by most root crops.

2.6 Irrigation

Most of the coco yam production in Belize is rain-fed and planted to coincide with the rainy season. Irrigation is a costly input as far as financial and physical resources are concerned, especially if water harvesting needs to takes place. However, there is research evidence that suggests that irrigation can result in the doubling of yields. Supplemental watering is usually applied once to twice a week during dry periods to attain the yields possible in the irrigated system.

2.7 Weed Control

Presently in the Cayo district, weed control achieved through manual weeding or spraying herbicieds. The herbicide Gramaxone is applied approximately every two and a half months at the stage when weeds are about twelve inches high.

2.8 Harvesting

The desired product for the market should have the longest shelf life possible.

This quality is attained not only by planting varieties with the longest bud dormancy but also through the proper handling of the cormels once they are harvested. Care and caution must be exercised during harvesting in order to avoid bruising, which will negatively affect the product's shelf life and marketability.

Prior to harvest, the crop is prepared by mowing down the dried top sections. This plant residue is then left in the field to build soil fertility and increase soil organic matter. In a mechanized system, the cormels are harvested with a digging implement pulled behind the tractor, similar to the harvesting of potatoes. The cormels are separated, graded, and bagged in the field and shipped off dry without the need for washing.

Yields of eight thousand pounds per acre have been obtained within nine to fourteen months. In the Cayo district, harvesting is done manually. Plants are pulled from the ground with their roots and cormels still intact using wooden digging implements. Corms are collected by hand, graded and bagged in the field.

In order to attain the 100,000 pounds per week that are currently demanded by an export market, Belize will need to dedicate at least 650 acres to coco yam production each year. Presently, there are several constraints that would need to be addressed. These are in the areas of both technical and financial support. Technical in terms of agronomic practices; financial in terms of capital requirements of the commercial production system.

3.0 Production Sector Characteristics

Coco yams are currently grown and marketed on a year round basis within Belize, Central America, CARICOM and the U.S. In Belize, coco yams have been on the list of export promotion crops for the last two years for the following reasons. First, it is thought to be an economically feasible activity for small-scale agricultural producers. With ninety-four percent of Belizean farmers classified as small farmers with holdings under five to ten acres, production of cocoyam is seen importantly as a crop to increase the agricultural diversification of small farm productions systems. Secondly, there is a niche export market possibility, mainly among Cuban-Americans residing in the United States.

Currently, there is considerable attention in Belize with regard to growing and diversifying the small farms sector in a manner that is culturally sensitive and equitable. This would address past development efforts that resulted in large farms characterizing the main agricultural production areas. By focusing on the provision of technical assistance to small subsistence farmers, poverty in the rural sector can also be better addressed.

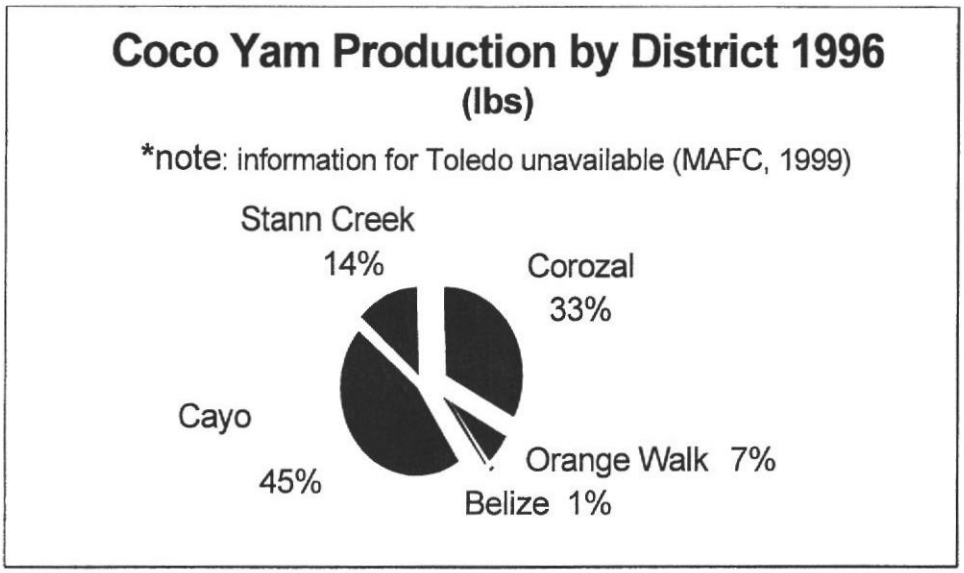
3.1 Production by District

Coco yam has long been a traditional, domestically grown root crop, particularly in certain areas within the western and northern districts. This food crop is quite popular among subsistence farmers scattered throughout Belize's diverse landscape. It is not uncommon for a family to have a few coco yam plants in their backyard for home consumption.

Corozal and Stann Creek districts have led the nation in coco yam production in

the past. The Cayo district has been increasing production rapidly from 181,500 pounds in 1990 to 556,800 pounds in 1996, surpassing Corozal's production (See Figure 1)

Figure 1 Coco Yam Production by District 1996



3.2 Cost of Production

An initial expense for new farmers who are contemplating coco yam production (rain-fed or irrigated) is the buying of the seed. The most efficient method of seeding is to plant corm cuttings with one or more eyes. The bits range in price from $0.10-0.50 a piece. Quality seed in the United States is priced at $0.07 US each and can be purchased from neighboring farmers whose crops are already well established. Once established, the annual crop renews itself, producing the seed for the next generation. Thus, the purchasing of seed is typically a one-time cost of production.

Labor is another major cost in coco yam production. The average wage for laborers is $3.12 per hour. Workers regularly are paid $25 for an eight hour day or $20 a day plus food. An irrigated acre of coco yam requires 112 person-days of labor from preparation to harvest, while a rainfed acre requires only 68 person-days.

Figure 2a: Estimated Cost of Production for Mechanized Coco Yam Production (MAFC, 1999)

Activity	Unit/Cycle	Cost per Unit	Total
Land Clearing	2	$150.00	$300.00
Plowing	2	$35.00	$70.00
Harrowing	1	$35.00	$35.00
Ridging	1	$35.00	$35.00
Planting Material	7260	$0.10	$726.00
Planting	2	$30.00	$60.00
Fertilization	2	$30.00	$60.00
Weed Control	5	$2.50	$12.50
Fertilizer			$144.65
Herbicide			$27.45
Harvesting	120	$2.00	$240.00
Bags	120	$1.00	$120.00
Total Cost per Acre			$1,830.60

Figure 2b: Estimated Cost of Production for Milpa Coco Yam Production

Activity	Unit/Cycle	Cost per Unit	Total
Labor	68 person days	$25.00/day	$1,700.00
Herbicide	6 liters	$11.75/ liter	$70.50
Bags	80	$1.00 each	$80.00
Total Cost per Acre			$1,850.50

Cost of production is varied in the coco yam production system. In the milpa system, plowing, harrowing and ridging (See Figures 2a and b above) are not applicable, but are replaced by higher costs dedicated to labor. Some milpa farmers claim a cost of production as low as $500 annually. However, this figure is presumed to be a fairly low estimate. Figure 2b estimates cost of production in the milpa system to be similar to that of the mechanized system because of the increased labor requirement.

The above tables ignore irrigation as a potential variable. In an irrigated system, the cost of production may go as high as $4,142.80. The increasing yields would off set the cost difference. Despite the difference in production systems, cost of production per pound is similar in the milpa and mechanized system (See Figure 2c). The cost of production information for the milpa system is based on a small sample and these figures should be used cautiously. There is evidence that the actual labor and resulting cost of production for the milpa system may, in fact, be lower than estimated here.

Figure 3c Cost of Production per Pound for Coco Yams

Yield per Acre	Mechanized System	Milpa System
8,000 lb.	$0.23	$0.23
10,000 lb.	$0.18	$0.19
12,000 lb.	$0.15	$0.15

3.3 Production Constraints

Coco yam appears to be a lucrative crop for both commercial and milpa farmers in Belize. Its relatively low investment requirements and cost of production allow for considerable profit to be realized by the producer, especially when prices as high as $1.50BZ per pound are realized. There is a niche export market that has been identified in the U.S. that is demanding over five million pounds of coco yams per year. The Ministry of Agriculture has noticed a desire among many farmers in Northern and Southern Belize to increase production to supply the U.S. However, in order to efficiently increase production several existing constraints to production must be addressed.

Pests:

There are relatively few pests in the production of coco yam. This low incidence is due mainly to the small size of coco yam operations within the country. However, it is essential to provide further research with respect to the potential for pest damage as Belizean farmers expand their coco yam production in the near future. Pests that are seen as a possible hindrance to future operations include the following:

- Root-feeding nematodes;
- White flies (though not a direct threat, they have the potential to transmit viruses);
- Thrips;
- White worm (presently unidentified but under investigation in the Cayo district);
- And root weevils (*Diaprepes* sp.).

The Ministry of Agriculture has recently found evidence of a white worm that burrows from inside the plant's shoots directly down into the roots, completely destroying the individual plant. Possibly a beetle larva, the species and its impact is currently unknown in the Cayo district and in Belize.

Diseases:

Like pest infestations, farmers have few problems with diseases in coco yam production. Some diseases have turned up in the fields during periods when the plants are subjected to water stress. Agricultural Extension in Orange Walk has seen cases of bacteria and leaf spot from which the plants recover with age. Diseases currently present in coco yam production within Belize include the following:

- Dasheen mosaic virus,
- Cercospora leaf spot,

- Bacterial necrosis affecting leaf margins,
- Root rots.

Plant Protection

Seed Quality:

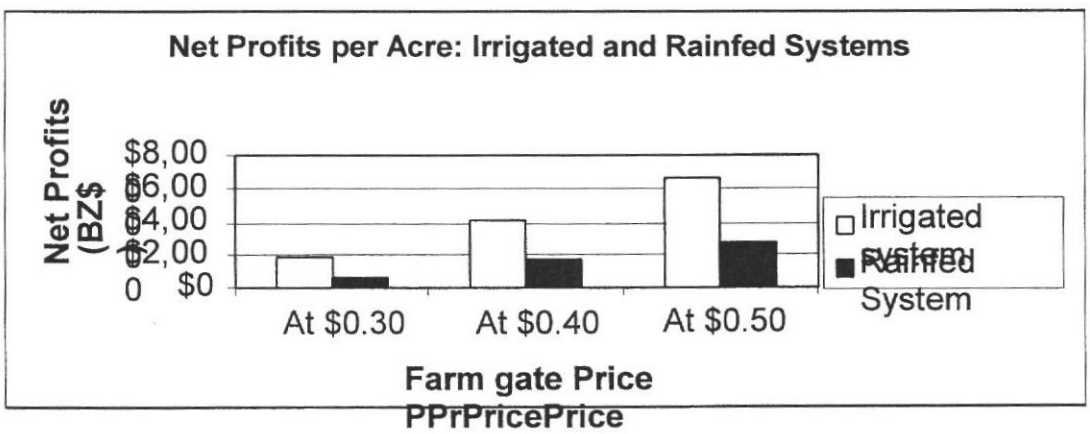
Lacking of a constant source of high quality seed has been a serious constraint in coco yam farming and if not addressed will continue to be so as production expands. Phytosanitary standards and regulations for seed quality in Belize need to be increased to ensure adequate supplies of disease free planting materials.

Infrastructure

Irrigation and Drainage:

An efficient irrigation system is one of the most important factors in sustainably intensifying coco yam production in any location. Irrigated production systems can produce over twice the yield seen among rain-fed coco systems in Belize. While drip irrigation will serve to increase profits, the equipment plus installation is a major cost to farmers. Irrigation over one acre of coco yams is valued at approximately $3,000, or $5,000 if a well needs to be dug. The initial capital investment is sizable for small scale farmers currently involved in coco yam production. If there is access to affordable credit, the installation and maintenance of an efficient irrigation system seems likely to be a profitable venture (See Figure 3). Furthermore, with the ability to access capital, farmers who invest in field drainage and irrigation have the potential of making the planting of coco yams a year round activity. In the past, this option has not been exercised for many reasons, (most importantly) including the lack of sufficient collateral.

Figure 3: Comparing Net Profits in Irrigated and Rainfed Systems



Research and Extension:

Fertilization rates for coco yam in Belize are yet to be established. The fertilization practices in Belize are based on knowledge of production systems in the United States and other Caribbean countries. Low and uneven yields and low marginal productivity of inputs currently result from lack of (integrated) fertilizer research being completed. Lack of research into pest and disease problems of coco yam will be a

limiting factor in the future if production of coco yam is to increase.

At present, information regarding fertilizer application, soil testing and soil fertility management is generally unavailable at worst, or currently difficult to access for Belize's small farmers. Experience of the banana and sugar cane sectors positively demonstrate the benefits of maintaining a fully integrated extension service.

Organization of Producers:

In the Belize production sector, it is apparent that farmers typically work alone in making production decisions. Individual farmers attempt to produce for the market in the high-price months of September to November. This leads to a greater degree of fluctuation in the year round market price of coco yams because of supply fluctuations. There is consequently a very low price when the market is oversupplied during the months of December to February.

The promotion of improved farmer organization for coco yam production could assist with both lower input and marketing costs.

Storage:

Storage is another constraint to coco yam production. Cormels store up to 150 days in cool storage of 11-13 degrees Celsius and 85-90% humidity. Generally, coco yams can be stored in a relatively cool area without the need for cold storage. Many farmers in the Cayo district currently store their coco yams in the ground or in shaded pits. There has been some mention of improvements in this area with respect to increasing the capacity and capability of present storage techniques. For exports, improved storage is needed to provide a high quality product to the market.

Access to Credit:

For small farmers to purchase many of the inputs necessary to increase coco yam production (fertilizers, mechanization, and irrigation), access to credit is required. Lack of credit currently limits the small farmer to the current milpa, non-irrigated practices.

3.4 Environmental and Sustainability Issues

An interesting technique to maximize production efficiency and crop turnover is to allow space in between the existing plantings for the next year's crop. This practice serves to give the developing coco plants room for root development and identifies the planting area for the next year's crop. Yields generally increase for both crops. This method also serves to reduce tillage and subsequent erosion.

This method, however, raises the issue of whether or not crop rotation is practiced and whether one fallow cycle roughly equivalent to the coco yam's growing season is enough time to allow production of coco yams once again. Root rot and pest problems are also a concern, especially with increased acreages, and when continuous cropping is practiced on the same plot of land.

Coco yams are commonly grown on hillsides to benefit from the improved drainage on slopes. This cultivation of cocos on slopes in order to take advantage of beneficial soil characteristics is not a sustainable practice since it may lead severe erosion.

4.0 Marketing and Pricing Issues

Export market opportunities for the coco yam are quite favorable currently. The market size and lowest price opportunity is identified to be 5.2 million pounds per year and $0.30 per pound, respectively.

4.1 Pricing

The domestic farm gate price for a one hundred pound bag of coco yams can range from BZ$20-60. As with cassava and some other root crops, coco yams can in fact be left in the field for a limited amount of time (one month to 120 days) until the farmer decides to market the crop. Many local vendors at the Saturday, Cayo market retail coco yams. The retail market price for coco yams ranges from BZ$0.75 to $1.50 per pound. Typically, in the Cayo district, one hundred pound bags of coco yams can be purchased wholesale at the market for BZ$30 to $100. Producer prices in the Belize district are much more attractive if the farmer can transport the produce to that market. Coco yams are marked-up to the price the seller assumes will be accepted in the market. There is no guide to retail pricing, and the sellers strive for the maximum price given season and location. Figure 4a and b present the variability in the Cayo and Belize districts.

Figure 4a Average Producer Prices for Coco Yam in Cayo and Belize Districts 1998

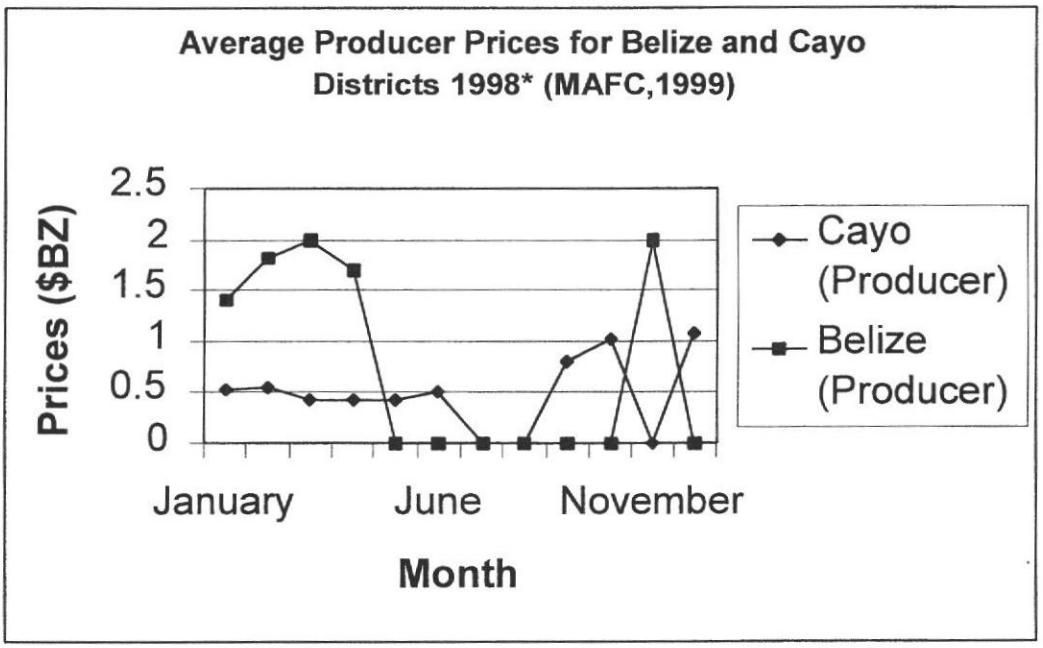
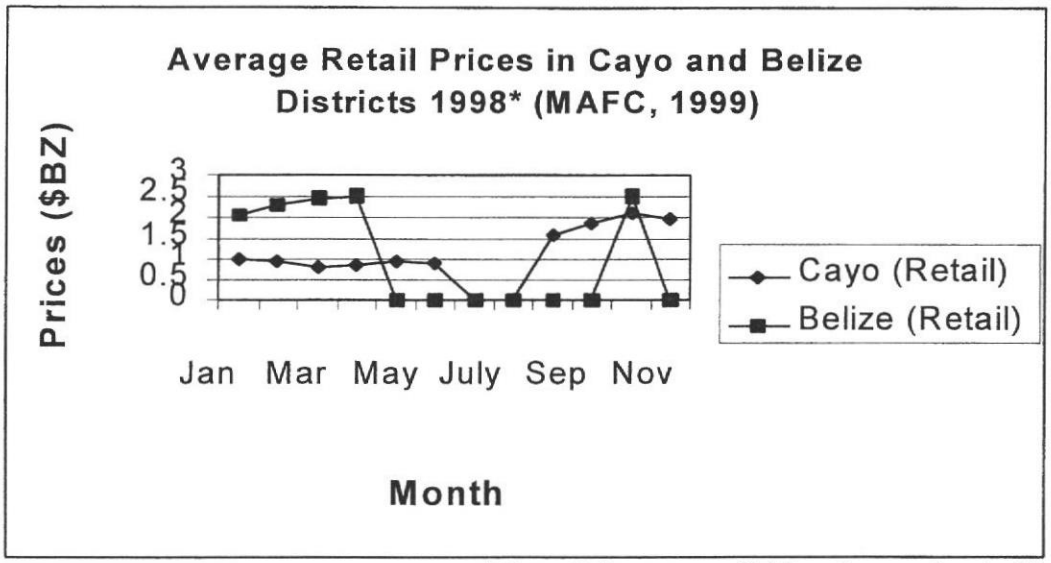


Figure 4b Average Retail Prices for Coco Yam in Cayo and Belize Districts 1998



*Note: Prices unavailable where value is $0.00

Price instability is a major issue for both producers and consumers. Unstable prices make coco yam a seasonal product in many homes, where consumption is highest when prices are low.The low prices during the main harvesting season and the limited market in Belize City serve as a disincentive to production expansion.

4.2 Markets

Coco yam farmers in Belize have three main market outlets for their product. The first is the local market where farmers can directly retail their produce. This market is limited and time consuming for the individual farmer. The second market involves sale of products to middle men or wholesalers. Cayo farmers may carry their produce to San Ignacio, Belmopan or Belize City via bus or pick up truck to sell by the hundred pound bag to wholesale purchasers. Some wholesale buyers also arrange to pick up produce at the farm gate. A third market option for coco yams is the potential export market in the United States.

4.3 Substitutes

Coco yams are commonly replaced in the Belizean diet by potatoes, sweet potatoes and other yams. Their use in baked, fried and soup dishes is readily replaced by these products and at a lower cost to the consumer. Yams retail for $0.75 per pound, Irish potatoes sell for $0.70, sweet potatoes sell for $0.50, while coco yams currently retail at $1.00 per pound.

4.4 Potential Value-Added Products

Coco yam may be ground at the household level for coco yam flour which may be to be used in breads and to thicken soups. A niche market for coco yam flour is a possibility. Sabroso is a warm beverage made of coco yams, vanilla and sugar, which might have high potential as a value-added product for the local and export markets. Coco yams are also made into a milk-alternative known as macal milk. Another potential value added product includes fresh or fried greens taken from young coco yam leaves that have not yet unfurled.

Additional possibilities are the processing of the coco yam into a French-fried potato substitute and the use of the coco yam as a landscape plant.

4.5 Marketing Constraints

Inadequate production and marketing systems characterize the constraints to increasing production, productivity and efficiency in coco yam production. The following specific constraints need to be addressed:

Export quality:
Currently, there is a market opportunity to export 100,000 pounds of coco yam per week to the United States. The price is quoted at no less than BZ$0.30 per pound with potential price increases of up to BZ$0.80 during the months of September, October and November when supply is low. The characteristics that are standard for coco yam exports are the following:

- Club shape (ball shape is also acceptable but not ideal);
- Smooth skin (possessing very few bumps; a characteristic of certain varieties);
- White flesh (also a characteristic of variety as there is limited market demand for the purple-fleshed coco that is satisfied by domestic growers);
- Six to twelve inches in length;
- Two to four inches in diameter;
- Weight of 6 ounces or more;
- Longest possible dormancy;
- Same or compatible variety to that which is grown and consumed in Florida, the South Dade White.

Common defects under which a cormel may be rejected includes: uneven shapes which may be caused by nutrient and/or water deficiencies at some point in the plant's development cycle. Hand shapes and bumpy skin are varietal attributes which may be an important factor in producing for the export market. Coco yams with these qualities are frequently seen in the Belizean markets. Rotten spots, cuts, bruises or insect holes are all suitable causes for shipment rejection of the crop. Bruising often does not appear on the fruit for one or two weeks after the damage has occurred. Thus, proper handleing at all stages needs to be stressed. Satisfying the standards listed above may present a challenge to the small-scale farmers who wish to export this commodity from Belize because of the

constraints of infrastructure, transportation, research and extension support, storage, and marketing information.

Use of herbicides:

Sanitary and phytosanitary regulations governing root crop imports are becoming more stringent. These regulations will have to be analyzed and updated regularly for growers.

Research, Extension and Development:

Utilizing improved varieties and sharing or increasing knowledge with regard to total quality management in the production and marketing of coco yams will lead to greater profits within the industry. This issue is currently being addressed by IICA and the Ministry of Agriculture.

Infrastructure:

There needs to be significant improvements with regard to infrastructure such as roads, bridges and ports, particularly in order to better connect farms to their markets. The current infrastructure system in Belize needs to be upgraded allow small coco yam farmers to benefit from the new export possibilities in the United States. Farmers need good quality farm roads and bridges to transport their delicate produce from remote farmlands to markets. An easy-access, deep water port may also reduce the costs of shipping for sellers interested in exporting.

Buying Centers:

There is the need for the creation of buying centers (wholesalers) to assist with marketing and to improve efficiency in the marketing networks. Strategically-placed buying centers will ensure that a market exists that producers can access and a supply exists for traders, whether domestic or international. Organized buyers or buying centers can help to facilitate the movement of the large volumes of produce that would need to be produced to shipped to penetrate the export market.

Supply and Price Variability

The coco yams market is characterized by supply and price variability. Prices vary from as high as $1.50 per pound during the early part of the coco yam season in October to $0.20 by February. Typically, the best price for coco yams ($1.20-1.50 per pound) can be seen during October and November. The cause of this price fluctuation is primarily inconsistency in market supply.

Transport Services:

The lack of adequate transport services is a major constraint to efficient marketing of coco yams. The rental of a truck is unaffordable by many small farmers because of the low volumes of produce. Yet the volumes are too large for other alternatives, public buses, which places a limit of five to six bags.

Unreliable export markets:

Another constraint to marketing and increasing production of non-traditional

exports is lack of confidence in the export product markets. Historically, for several different reasons, these markets have fallen apart, resulting in significant financial loss to the farmer.

5.0 Trade

The Ministry of Agriculture, Fisheries and Cooperatives (MAFC) in Belize has two policy objectives with respect to coco yams. The first commodity policy objective is to increase food security and cash incomes. The second is to increase exports out of Belize. Belize is currently negotiating an export agreement to export 5.2 million pounds of coco yams annually to the United States through Miami.

MAFC is collaborating with IICA to obtain new technology packages for coco yam producers and to promote contract farming in order to effectively supply the external market.

6.0 Social and Cultural Importance

6.1 Food Preparation and the Diet

Coco yam is used for making soups and as a thickener. Another method of preparation is boiling the peeled coco yams, which can then be eaten plain or with honey if so desired. Young leaves of the coco yam plant are fried and eaten, often at breakfast. The commodity is consumed year round.

Coco yams can be made into flour, for use in bread or tortillas.
The market vendors in Belmopan indicate that coco yams make up a large percentage of the Belizean diet and that demand is highest during the month of December because that is when the price is lowest. They recognized cocos yams to be one of the healthiest vegetables on the market.

Coco yams are a valuable source of dietary nutrients (See Figure 5). As a starchy root crop, coco yams supply carbohydrates and protein along with calcium, magnesium and betacarotene.

Figure 5: Nutritive Value of Coco Yams

Characteristic	Nutritive Value of Tubers/100g	Nutritive Value of Leaves/100 g
Calories	102	24
Protein	1.8 g	0.5 g
Carbohydrate	23 g	6 g
Fat	0.1 g	0.2 g
Calcium	51 mg	49 mg
Phosphorus	88 mg	25 mg
Iron	1.2 mg	0.9 mg
Betacarotene	trace	180 nanograms
Thiamine	0.10 mg	0.02 mg
Riboflavin	0/03 mg	0.04 mg
Niacin	0.8 mg	0.4 mg
Ascorbic Acid	8 mg	13 mg

6.2 Employment levels and Income

From an employment perspective, coco yams provide self-employment for the subsistence farmer and his family who are managing the crop. In Cayo, most coco yam is currently grown on one to two acre plots. These plots are small enough to be managed by one year round worker and one part-time helper for labor intensive periods like planting and harvesting.

Income levels for hired laborers are slightly higher than minimum wage. Workers in Cayo generally earn $20 per day with food included or $25 per day with no food. This brings an average hourly wage of $2.50-$3.12.

6.3 Profitability/Farmer Incomes

Coco yam production is considered an important contribution to farmer incomes because it is a low-input crop with a relatively high market price. The production of coco yams is not yet a sole source of income for farmers in Belize. In seeking to expand production, this situation must be considered.

Because of a lack of accurate data, it is difficult to determine yield per acre and profitability of coco yam production in the Cayo district. Further research is essential. Based on figures regarding plants per acre and yield per plant, one can determine an average possible yield and profitability, but these figures are based on speculative numbers rather than actual field observations (See Figures 7a , 7b).

Figure 7a Gross Farmer Income per Acre of Coco Yam Production

	8,000 lb./acre	**10,000 lb./acre**	**12,000 lb./acre**
At $0.30/lb.	$2,400	$3,000	$3,600
At $0.40/lb.	$3,200	$4,000	$4,800
At $0.50/lb.	$4,000	$5,000	$6,000

Figure 7b Net Farmer Profit per Acre Coco Yam (at Market Price $0.30/lb) (MAFC,1999)

	8,000 lb./acre	**10,000 lb./acre**	**12,000 lb./acre**
Mechanized System	$569.40	$1,169.40	$1,769.40
Milpa System	$549.50	$1,149.50	$1,749.50

The above charts seem to dictate greater profits in the mechanized system. This is primarily caused by the high labor-intensity of land clearing, planting and harvesting in the milpa system. It should be noted that these profits are only realized under the specified yields. Statistics on average yield per acre vary so greatly (from 500 pounds per acre to 20,000) that it is difficult to determine producer margins accurately. As cost of

production information for the milpa system is considered tentative, the net farmer profit per acre should be regarded in the same manner.

7.0 Conclusions and Recommendations

Coco yam production can be a significant source of increased diversification and income for small farmers in Belize. The most common milpa production system, while profitable for the small farmer, does not produce the volumes needed for competitive ezports of this crop. Expansion on the intensive and extensive margins must occur if Belize coco yam production is to be exported successfully. A change in practices, particularly fertilization and irrigation will significantly increase yields for farmers. The current export opportunity is an excellent chance to increase small farmer incomes in the Cayo district and Belize.

7.1 Production

Producers need to be better organized to facilitate growth and efficiency in the coco yam sub-sector. Farmer cooperatives have been unsuccessful in the past, but some kind of association/organization is needed to increase access to resources and opportunities. Farmer organizations for input purchasing, transport, storage and planning of planting schedules will help to reduce costs and risk to farmers, increase efficiency and facilitate the negotiation of improved prices with greater market stability.

7.2 Marketing

Production and marketing planning driven by the needs of the market and timed to assist producers in receiving a high and stable price is essential to the success of the marketing system. The incentives derived from this could lead to producers targeting specified markets. Hopefully, marketing norms will become well established and product quality and delivery will lead to increased profitability and market stability.

7.3 Record-keeping

The information on coco yams from the Ministry of Agriculture, Fisheries and Cooperatives is limited. Research offices and Extension agents continue to produce less root crop information relative to other crops. Currently, statistics show land under cultivation for coco yams at 58 acres in 1995 and three acres in 1996. This discrepancy results from unreliable data collection. Whether public or private, accurate figures and records are important to developing coco yam production in Belize.

7.4 Research

To ensure successful development of coco yam production system, research is an essential component. Research needs to be increased in the areas of pests and diseases, fertilizer requirements, economic efficiency and marketing. This work will be important to improving yields and efficiency in the production of coco yams.

7.5 Extension

Currently, the extension system in the Cayo district is insufficient to assist all of the frmers' needs associated with the potential increase in coco yam production in the district. Resources, both human and financial, are a limiting factor affecting several areas that are important. To accommodate the potential increase in production associated with the niche market available in the United States, farmers will nee assistance with soil fertility management, improved farming practices, and more efficient marketing and trade.

7.6 Infrastructure

In any development plan, infrastructure must be improved in Belize's districts to facilitate any increase in coco yam production and marketing. Improved water systems at the village level to accommodate irrigated systems are essential to realizing potential yields in coco yam production. Improved highways, bridges, and feeder roads are essential to ensure farmer access to the market for their produce in all seasons.

7.7Regulations and Standards

Establishing regulations and standards that are recognized and understood will serve to create uniformity in the market. Standards regarding sanitation and health of seed pieces need to be instituted to ensure a high-quality source of seed for new farmers. Meeting these standards will help farmers to achieve export quality produce.

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