

Agribusiness Development and Evaluation for Processed Local Sweet Corn in Trinidad and Tobago

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The study examined the technical and financial feasibility of an integrated production and processing venture for sweet corn in Trinidad and Tobago. Based on information derived from market studies, consumption levels and potential product lines were determined.

Evaluations were conducted in the processing of local synthetic cultivar (UW7) as a substitute for imports. Processing systems were identified and modified for the Trinidad and Tobago market. Financial analyses based on various pricing scenarios were conducted. The study concludes that an integrated production and processing project aimed at full import substitution for the Trinidad and Tobago Market was technically feasible with attractive financial returns.

BACKGROUND OF THE INDUSTRY

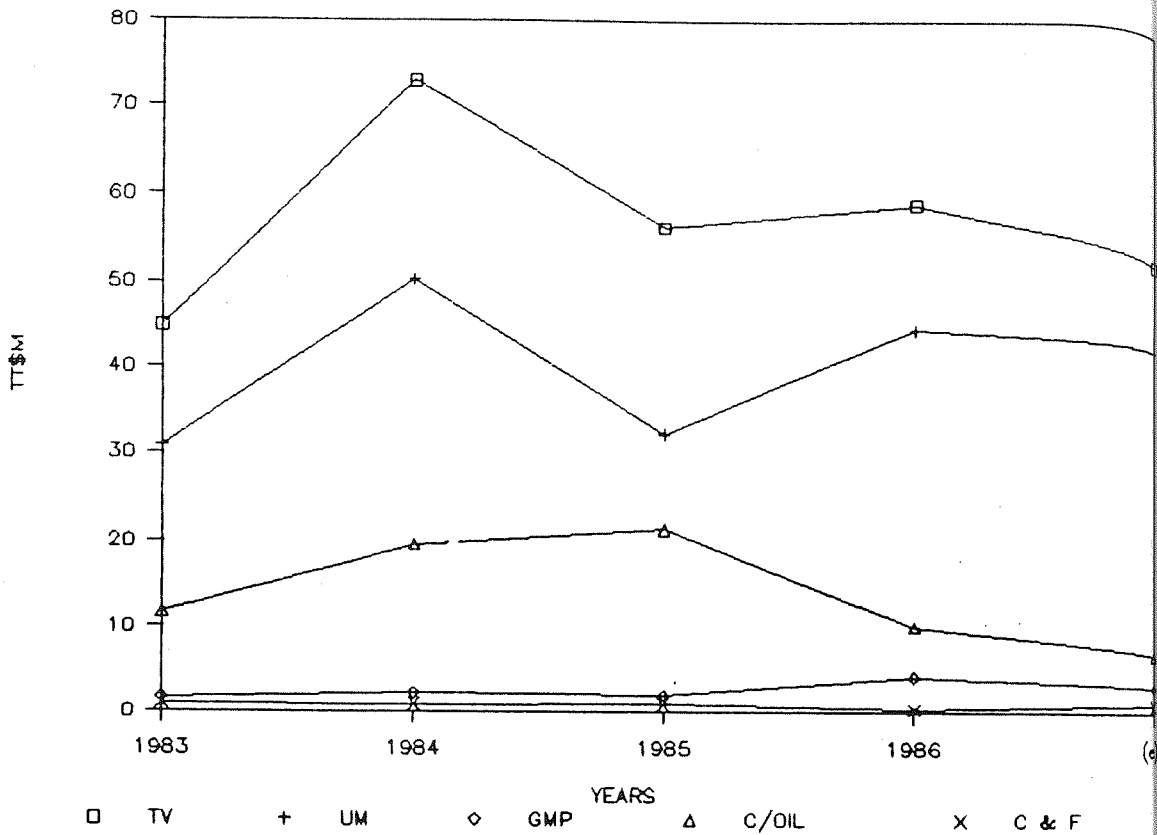
The average annual value of imports of corn products by Trinidad and Tobago over the five-year period 1983–1986 is TT\$60 million. Imports are channelled mainly into three processing lines – yellow cracked degerminated corn is used for cereal production, yellow whole grain corn is used for animal feed production and whole kernel corn for canning.

Over the period 1983–1987, imports of sweet corn for table use amounted to an average of 0.5% to 2% of the total annual imports. For 1987 the estimated value of imports was TT\$411,000.

As a broad strategy for agricultural development, Trinidad and Tobago is currently focussing on import substitution and export promotion within the context of promoting sectoral linkages through agro–industry. This particular project is seen as a potential activity within the above strategy.

OBJECTIVES OF THE STUDY

The broad objective of this paper is to report on the feasibility of a project for developing agro–industry in the processing of sweet corn for the food industry. The primary focus is on the processing of locally grown sweet corn in order to substitute for the imported products currently supplying the market.



TV - Total Value, UM - Unmilled Maize, GMP - Groats, Meal & Pellets
 C & F - Canned & Frozen, C/OIL - Corn Oil

(e) - Estimated

Source : C.S.O. Overseas Trade Report (1983-1987)

Figure 1
 Value of Imports of Corn Products

More specifically this project aims to:

- (i) identify product lines of sweet corn which have good market potential in Trinidad and Tobago;
- (ii) determine the processing systems, product handling (inclusive of in-field handling) and packaging required for the various product lines selected for evaluation;
- (iii) evaluate alternative technologies by processing samples of the various product lines;
- (iv) evaluate process samples against current product lines in the market in order to determine consumer acceptability;
- (v) identify plant and equipment and estimate the capital investments for the processing systems selected; and
- (vi) conduct a financial appraisal of the project encompassing the spectrum of activities from production to marketing.

METHODOLOGY

This study attempted to examine the feasibility, both technical and financial, of the production, processing and marketing of sweet corn in Trinidad and Tobago. The methodology adopted is based on the concept that agro-industrial development should be market-led.

Two broad aspects of the market were investigated. The first focussed on trade, consumption, market structure and merchandising of sweet corn products. The second area of analysis was related to consumer preferences. Here an attempt was made to obtain consumer preferences for the various product lines of processed corn as well as preferences relative to substitutes such as peas, beans etc.

In order to evaluate the adaptability of processing technologies, samples of the various products were processed. Three processing systems were identified. Samples of UW7 obtained from the UWI Field Station were subjected to slow freezing (cobs), blast freezing (cobs and kernels) and canning (kernels). Blast freezing and canning were undertaken by commercial processors namely, Food Masters Ltd. and National Cannery Ltd.

Products were successfully processed and were evaluated for quality as well as consumer acceptability. This evaluation comprised of both laboratory analysis as well as consumer reaction test (taste and well as other product attributes).

The processing systems determined for the product lines as well as information on targeted market volumes informed on the selection of plant and equipment for a commercial operation. Determination of both capital as well as operating costs were necessary. Information sought was not restricted to traditional suppliers of such plant and equipment but through collaboration with the Faculty of Engineering at UWI, the potential for locally designed and fabricated components was considered.

The feasibility of producing sweet corn under the climatic conditions in Trinidad and Tobago has been established in research and development work conducted by Dr. R.A.I. Brathwaite and other staff of the Crop Science Department of UWI. Experiences gained from this work provided information on crop agronomy, production systems, productivity and costs of inputs for the primary production component of the study. Existing production provided samples of product for processing and evaluation. The final step in methodology was the financial analysis of an integrated production and processing venture for sweet corn.

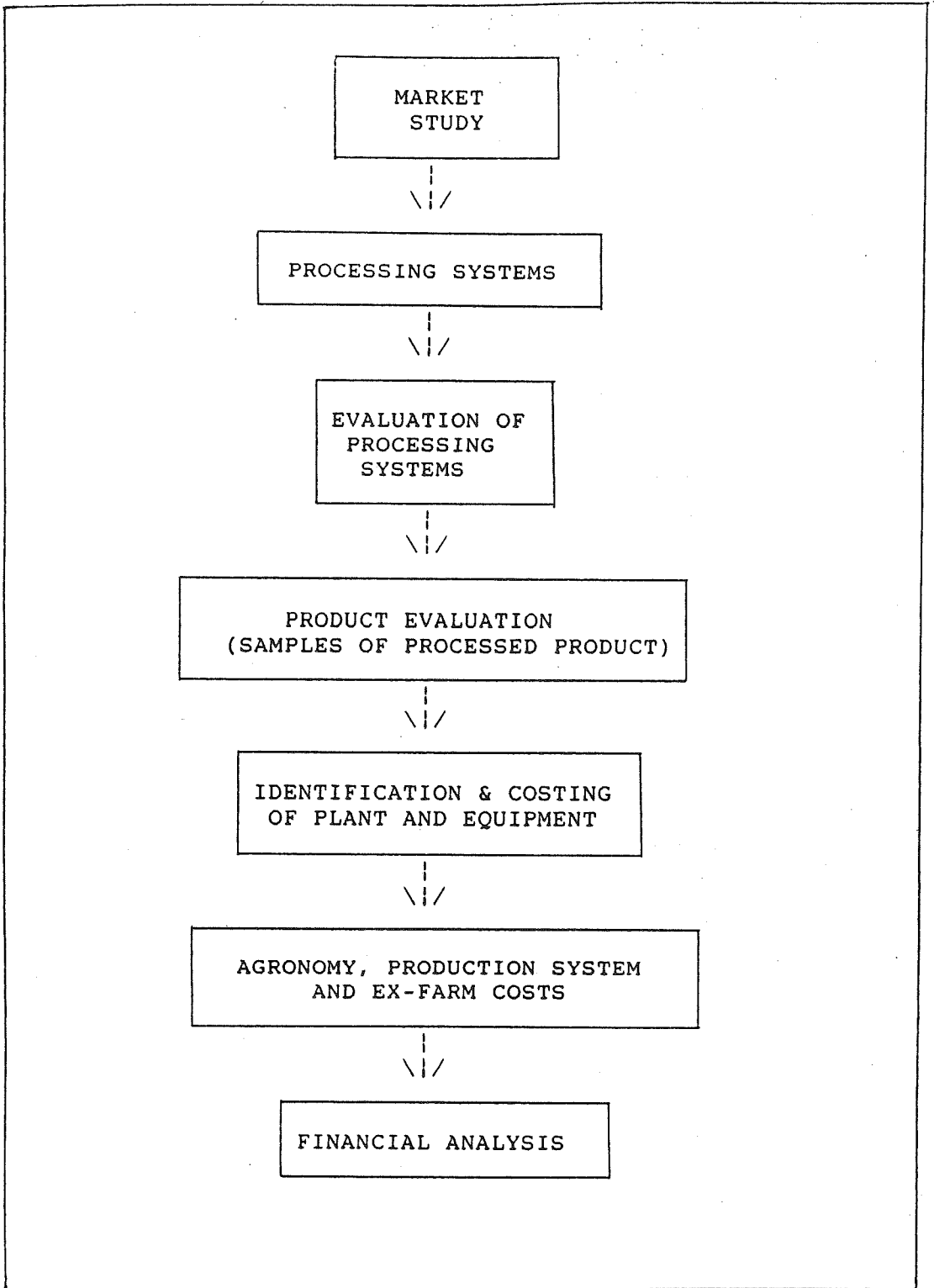


Figure 2
Methodological Steps

MARKET STUDY

The market study revealed a consumption level for sweet corn of approximately 206,000 kg of kernel corn much of which is in the canned form. Consumption of corn-on-cob (frozen) is much less being approximately 307,000 cobs (76,750 kg).

The production volume which was targeted for the purpose of this feasibility study is the most recent consumption levels given above. This particular study therefore assumes that changes in consumption of processed corn in the near future is unlikely to significantly vary from the figures above. Further, no consideration is given to the export potential of the product for the Caricom Region or for the substitution of sweet corn for other vegetables. Processed volumes are therefore restricted to current consumption levels – 282,750 kg of processed corn, kernel and cobs combined.

In converting the final products to raw equivalent, that is the number of cobs, the following factor which was developed from our investigations is used: 1 cob yields 77.5 gm of kernel. Accordingly, the production target in cob-equivalent is as follows:

For kernel corn	2,678,000 cobs
For corn-on-cob	<u>307,200 cobs</u>
Total	<u>2,985,200 cobs</u>

COMMERCIAL PROCESSING SYSTEM

Commercial processing equipment which was identified, was designed for large volume throughput such as to be found in the United States and Canada. Most of the operations are automated. Given the relatively small volume of output targeted for processed corn for the local market, it was important to select appropriate plant capacities and to avoid over-capitalization in plant and equipment. Accordingly, the conventional system for processing corn was modified/re-designed to produce a system more appropriate for the conditions under study. In this regard, many of the process activities were designed to operate in a mechanically assisted mode rather than being fully automated. Capitalization was reduced as much as possible since the plant is specialised and will only operate for a limited period – less than three months in the year. This approach to the design therefore meant that labour input for processing was relatively high, but for a limited period of time.

The processing system which was designed for the local industry is shown in Figure 3. The flow diagram shows that green corn, freshly harvested and field cooled, enters the plant at the first stage – husking. After husking, silking takes place then the cobs are inspected for defects as well as separation of cobs for the cob line and the kernel line. Since only 15% of total demand is for cob, the top 15% in terms of desirable attributes for cobs will be channelled off into this line.

The processes along the cob line are all mechanically assisted. The sequence of these are as follows: trimming, washing, tray loading, blanching, cooling and draining, blast freezing, packaging and finally cold storage. A significant amount of manual handling is involved in these operations.

The kernel line has the following processes: cutting, sizing, inspection, tray loading, washing, blanching, blast freezing, packaging and cold storage.

The plant throughput is constrained by the capacity of the husker. The minimum capacity husker which was located is 1.5t/hr. or approximately 6,000 cobs/hr. The final processed product has the following throughput:

- (1) Kernel : 22 boxes per hour
Where : 1 box = 18 x 1 kg packs.
- (2) Cobs : 11 boxes per hour
Where : 1 box = 12 x 1 kg packs.

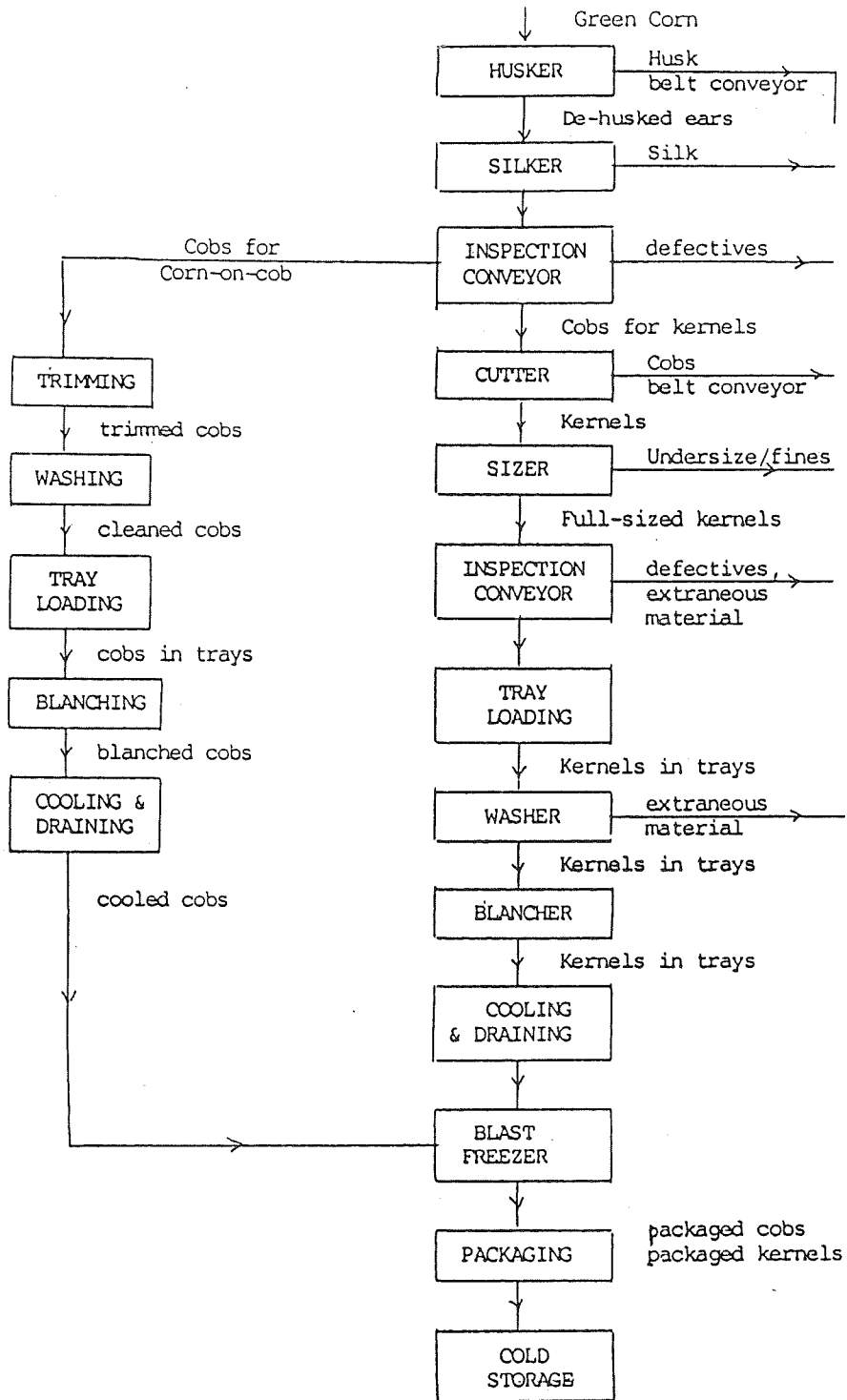


Figure 3
 Process Flow for Freezing Preservation of Corn on Cob and Corn Kernels for the Trinidad and Tobago Market

PRODUCT EVALUATION

The local synthetic cultivar (UW7) selected by UWI possesses several desirable characteristics for processing into kernels and corn on cob. Cobs selected from a field of UW7 for the cob line were uniform in length and width. This characteristic is favourable for commercial processing of corn-on-cob. However, they are at least 1 cm longer than imported cobs, slightly tapering in length and at least 2 cm smaller in width with a smaller kernel depth.

With respect to the processing techniques used, it was found that blast freezing was better than slow freezing in terms of uniformity in colour and general appearance. From the report submitted by National Cannery, it appears that:

- (i) the local sweet corn (UW7) is suited for commercial canning and freezing;
- (ii) this synthetic cultivar is better than the variety presently canned by the company; and
- (iii) there was an acceptable drained weight after processing (280 g versus 270 g).

From the results of the Consumer Reaction Test it would seem that canned local kernels are comparable to canned imported kernels. Blast frozen kernels had the best colour out of the samples presented. Blast frozen and slow frozen local corn on cob can be considered as acceptable products. However, the blast frozen corn-on-cob appears to be the better of the two products. When compared to the imported corn-on-cob, the blast frozen cobs can be considered as a possible substitute. However, the sweetness of the processed local product could be improved.

When considering the various attributes which are important for kernel corn, evaluation conducted showed that UW7 produced a product which was similar to the imported product. Similar results were obtained for corn on the cobs.

This aspect of the investigation therefore demonstrated that a local sweet corn cultivar, UW7, could be successfully processed into products which can effectively substitute for imports.

CAPITAL COST FOR PLANT AND EQUIPMENT

The estimated capital cost for the plant and equipment is TT\$561,685 whereas the cost of the building is TT\$150,000 – giving a total cost of TT\$711,685 for plant and facilities for the processing of sweet corn. The cost of the various components are itemized in Table 1. The useful life for plant and equipment is assumed to be eight years whereas the building is 15 years.

Table 2 presents the annual fixed operational cost for the processing of sweet corn. The total cost shown is \$18,300. The variable production cost per metric tonne of processed product (1000 kg) is shown in Table 3. The total amount per 1000 kg is \$670.70 with labour and packaging material being the most significant cost items.

The final cost item is for storage and distribution. This is assumed at 5% of the variable cost which gives \$34.54/1000 kg.

Table 1
Capital Cost of Plant and Equipment and Building for Processing Sweet Corn

A.	Plant and Equipment	Cost (\$)	
	Husker	81,995	
	Silker	71,300	
	Cutler	108,732	
	Sizer	6,000	
	Trays	15,000	
	Washer (2)	4,000	
	Blancher (2)	10,000	
	Blast freezer	84,800	
	Packaging	21,200	
	Cold storage freezer	42,400	
	Inspection conveyors	12,000	
	Trimming	1,000	
	Material handling	10,000	
		<u>\$468,000</u>	
	Contingencies (20%)	93,685	
	Sub-Total		<u>\$561,685</u>
B.	Building		
	(100' x 50') = 5000 ft. @ \$30/ft.	\$150,000	\$150,000
	Total Capital		<u>\$711,685</u>

Table 2
Fixed Annual Operational Cost – Processing of Sweet Corn

Items	Annual cost (\$)
1. Management (50% x \$36,000)	18,000
2. Land Rent	300
3. Overhead (10% of variable costs)*	19,912
TOTAL	<u>\$38,212</u>

* (282,750 kg x \$704.24/1000 x 10%)

Table 3
Variable Processing Cost for Sweet Corn*

Items	Cost/1000 kg of Processed Product (\$)
Electricity	10.34
Water	3.69
Labour	325.00
Plastic bags (100 bags/1000 @ 0.10/bag)	100.00
Cardboard boxes (62 boxes/1000kg @ \$2/box)	124.00
Miscellaneous Items	25.00
Plant maintenance (5% of annual cost)	21.70
	609.73
Contingency (10%)	60.97
	670.70
Marketing and Storage (5%)	34.54
Total Variable Cost	\$704.24

* Excludes financing charges for working capital

FINANCIAL ANALYSIS

Production Target

Financial analysis was conducted for an integrated production and processing business venture for sweet corn. Production was targeted for full import substitution for the following product lines:

Kernel corn – 206,000 kg.
 Cobs – 307,000 cobs

Although kernel corn currently appears in the market in only the canned line, the project envisages the final marketing of both canned and frozen kernel corn. However, given the existing capacity for canning in the country, the project aims to produce only frozen kernels, leaving the canning to existing packing firms. Frozen cobs will be packaged in units of four each weighing 1 kg.

The above target for processed product is estimated to require 2.9 million cobs. Two crops are programmed and thus a total of 36 hectares of land will be required, since the marketable yield per hectare is 41,472 cobs.

Investment and Operational Costs

As an integrated production and processing agribusiness venture targeted at full import substitution, the overall capital investment for this project is \$742,000 whereas the annual operational costs total \$671,000 (Table 4). Most of the capital expenditure (96%) associated with the project are for plant and equipment for processing. Operational

expenditure, however, is greater for the primary production of corn – being approximately twice that required for the processing of corn.

Table 4

Summary of Capital and Operational Costs for Production and processing of Sweet Corn in Trinidad and Tobago*

Item	Amount (\$)
Primary Production/On-Farm	
(i) Capital	30,000
(ii) Operational	443,520
Processing (inclusive of Post Harvest)	
(i) Capital	711,685
(ii) Operational	227,852
Integrated Production and Processing	
(i) Total Capital	741,685
(ii) Total Operational	671,372

* Notes:

- (1) Production is geared specifically for substitution of current levels of imports : 206,000 kg of kernel and 307,000 cobs.
- (2) Production is based on two crops/year.
- (3) Production area required is 36 ha.
- (4) Interest on working capital excluded.

Unit Production Costs

Unit production costs were included for the two final products. With respect to the unit cost of frozen kernel corn packaged in 1 kg polypropylene bags and re-packaged in 20 kg cardboard boxes, the estimated cost is \$3.18/kg. The computations are shown in Table 5 in which a conversion of 13:1 is used in processing the cobs into kernel. The primary production cost for the raw material necessary to produce 1 kg of kernel is \$2.00. This together with a processing cost of \$1.18/kg results in a total cost of \$3.18/kg of frozen kernel. This cost does not include allowances for profits. The distribution of final product cost between primary production and processing is 64%:37%, respectively.

With respect to frozen cob, the unit cost of the final product is much lower – \$0.45/cob. This differential arises on account of two factors. Firstly, the average weight per cob is 0.25 kg and secondly, the conversion from the primary product to final product is 1:1.

Table 5
Unit Costs – Final Product

A. Kernel/Kg.	
(i) Primary Production	
No. of cobs/kg.	13
Unit primary cost/cob	\$0.154
Cost of raw material/kg. kernel (13 @ \$0.154)	\$2.00
(ii) Processing Costs	
Cost/kg. Kernel	\$1.18
(iii) Total Unit Cost	
(\$2.00 + \$1.10)	\$3.18/kg
B. Cobs	
(i) Primary Cost	
Unit cost (\$/cob)	\$0.154
(ii) Processing Cost	
Unit cost (\$/kg)	\$1.18
Cobs/kg	\$4.00
Unit cost (\$/cob)	\$0.295
(iii) Total Unit Cost (\$/cob)	
(\$0.154 + 0.295)	\$0.45

Returns to Investment

Returns to investment were computed assuming two alternate price levels. The first price assumed the import substitution prices or the C.I.F. values which are:

For kernels – \$4.88/kg
 For cobs – \$1.44/cob

The Returns to Total Capital under this price scenario are as follows – IRR = 105%; NPV = \$3.2 million; Payback period = 1 year.

The second price level used assumed a 30% margin above unit costs. The respective prices here were:

For kernels – \$4.13/kg
 For cobs – \$0.59/cob

The returns to owners equity were – IRR = 85%; NPV = \$1.1 million; Payback period = 2 years.

Table 6
Summary of Financial Returns

	IRR (%)	NVP @ 12% (\$million)	Paybacks (Yrs)
ANALYSIS 1			
Return to Total Capital at C.I.F. price	105	3.2	1
ANALYSIS 2			
Return to Total Capital at price = 30% Margin	47	1.1	2
ANALYSIS 3			
Return to Owner's Equity at price = 30% Margin	85	1.1	2

SUMMARY AND CONCLUSION

The following is the summary of and major conclusions from the analysis of this project:

- (1) It was established that the average annual importation of sweet corn in Trinidad and Tobago is approximately:
 - 206,000 kg of kernels
 - 307,000 cobs.
- (2) The local synthetic cultivar, UW7, has the potential to substitute for imported varieties of sweet corn.
- (3) This cultivar has been agronomically tested at the University Field Station over a period of time giving yields of approximately 40,000 marketable cobs per hectare.
- (4) An appropriate processing system was designed considering both the targeted production volume for the substitution of imports and the production structure for primary production. The investment in plant and equipment is \$712,000.
- (5) Processed products (kernels and cobs) were evaluated using:
 - (i) Laboratory tests.
 - (ii) Consumer taste tests.
 - (iii) Commercial processors' (packers) evaluation.
- (6) Encouraging results have been obtained from all three evaluations. National Cannery Ltd. indicated that UWI kernels are better for processing than imported corn and give a higher drained weight than the kernels the company is presently importing.
- (7) The total investment for an integrated production and processing venture is \$742,000, whereas annual operational expenditure is \$671,000.

- (8) The project shows extremely attractive financial returns.
- (9) The project is technically and financially feasible and will result in foreign exchange savings.
- (10) This venture can supply the following products:
- Directly to distributors:
 - (i) frozen kernel corn in 2 kg and 1 kg polypropylene bags,
 - (ii) frozen corn on cobs in 1kg polypropylene bags.
 - To packing houses:
 - (i) frozen kernel corn sold in bulk for canning.

ACKNOWLEDGEMENT

This project was undertaken as a special project under the UWI/GORTT research programme. The project examined both the technical and economic feasibility of an integrated production/processing venture for sweet corn for table use. Accordingly, the study relied heavily on multidisciplinary inputs. In this regard we wish to acknowledge the extensive and most valuable support provided by Dr. R.A.I. Brathwaite of the Crop Science Department of the Faculty of Agriculture, The University of the West Indies. His own research experiences as well as those of his colleagues in the production of sweet corn provided the basis for establishing the feasibility of sweet corn under tropical conditions. Indeed, the existence of a crop of UW7 synthetic cultivar at the Field Station facilitated the processing and product activities. We are grateful to Dr. Brathwaite and Mr. Sarran Harryram, Technical Assistant, in making available samples of the product as well as the general support provided.

The project received valuable support from two firms involved in food processing and distribution. National Cannery Ltd. assisted with the canning of a sample of kernel corn as well as providing an evaluation of the raw material. Food Masters Ltd. assisted with the blast freezing of the products. We convey our appreciation to both firms as well as the personnel involved - Mrs. M. Applewhite, R & D Officer of National Cannery Ltd. and Mr. Nathaniel Lord, Production Manager of Food Masters Ltd.

Finally, we wish to thank our secretarial staff in the Department of Agricultural Economics and Farm Management for the support provided.

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