1. Background and History

The watermelon (Citrullus lanatus) originated in tropical and subtropical Africa. Taken to the New World in post-Columbian times, it is now widely spread throughout South East Asia, India, the southern United States and the Caribbean (4, 5).

Watermelons are produced throughout the six districts of Belize, but as **Table 1.1** shows, production is mainly concentrated in the central and northern regions. The semi-tropical climate is ideal for producing watermelon most of the year. The reports of the Ministry of Agriculture, Fisheries and Cooperatives indicate that in 1997, there was a total of 83 acres of watermelon in the Cayo district. Given this information, along with the average plot size, it is estimated that there were 80 watermelon producers in the Cayo district alone. Watermelons are grown on a much smaller scale in the Stann Creek and Toledo areas. In the MAFC crop report, no information was available for watermelon production in these two regions.

Table 1.1: Watermelon Production 1997

	Corozal	Orange Walk	Belize	Cayo	Stann Creek	Toledo
Total Acreage	77	90	30	83	NA	NA
Total Pounds	1,078,000	360,000	120,000	250,200	NA	NA

Source: Ministry of Agriculture, Fisheries and Cooperatives, 1998
NA = data not available

2. Production Systems

Small farmers with mixed production systems produce the majority of watermelons in the Cayo district. Farmers growing watermelon in the Cayo District generally own their land may also rent plots closer to a source of water during the dry season. Plots are small, usually between 0.5-2 acres. Production is seasonal being highly dependent upon rainfall. Watermelon growth is most rapid during dry, sunny periods. In this system, crops are planted

one to two times per year: once in October/November/December/ January, with a second planting in June. Harvesting generally begins in February/March for the first crop and in September/October for the second crop. During the dry season, ninety percent of farmers discontinue the production of watermelons. Farmers grow watermelons for sale in the local markets.

Seeds and Seedlings

All seeds are purchased either from agro-chemical shops or directly from the United States. One ounce, which contains approximately 600-930 seeds, is adequate for planting half an acre. There are two main seed varieties: Top Yield (BZ$30/oz) and a much more expensive seedless variety estimated at more than $BZ1.00. Apart from the special seed, there is little need for increased inputs for seedless varieties.

Land Selection and Preparation

Soils should be well-drained, high in organic content, with good moisture-retaining capacity. Although watermelons can be grown on various soils, certain soil types are more appropriate depending on the season. During the dry season, black soil mixed with clay is better suited for production because of the ability to retain water. Alternatively, during the wet season, sandy soil is preferable for its ability to prevent water logging. Excessive amounts of water may reduce sweetness and increase the chances of fungal disease infection. Extremely high temperatures (greater than 30 degrees centigrade) affect the pollination process and retard the growth of the plant. Stable day and night temperatures help to promote a rapid growth rate.

During the land preparation stage, soil is ploughed or tilled mechanically and formed into mounds, approximately ten feet apart, 200 mounds per acre. Herbicide is applied prior to

planting. Seeds and fertilizer are sown two to four centimeters deep in trenches on the mounds. Plants are sprayed with pesticides every 21 days to prevent pests and diseases. Two people can potentially plant one acre of watermelon in one day if the land has already been ploughed.

Fertilization and Weed Control

Generally, watermelon farmers throughout the Cayo district use chemical fertilizers. Chicken manure is an inexpensive alternative to chemicals ($.50-$1/100lb. bag) and is used primarily by Mennonite farmers in Barton Creek. A complete fertilizer, a mixture of NPK, is widely used and may sometimes be mixed with urea. Farmers may apply fertilizer up to four times during a single season: first, when the seed is planted; second, when germination begins; third, when the plant flowers; and lastly, when the fruit weighs approximately ten pounds. For one acre of watermelon, during one season, a total of 550 lbs. of fertilizer is generally applied. While farmers may control some weeds manually, herbicides are commonly applied to prevent weed infestation.

Pests and Diseases

A major constraint to the production of watermelon is the Whitefly, which is a vector of the Gemini virus. This disease causes mottling, puckering and rolling of the leaves which prevents the formation of new fruits. Aphids are another pest which leave a sticky film all over the watermelon, causing yellow spots and poor flavoring. During the rainy season, there is an increased risk of blight (a type of fungus). Many farmers grow watermelons in rotation with other crops (i.e. corn, potatoes) as a means of pest control and soil rehabilitation.

Harvesting

Depending upon fertilization practices, watermelons are usually ready to be harvested 90 days after planting. The withering of the tendrils and the density of the fruit indicate maturity. The two main harvest periods are between late March/April and again in October. On average, one acre of watermelons yields 10,000-30,000 lbs. though yields vary considerably across individual farmers and districts. Watermelons are generally harvested (manually) once a week for three weeks. **Table 2.1** provides a calendar of watermelon production, indicating what steps are taken each month.

Table2.1: Activity Plan for Watermelon Production

Month	***Procedure***
October/ November	Some planting can be done
December	Planting; last month to apply fertilizer
January	Last month to plant Top Yield variety on sandy loam soil
February	Apply complete fertilizer (NPK); control weeds manually; prepare for dry season
March	Dry season sets in; some harvesting
April	Start to harvest mature crop; prepare land for another crop; identify seed sources
May	Prepare for first rains
June	Plant second crop

Source: Ministry of Agriculture, Fisheries and Cooperatives

2.1 Production Constraints

Watermelon production in the Cayo district is reported to face a number of major constraints, primarily related to water and soil management.

Access to water

Lack of sufficient water during the dry season is a major constraint to watermelon production. With the limited supply on the market, prices are higher in the market. Farmers

who produce during this season may transport water from rivers, man-made ponds, or other sources. Plants require between .5 gal-2 gal of water every two of days. This requires a significant amount of labor, which is hired when family members are not available. In addition to lack of water, too much water during the rainy season may result in low germination.

Soil type/drainage

For some watermelon farmers, sandy soil is a constraint during the dry season, given its low water retention capacity. Farmers are required to water the plants more frequently and this increases costs and serves as a disincentive to growing a second crop.

Input Costs and Access

The cost of chemical inputs is high for small farmers. Input usage varies depending upon the production systems and financial resources of each farmer. The degree of chemical use increases throughout the year is normally higher during the rainy season when more pests and diseases are prevalent.

Another constraint is the high cost of seeds. Seedless varieties of watermelon, which are preferred for the export market, are much more expensive than seeded varieties. This may prevent farmers who lack sufficient financial capital from producing watermelons for export.

2.2 Cost of Production Analysis

Initial crop establishment costs for seeded watermelon production are low enough to permit most small farmers to plant the crop. These costs include land, machinery rental, seeds and spraying equipment (**Table 2.2**). Costs of production for seedless watermelons are shown in **Table 2.3**.

While many farmers utilize members from within the household, sometimes outside laborers may be hired to assist with watering and spraying. Most laborers are young men between the ages of 18-25 and receive $2.00 an hour. **Table 2.4** details some of the costs associated with hired labor.

Box 2.1 shows the revenue, income and feasibility of two levels of watermelon production (10,000lbs/acre and 30,000lbs/acre). When the price is $.25/lb., a yield of 10,000lbs will generate revenues of approximately $2,500 and an income of $1,823. This level of production becomes infeasible when price falls to $.07/lb., which is equal to the unit cost of production (see **Table 2.2**). An above average yield of 30,000 lbs. (common for Barton Creek) generates a revenue of approximately $7,500 and an income of $6,823 when the price is $.25/lb. This level of production becomes infeasible when prices fall to $.02/lb. Increased yields per acre enhance the economic feasibility of watermelon production despite associated increases in the cost of production.

Table 2.2: Costs of Production (Seeded Variety)

Production Activity	Price	Quantity (per acre)	Average Cost
Fixed Cost			
Land Use	$2/acre	1	$2
Machinery (rented)	$40/hr.	1	$40
Spraying Equipment	$18	1	$18
Operating Cost			
Seeds (Top-Yield)	$30-48/oz	2 oz	$78
Fertilizer (Complete)	$30-35/100lbs.	550 lbs.	$179
Insecticide (Confidor)	$1/g.	150 g.	$150
Herbicide (Round Up)	$15-25/L.	.5-1L	$27
Fungicide (Antracol)	$8-9/lb.	3-5lbs.	$35
Labor	$2/hr.	69-79hrs.	$158
Total Input Costs			**$687**
Cost per pound		10,000-30,000 lbs.	$.02-.07/lb.

Table 2.3 Cost of Production (Seedless Variety)

Production Activity	Price	Quantity (per acre)	Average Cost
Fixed Cost			
Land Use	$2/acre	1	$2
Machinery (rented)	$40/hr.	1	$40
Spraying Equipment	$18	1	$18
Operating Cost			
Seeds (seedless)	$1.50/seed	1,400	$2,100
Fertilizer (Complete)	$30-35/100lbs.	550 lbs.	$179
Insecticide (Confidor)	$1/g.	150 g.	$150
Herbicide (Round Up)	$15-25/L.	.5-1L	$27
Fungicide (Antracol)	$8-9/lb.	3-5lbs.	$35
Labor	$2/hr.	69-79hrs.	$158
Total Input Costs			**$2,709**
Cost per pound		10,000-30,000 lbs.	$.09-.27/lb.

Table 2.4: Labor Costs per Season

Activity	**Hours (per acre)**	**Cost**
Plowing	1	$2
Planting	1	$2
Fertilizing	17	$34
Spraying	35	$70
Watering (*dry season*)	*10*	*$20*
Harvesting	15	$30
Total	79	$158

Box 2.1: Income and Feasibility of Domestic Watermelon Production per Acre (seeded variety)

Farmer #1 (yields 10,000lbs/acre):

- Average Revenue:
  $.25 x 10,000lbs. = $2,500
- Average Income:
  $2,500 - $687 = $1,813
- Feasibility:
  Production becomes infeasible at $.07/lb.

Farmer #2 (yields 30,000lbs/acre):

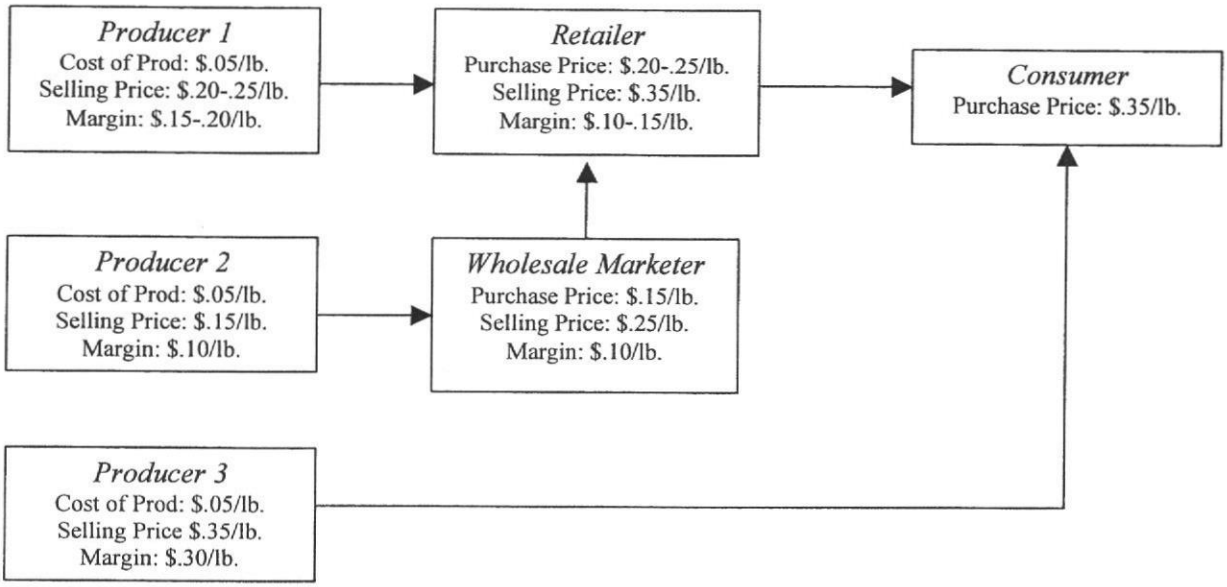
- Average Revenue:
  $.25 x 30,000lbs. = $7,500
- Average Income:
  $7,500 - $687 = $6,813
- Feasibility:
  Production becomes infeasible at $.02/lb.

3. Marketing and Pricing

Most producers sell their watermelons to generate income for the household. Farmers sell their product to retailers, middlemen, or directly to consumers themselves. Retail marketers usually sell for $.10/lb.-$.15/lb. above what they pay the farmer.

The two major marketing locations in the Cayo district are San Ignacio and Belmopan. Belize City and Stann Creek are also potential markets, but are farther away and less accessible for some Cayo farmers. For those who can market to these areas, prices are usually higher ($.10-.20 more per lb.). Door to door sales and roadside marketing are also practiced, especially in periods of glut. Growers who lack access to transportation sell watermelon to wholesale marketers for approximately $.20/lb. below retail price. **Figure 3.1** illustrates the marketing channels from producer to consumer.

Figure 3.1: Local Marketing Channels and Average Margins for Watermelon



Domestic Price Variability

Retail prices range from $.10 during the surplus months (late March to May) to approximately $.50/lb. in periods of shortage (January/early March or October/early November). The average price during most of the year is $.35/lb. Farmers who sell directly to consumers make the highest margin. While those who sell through wholesale marketers, or "middlemen", make a lower margin (see **Figure 3.1**).

Value-Added

There is potential for the creation of value-added products from watermelon. One product that is marketed in Cayo is watermelon juice. Though not widely processed and marketed, it is currently sold in a few restaurants. As shown in **Box 3.1**, watermelon juice sells for about $1.00 per 8-oz cup (retail); due to the low costs of the raw material and for processing, this juice product offers relatively high returns.

Box 3.1: Watermelon Juice Profitability

- 1 Watermelon = 15 lbs. (on average)
- 15 lb. Watermelon x $.35/lb. = $5.25
- labor and capital costs = $2.60
- 1 Watermelon = 1 gal. of juice
- 1 gal. of juice = 16 cup (8 oz.) of juice
- 16 c. of juice x $1/cup (8 oz.) = $16
- Profit margin = $16 - $7.85 = $8.15
- **Percent profit = 51%**

3.1 Marketing Constraints

Low Prices

During the peak season when watermelons are in surplus, prices fall to $.05/lb. For most farmers, this price is too low to make a profit. With this glut in the market, many growers cannot sell through normal marketing channels and resort to selling door to door.

Market Barriers

Wholesaler loyalty is another constraint facing farmers. Middlemen who sell to retailers build up a clientele that may be less willing to buy directly from growers. This prevents farmers from selling their crop in certain markets.

Size of Market

Watermelon production within the Cayo district is sufficient to meet consumer demand within the district for most of the year. Without additional market development, this limits the level of production from increasing significantly in the Cayo district.

3.2 Trade and Policy

Watermelons are not generally being imported into or exported from Belize. However, a local packaging/processing plant is experimenting with the possibility of exporting to the United States during mid-December to mid-April when there is a demand for imports.

Under the plan farmers will receive BZ$.12/lb. for seeded varieties, and $.15/lb. for seedless. While this price is lower than the average domestic price ($.35/lb.), it is an incentive for farmers who seek a fixed price and a guaranteed market for all of their produce. The export market requires watermelons of high quality, weighing between 18 and 24 lbs. Thus, select produce could be exported with the remainder going to into the domestic market. As an incentive to target this export market, the Ministry of Agriculture distributed seedless watermelon seeds free to small farmers in San Antonio. If farmers had to pay for these seeds, production would be infeasible with yields less than 18,000 lbs. (see **Box 3.2**).

Box 3.2: Income and Feasibility for Export Production per Acre (Seedless Variety)

Farmer #1 (yields 10,000lbs/acre):
Total Revenue = 10,000lbs x $.15/lb = $1,500
Total Cost (seedless production) = $2,400
Total Income = $1,500 - $2,709 = -$1,209

Farmer #2 (yields 30,000lbs/acre):
Total Revenue = 30,000lbs x $.15/lb = $4,500
Total Cost (seedless production) = $2,400
Total Income = $4,500 - $2,709 = $1,791

Farmer #3 (yields 18,006 lbs/acre):
Total Revenue = 18,006 lbs x $.15/lb = $2,709
Total Cost (seedless production) = $2,709
Total Income = $2,709 - $2,709 = $0

The plan for exportation is to collect watermelons in a central location, wash, inspect, and then place them into refrigerated containers for shipment. One container can hold up to 40,000 lbs.

For the 1999 growing season that began in December 1998, the goal is to export between 240,000 and 640,000 lbs. (6-8 containers) to Miami by mid-April. If successful, production will increase gradually each year.

3.3 Trade Constraints

Economic and cultural constraints to watermelon trade occur at both the production and marketing levels. In order to increase production and export potential, these constraints need to be addressed.

Management Skills

Many farmers are unfamiliar with and do not follow recommendations for successful exportation of watermelons. Recommended practices start with pre-germination and continue with improved maintenance throughout the growing period.

Quality and Regulations

High standards and regulations serve as a barrier to entry to potential exporters. Watermelons must meet certain quality requirements prior to exportation. For instance, fruits must weigh between 18 and 24 lbs. Further, sanitary and phytosanitary standards, particularly regarding pesticides and residues need to be met. These requirements necessitate changes in current practices.

Shipping

Watermelons need to be refrigerated during export to ensure high quality upon delivery to the buyer. One 40-foot refrigerated container with a maximum capacity of 40,000 lbs. costs approximately US$4000. This cost limits the exporting opportunities for small individual investors. The per unit cost of shipping is $.20/lb., while the per unit cost of the watermelon is $.15/lb. This illustrates the importance of efficiency at the marketing end of the commodity system. While these costs are high, prices paid to the marketer yield a $.15-.25/lb. margin (see **Box 3.3**).

Box 3.3: Per Unit Shipping Costs

- Cost of one container = $8000
- Container capacity = 40,000 lbs.
- Per unit cost of one container = $8000 ÷ 40,000lbs. = $.20/lb.
- Total per unit cost = $.15 (1lb.) + $.20 = $.35/lb.
- Price paid = $.50-.60/lb.
- Price margin = $.15-.25/lb.
- Total profit from one container sold = $6,000-10,000

*other costs (not included) are minimal

4. Household Usage

Watermelon is not considered to be a significant source of nutrition, and usually represents a small percentage of total household diet. While approximately 93.4% of the watermelon is comprised of water, only 60% of the whole fruit is edible. Watermelon contains minimal amounts of carbohydrates, fat, calories, and protein and trace amounts of vitamins and minerals (see **Table 4.1**). The watermelon is highly substitutable with other melons or fruit.

Table 4.1: Nutritional Values

Nutrients, Vitamins and Minerals		Nutrients, Vitamins and Minerals	
Water	93 ml	Iron	.3 mg
Calories	22	B-carotene	250 μg
Protein	.5 g	Thiamin	.04 mg
Fat	.1 g	Riboflavin	.05 mg
Carbohydrates	5 g	Niacin	.1 mg
Fiber	.4 g	Ascorbic acid	8mg
Calcium	8 mcg		

Source: Vegetables in the Tropics, H.D. Tindall

5. Employment and Income

For a number of small farmers, watermelons provide an important source of income. According to the Winrock International Institute for Agricultural Development, watermelon farmers receive an average gross income of BZ$2,210 from watermelons alone (higher than both sweet peppers and cabbage). This comprises more than half of the average gross income of vegetable farmers in the Cayo District. Most labor that is employed assists in the watering, spraying and harvesting of the watermelons. Laborers are mostly young men, between the ages of 18-25, from within the community and are paid BZ$2.00 per hour. While some laborers may be hired, household members are the main source of labor for the operation.

Watermelons also provide an additional source of income for retail marketers. The majority of the people employed in the marketing of fruit at this level are women. In addition to watermelons, these vendors sell other fruits and vegetables.

6. Conclusions and Recommendations

Production

- Institutional and policy interventions should be made to improve infrastructure facilities, specifically investment in irrigation facilities to ensure stable, year round watermelon production. Access to credit and technical assistance to small farmers would assist them to upgrade their own facilities.

- Given that watermelon production involves the frequent application of chemical inputs, it is important that appropriate measures be taken to protect nearby watersheds from contamination. Increased promotion of Integrated Pest Management (IPM) should be considered in order to reduce costs and ecological damage.

- The domestic production of watermelon helps to save foreign exchange through import substitution of other fruits and fruit juices. In addition, the potential for export may provide an additional source of foreign exchange in the near future. Information to facilitate domestic market expansion and foreign market penetration for watermelons should be provided because of the potential foreign exchange gains.

Marketing

- Fluctuation in market prices throughout the growing season increases risk and can contribute to unstable farm incomes. This can be a disincentive for producers to make significant investments in the production of watermelon.

- The small market in the Cayo district is a major constraint to production expansion. The development of marketing systems that allow farmers to access to additional domestic markets and the export market is important to production expansion.

- The potential for the value-added products, for example, processing and bottling of watermelon juice, should be researched to determine economic feasibility.

Community Economic Development and Food Security

- Watermelon production is an important source of income for some small farmers. With the growing potential to export, this may increase. Sectoral policy should include research, extension, credit, and marketing programs targeted to watermelon production and marketing. Numerous small farmers grow watermelon. In the interests of increased equity in the rural sector its production should be promoted.

- Incorporating watermelons into a diversified production system enhances the economic sustainability of the farm. Watermelons can be a short term source of income that can be relied upon for generating income two to three times per year.

- While the consumption of watermelon does not significantly contribute to food availability, the income generated from it is important to increasing food accessibility. In addition, watermelon production and marketing are important components of crop diversification because it promotes income stabilization for the small grower and marketer.

- The production of watermelons provides employment opportunities for the rural landless within the community and small vendors within the district. This source of employment should be expanded.

- Low start-up, maintenance and labor costs make watermelons a good crop for young farmers attempting to establish their own farms. This is important to ensuring farming is accessible to rural people in Belize and to the long run viability of the farm economy.

Other recommendations

- More accurate data and documentation for watermelon production and marketing are necessary to further analyze and assess the economic, environmental and policy impacts affecting all growers, marketers and communities. This information is very important in decision making at both the producer/farm level and the policy maker/sectoral level.

Persons Consulted

Cantos, Mr.	Grower, San Antonio
Caretela, Gumercindo	Consumer, Esperanza
Figuro, Oscar	Grower, El Progreso
Friesen, John	Grower, Barton Creek
Harrison, Orlando	Managing Director, Big-H, San Ignacio
Howe, Mario	Extension Officer, San Ignacio
Teck, Cristobal	Extension Officer, Cayo
Tillett, Elvis	Consumer, San Ignacio
Zib, Mr.	Grower, San Antonio

In addition, we interviewed various fruit vendors in both the San Ignacio and Belmopan markets.

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