Establishing Cucumber Production in Lesser Developed Countries: An Absolute Cost Advantage of Mexico versus Hispaniola Producers

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SUMMARY. During winter months, a substantial volume of various horticultural products are imported to the United States from the Caribbean and Central and South America. United States cucumber (*Cucumis sativus* L.) processors who market fresh-pack and refrigerated products require raw product daily to meet consumer demands. Mexico serves as a single-source supplier to all United States processors during this period, and thus Mexican production represents certain price risks. United States processors would consider other growing regions to reduce these risks if financially attractive alternatives could be identified. Therefore, a project was initiated to acquire information on production and export costs in Hispaniola (Dominican Republic and Haiti), and to compare those to Mexican and United States production and transport costs. Experimentation lead to the identifi-

cation of the critical influences of market prices, costs and conditions for the financial feasibility of establishing a processing cucumber industry on Hispaniola. Comparative evaluation indicated that significant variation in total cost was caused by fluctuations in transport, tariffs, and labor cost components. The causes of variation in transportation costs were distance, method (sea, air, truck), competitive demand (volume), and shipping frequency, consistency, and capacity.

The demand for nutritious, high quality horticultural products in the United States is increasing (USDA, 1993). Fruit and vegetables represent a significant portion of the total U.S. agricultural imports (about \$30 billion in 1995) (USDA, 1996). While the value of vegetables produced in the United States is relatively large (about \$11 billion), it imports ≈9% (about \$1 billion) of its total fresh vegetable produce (USDA, 1993). Although horticultural products are imported from the Caribbean and South America, Mexico is the major source of all U.S. fresh or frozen vegetable imports (≈69%) (USDA, 1996).

Close inspection of crop-specific markets can often lead to a better understanding of the risks and feasibility involved in the establishment of foreign export industries dedicated for U.S. import. Cucumber could be used as a model horticultural crop for this purpose because of the U.S. processing industry's year-round requirement for raw product, the crop's growing requirements, and its labor-intensive production demands. Since winter production of cucumbers (November to April) is not possible in the United States, processors must contract with foreign growers to meet consumer demands for fresh pack and refrigerated products. To meet this demand, the crop undergoes successive intensive harvests, resulting in large volumes of perishable fruit which require processing shortly after harvest.

About 586,980 t (647,024 tons) of cucumbers for processing are produced on 44,172 ha (109,150 acres) in the United States between April and October. The volume of raw product is relatively stable and valued at \$126 million (USDA, 1992, 1994). Mexico serves as a single source vegetable sup-

plier to many U.S. processors during winter months. The U.S. imports ≈230,969 t (254,595 tons) of cucumbers for processing valued at about \$99 million from Mexico and ≈20,004 t (22,050 tons) of cucumber valued at about \$8 million from other countries (USDA, 1996).

Because U.S. processors rely heavily on imports from Mexico, there is a single source risk of cucumber imports during winter months (USDA, 1996). Sudden cost increases occur when political instability, exchange rate volatility, inclement weather and/or the infestation of pests and diseases periodically interrupt this primary supply of cucumbers. Such interruptions may require processors to either temporarily shut down a processing facility or acquire raw product from alternative open market sources. During this gap in product supply, open market prices can dramatically increase the cost of raw product (sometimes >100% of production contract prices), thereby causing significant price and shut-down cost risk to U.S. processors. Thus, U.S. cucumber processors have attempted to acquire investment risk analyses regarding possible production sites (G. Mader, personal communication), and would consider alternative growing regions to reduce risks and to improve import predictability. Such data have been difficult to obtain because of the lack of consistent reporting and rigorous experimental design. Accurate export and production data, if it were available, would allow for the construction of models for international business development of cucumber and other vegetable imports. For these reasons, an experiment was initiated to determine whether processing cucumbers could be competitively grown and transported to U.S. processors from Caribbean locations between November and April for packing and quality assessment. If production areas competitive with Mexico could be identified, then the risk of single-sourcing cucumbers might be substantially reduced.

The Dominican Republic (DR) and Haiti, which occupy the island Hispaniola, were selected for experimentation because of their proximity to the United States [1215 km (750 miles) southeast of Florida], their socioeconomic infrastructure and their agricultural base. Information was acquired which defined cucumber pro-

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duction costs in Caribbean locations where a processing cucumber industry did not exist. The agricultural assessment presented herein compares production costs in Haiti and the DR to those of Mexico. Production cost comparisons among these countries allowed for the identification of factors important for the establishment of a cucumber industry in the Caribbean. United States production data by Shapely and Dudek (1991) were used to provide cost comparisons between domestic and foreign processing cucumber production and to define a baseline for future feasibility analyses.

Materials and methods

A series of variety and production trials were conducted that included a cooperative effort among USDA-Agricultural Research Service (ARS); the University of Wisconsin, Madison; Instituto Superior de Agricultura (ISA); U.S. Agency for International Development (USAID) located in Haiti and the DR; and Pickle Packers International, Crystal Lake, Ill. (a trade association for the cucumber industry). The experiment was partitioned into variety testing, production evaluation, and export evaluation.

VARIETY TESTING. Initially, a series of replicated small-plot variety trials (49,000 plants/ha, 20,000 plants/acre) were conducted to obtain preliminary production data for the identification of potentially useful varieties for larger trials. These trials were conducted on test fields at the ISA campus, Santiago, DR, and on growers' fields near Port-au-Prince, Haiti. Of the seven U.S. commercial processing cucumber hybrids trialed, 'Royal' (Harris Moran Seed Company, Modesto, Calif.) was chosen for more extensive trials based on its yield potential and fruit quality. Upon completion of small-plot trials, more extensive trials (0.5 ha, 1.2 acres) were conducted in Haiti at Les Cayes, Leogane, and Port-au-Prince, and in the DR at Santiago, Bani, San Cristobal, Azua, and Esperanza. Finally, 1.6 to 3.2 ha (3.9 to 7.9 acres) production trials were conducted in Les Cayes, Haiti and Santiago, DR, to obtain yield data and fruit for transport to U.S. processors. Large plot plant spacing and harvesting criteria were similar to that of preliminary trials, and fruit yield was calculated as weight per hectare.

Variety trials indicated that a yield

of 500 bushels (1 bushel = 26.6 kg = 58.6 lb) per 0.25 ha (0.62 acres) was a reasonable expectation of productivity in any given field (Frenz, 1996). Variety plot and production trialing data were used to determine production costs per bushel and potential profit margins for contracts between growers and exporters. To acquire comparative data for analysis, the fixed yield at 309 bushels/0.25 ha (500 bushels/acre) and cost per hectare of expected output [500 kg (1,102 lb)] were used in the comparison of cost components (Table 1). This was considered to be a processing cucumber yield optima for Hispaniola given the results of the large-scale production experiments (Les Cayes, Haiti and Santiago, DR).

PRODUCTION COST ESTIMATIONS. Data collected provided information used to determine relative costs for production (labor and materials), packing (sorting and packaging) and transport (air, land and tariffs) (Frenz, 1996). Production costs are given as major component categories to include labor, material and fixed costs (Table 1). The categories were converted to costs per bushel by dividing the category cost by the quantity of bushels produced per hectare. Thus, production cost elements (i.e., land preparation, and growth and development) among countries directly affected costs per bushel.

Most of the potential cucumber growers on Hispaniola manage small-scale farms [<1.6 ha (4.0 acres)]. Their investment in machinery is minimal, and the interest paid as landholders can fluctuate drastically depending on social and political conditions. Therefore, the effects of interest, depreciation and profits on long-term competitiveness were not considered and provide certain biases in the production assessment. For instance, the exclusion of interest and depreciation sharply biases data for the United States relative to other countries due to differences in capital intensity.

Only the location in Les Cayes, Haiti was directly supervised by the authors. After several seasonal plantings, multiple harvest yields at this location were comparable to average yields achieved in Mexico [≈ 1235 bushels/ha (500 bushels/acre)] (Carl Jankay, personal communication). This average was used in comparisons for analysis and interpretation. The Les

Cayes location furnished the raw product that was delivered to the U.S. processors to test quality and acquire transport data for analyses. Cucumber production and export data from Mexican growing areas were collected from the Celaya, Mexico under the direction of Vlassic Foods, Inc. production staff. Data collection in Mexico was similar to those used in Hispaniola experiments, and thus direct cost comparisons (production and export) could be made among experimental locations.

EXPORT EVALUATION. Considerations were given as to how and when raw product could be exported from Hispaniola (Frenz, 1996). Data were collected on production (e.g., land preparation and labor) and transportation (e.g., truck, sea and airfare) costs and converted into U.S. dollars (\$) at existing bank exchange rates for comparison. Sea and air transport firms were contacted and cost comparisons were made based on quotations of then current freight prices and the time required for raw product to reach U.S. processing plants. Because truck freight containers typically hold ≈ 800 bushels [21.3 t (23.5 tons)], transportation costs were calculated based on the shipment of such containers. Data were collected on the segmented transportation costs from the fields to the packing facility, from packing facility to the border and then from the border to the U.S. processor. These segmented transportation costs were added together to derive the total transportation costs as a component. Quotations of the transport costs were obtained from local sources and domestic freight carriers (Frenz, 1996).

Refrigeration costs of sea transport were found to be costly and transport schedules not dependable (Frenz, 1996). Therefore, the feasibility assessment presented herein only considers air transport (Tables 2 and 3). In-country (U.S. and Hispaniola) trucking costs for imports were tabulated as those expenses required for shipment from the field to Hispaniola export facilities and then from U.S. ports of entry to processing facilities.

Results and discussion

The analysis uses the production and export variables examined (i.e., cost components), and describes the absolute advantage of a country for each component (Tables 1 and 2). In

general, financial feasibility is influenced by the total costs of production and export in each country examined (Tables 1–3). More specifically, financial feasibility is most influenced by the transport component of total cost, followed in order of relative importance by tariffs, labor, export management, and production materials. Other influences analyzed were available technology, foreign currency exchange, fixed assets and global price.

TOTAL COSTS OF PRODUCTION AND EXPORT. Production analyses used the significant input items (components of cost) based on several trials, and describes the comparative costs as expressed as inputs based on bushels/0.25 ha (0.62 acre) (Tables 1 and 2). The segmented transportation costs (i.e., field to packing facility, packing facility to U.S. border and then to U.S. processor) are taken collectively as total freight and handling (Table 2).

Data indicate that, given the production and export constraints observed in this study, the delivery of a quality product from Hispaniola is

possible at costs competitive with Mexico (Table 3). Export production feasibility was indicated by the delivery of a quality product from specific locations in the Caribbean, price to processors, and growers' cost comparisons (Table 2). To ensure the delivery of a quality product, the experiment was completed under conditions of intense collaborator supervision. Extensive data was collected on costs and problems related to production and transport. These data then became the basis for comparative analysis with Mexican and U.S. production (Table 1).

The initial criteria for feasibility is the comparison of total costs per bushel [based on U.S. dollar (\$)]: \$13.18 for the DR, \$9.64 for Haiti, \$10.08 for Mexico, and \$6.53 (summer months only) for Michigan (Table 2). The reasons for a country's potential as a cucumber exporter can be deduced from line by line comparison of the cost of each input and price. These calculations provided the information necessary to determine total costs to the processor given a receiving site in

the northern United States (Claussen Pickle Company, Woodstock, Ill.) (Table 3). Components are presented as a percentage by dividing the costs from Table 2 by the highest cost \$13.18 (set at 100%).

Table 1 provides detailed production costs per ha among the four countries. With all costs expressed per bushel, the most significant costs of production and transport are identifiable. In 1990, the production cost of 1 bushel from the DR was \$1.36, Haiti was \$1.23, Mexico was \$1.99, and the United States was \$6.37. The transportation cost of 1 bushel from the DR was \$9.59, Haiti was \$7.36, Mexico was \$5.54, and the United States was \$0.17 (Table 2). The relative costs are easier to compare when dollar values are changed to percentages (Table 3). Transportation was identified as the major component of the cost of the delivered product from outside the United States.

INFLUENCES OF TRANSPORT COST. Considerations were given as to how and when raw product could be ex-

Table 1. Comparison of costs to produce processing cucumber in four countries.

Cost components	Preunit production costs (U.S. \$/ha) ²			
	Dominican Republic	Haiti	Mexico	United States ³
Exchange rate conversion ^x	6.28:1	5:1	3000:1	1:1
Land preparation				
Plowing	10.25	20.24	16.19	Combined ^w
Crushing	12.31	16.34	16.19	Combined ^w
Bed making	4.10	4.04	8.10	Combined ^w
Subtotal land preparation	26.66	40.49	40.49	Combined ^w
Fertilizer	160.28	137.25	143.93	53.00
Insecticides	45.88	15.40	115.72	12.64
Fungicides	32.55	11.20	Combined ^y	16.00
Nematicides	23.07	93.50	Combined ^y	Combined ^y
Machinery and related	Combined ^w	Combined ^y	combined ^w	336.37
Seeds	12.31	Combined ^w	Combined ^w	39.75
Total	300.75	297.97	300.13	457.76
Growth and development				
Planting	20.51	9.00	14.04	20.70
Weed control	41.02	33.00	35.09	37.80
Irrigation	30.76	16.75	13.49	11.34
Fertilizer application	46.15	12.00	15.18	Combined ^w
Vine handling and training	30.76	16.66	17.54	1.80
Pesticide application	30.76	5.00	15.18	5.40
Harvest labor	164.08	206.42	505.26	1,430.50
Total labor costs	364.04	298.83	615.79	1,507.54
Fixed costs	Combined ^w	Combined ^w	Combined ^w	1,090.42
Land rental	15.38	20.24	80.97	128.75
Total	15.38	20.24	80.97	1,219.17
Total production cost	680.18	617.04	996.89	3,184.47

²Fixed yield at 500 bushels/0.25 ha (690 bushels/acre).

³Michigan grower data (Shapley and Dudek, 1991).

^xAccording to average rates December, 1990.

^yAs a component of the section total.

^wCombined with insecticide costs.

ported from Hispaniola. The freight cost of \$9.59/bushel from the DR was 78.8% of the total cost, \$13.18, Haiti's freight cost of \$7.36 is 76.2% of total cost \$9.64, Mexico's freight cost of \$5.54 is 55.0% of total cost \$10.08, and U.S. freight costs of \$0.17 are only 2.6% of total cost \$6.53 (Tables 2 and 3). Airline transportation from Haiti (\$5.00/bushel) and the DR (\$7.00/bushel) was substantially higher than truck costs from Mexico to the border (\$3.00/bushel).

Based on quotations from freight forwarders and growers, sea freight was about \$4.00/bushel from the DR (Frenz, 1996). Despite this low cost, sea delivery frequency and speed were inadequate from Haiti and the DR during 1989-91 for processing cucumber export. Processors require delivery of raw product within 5 to 7 d from harvest to ensure product quality. Sea freight is often as infrequent as once a week, and delivery to Miami cannot be expected in <4 d. Transferring raw product from sea freight to truck freight and then delivering it to the processor requires an additional two to three days. With the establishment of a vegetable industry, it can be predicted that sea freight will improve to match the delivery requirements of

the industry. This potential lower-cost sea freight would then replace the higher-cost air freight, therefore making freight cost from the Caribbean more competitive with that of Mexico.

The freight cost from the receiving facility to the U.S. processing plant depends upon the trucking distance. While costs of growers located within 161 km (100 miles) of U.S. processors are as low as \$0.17/bushel, the costs of shipping from Florida to Illinois processors are comparatively high (e.g., \$2.11; Exotic Fruit Importers, Inc., Miami, Fla.) (Frenz, 1996). The location of the processing plant is a critical freight cost component to all U.S. growers, especially when international sourcing alternatives are competitive.

Data from the experiment includes variations from the expected average costs (Frenz, 1996). For example, the contracted price for air freight fluctuated in Haiti from \$5.00 per bushel (\$0.19/kg, \$0.09/lb) to \$11.00 per bushel (\$0.42/kg, \$0.19/lb), and depended on airline companies' demand for air freight. Evaluation of cost variations from the expected mean value is the subject of Frenz and Staub, 1999. The values presented herein are based on international strategic alliances between participants (e.g., grow-

ers and transport companies).

INFLUENCE OF TARIFF. The second most critical cost component was different for each country examined (Table 3). The second highest percentage of total cost was export packing plant cost (12.4%) in the DR, labor or materials (both 6.2%) in Haiti, and tariffs (14.9%) in Mexico. Thus, in the case of Mexico, tariffs represented the second highest cost variation among countries which is most usually caused by governmental intervention. Neither the DR nor Haiti had U.S. tariffs for trade in 1990 (Tables 2 and 3). The 1990 U.S. tariffs for Mexico were \$1.50/bushel that was 14.9% of total costs of \$10.08.

The tariff difference was a primary factor that resulted from the initiation in 1988 of the Caribbean experiment (Table 2). The 1983 Caribbean Basin Initiative (CBI) eliminated U.S. tariffs on cucumbers from the Caribbean. Mexico was not a beneficiary of CBI. The tariff comparative advantage given to CBI countries over Mexico was a significant cost component.

In March 1990, the United States canceled (for one month only) the \$1.50/bushel tariff from Mexico. This foreshadowed the anticipated potential impact of the North American Free

Table 2. Comparison of export costs of processing cucumber among four countries.

Cost components ^z	Export costs (U.S. \$)			
	Dominican Republic	Haiti	Mexico	United States ^y
Labor	0.73	0.60	1.23	3.02
Materials	0.60	0.60	0.60	0.92
Fixed costs	0.03	0.04	0.16	2.44
Production cost per bushel ^x	1.36	1.23	1.99	6.37
Freight to packing plant	0.48	0.25	0.43	0.17
Freight to U.S. border	7.00	5.00	3.00	0.0
Freight from U.S. border to processor	2.11	2.11	2.11	0.0
Total freight	9.59	7.36	5.54	0.17
Export packing plant cost	1.65	0.47	0.47	0.0
Border handling and U.S. fees	0.58	0.58	0.58	0.0
Tariffs	0.0	0.0	1.50	0.0
Total freight and other costs	11.82	8.41	8.09	0.17
Total export costs per bushel ^w	13.18	9.64	10.08	6.53
Grower's production profits ^{v,u}	1.14	1.27	---	---
Exporter's cost per bushel ^{v,u}	14.32	10.91	10.08	6.53
Exporter's profit or loss ^{v,s}	(1.32)	2.09	2.92	---
U.S. costs over 1990 market value ^{w,s}	---	---	---	(2.36)
Processor's cost per bushel	13.00	13.00	13.00	4.18

^zTransport costs per unit (bushel) of output.

^yMichigan cost (Shapley and Dudeck, 1991) less value (USDA, Agricultural Statistics, 1992). Loss given in parentheses.

^xYield per acre is fixed at 500 bushel (1 bushel = 26.6 kg = 58.6 lb) for comparison.

^wTotal export costs per bushel are the transportation margin between the farm gate and processor.

^vEstimated based on market conditions without consideration of interest and depreciation.

^uCaribbean grower's contract price: average \$2.50/bushel.

^sMexico grower's and exporter's profits are combined.

^tExporter' contract price: average \$13.00/bushel. Loss given in parentheses.

Trade Agreement (NAFTA). The United States, Canada, and Mexico completed negotiations on NAFTA on 12 Aug. 1992. The negotiated agreement stipulates that over a period of not more than 15 years, NAFTA will eliminate all tariffs, quotas, and licenses for vegetables among the three countries. A USDA review (Porter, 1990) states that, "The majority of U.S. vegetable exports to Canada and Mexico would have tariffs removed immediately or phased out over a 5-year period." The 18 Aug. 1992 NAFTA Side-by-Side Tariff Schedule classified cucumbers in category A (i.e., immediate phase-out of tariff). The current tariff is as low as \$0.033/kg (i.e., \$0.74/bushel; \$0.013/lb) from 1 July to 31 Aug. \$0.049/kg (i.e., \$1.11/bushel; \$0.022/lb) from 1 Dec. to 28 Feb., and \$0.055/kg (i.e., \$1.24/bushel; \$0.025/lb) from 1 Mar. to 30 June and 1 Sept. to 30 Nov. (USDA, 1995). In 1993, NAFTA was confirmed by the U.S. Senate and House, and by governments of Mexico and Canada. In 1994, NAFTA eliminated the CBI's comparative advantage of tariffs.

The U.S. comparative transportation advantage over Mexico of \$5.37 (Mexico at \$5.54 less U.S. at \$0.17) was approximately two times greater than Mexico's comparative labor advantage of \$1.79 (Mexico at \$1.23 less U.S. at \$3.02). The U.S. total cost absolute advantage of \$3.55 (Mexico at \$10.08 less U.S. at \$6.53) was greater

than the \$1.50 tariff (Tables 1–3). To the extent that 1990 tariffs were designed to protect U.S. labor and domestic investments, the tariffs may not have been required. Changes in the locations of processing plants may alter the comparative advantage caused by transport cost components. Thus, the impact of adjustments in one component cost is dependent on changes in other costs and prices.

INFLUENCE OF LABOR COSTS. Labor was the most critical cost component of total cost in the United States, second in Haiti, third in Mexico, and fourth in the DR (Table 1). As described earlier, production costs such as labor are determined by yield potential and labor costs. The labor rate is combined with yield data and grower's profit incentive to determine labor cost. Tables 1 and 3 provide the per hectare cost of production labor for the DR (\$0.73 and 5.5% of \$13.18), Haiti (\$0.60 and 6.2% of \$9.64), Mexico (\$1.23 and 12.2% of \$10.08), and the United States (\$3.02 and 46.1% of \$6.53). Clearly, Haiti had the lowest relative field labor cost.

Discussions of international trade with developing countries frequently focus on the comparative advantage of lower labor rates. Table 1 confirms the importance of the labor cost advantage since Mexican labor costs were the third highest cost after transportation and tariffs. Since the enactment of NAFTA, labor replaced tariffs as the second highest cost.

However, all cost components (not solely labor rate) must be considered. A more significant component cost, transportation, can frequently overcome the comparative advantage of low labor rates (Frenz, 1996). Mexico's comparative transportation advantage over Haiti of \$1.82 (Haiti at \$7.36 less Mexico at \$5.54) is three times greater than Haiti's comparative labor advantage of \$0.63 (Mexico at \$1.23 less Haiti at \$0.60) (Tables 2 and 3).

When comparisons were made between the DR and Haiti in 1990, Haiti had a labor advantage, a transportation advantage of \$2.23 (DR at \$9.59 less Haiti at \$7.36) and an export packing plant cost advantage of \$1.18 (DR at \$1.65 less Haiti at \$0.47) (Tables 2 and 3).

INFLUENCES OF EXPORT MANAGEMENT COSTS. The fourth critical cost component, export management, reflects export packing plant costs and exporter profits (Table 2). Haiti's comparative cost advantage over the DR was \$1.18 (DR at \$1.65 less Haiti at \$0.47). Haitian exporter's estimated profit advantage was \$3.41 (Haiti at \$1.09 plus DR loss at \$2.32). The DR exporter's estimated loss reflects the unsuccessful efforts by participants to form an DR transport strategic alliance similar to the Haitian alliance (Tables 2 and 3). The strategic alliance that managed Haitian transport tasks and costs obtained adjustments in air freight, shared export facilities and al-

Table 3. Comparisons of costs of production of processing cucumber and transport as a percent of the highest production cost among four countries.^z

Cost components ^{y,x}	Production and transportation costs (%) ^y			
	Dominican Republic	Haiti	Mexico	United States
Production				
Labor	5.5	6.2	12.2	46.1
Materials	4.6	6.2	6.0	14.1
Fixed costs	0.2	0.4	1.6	37.2
Total	10.3	12.9	19.7	97.4
Transportation and packaging				
Freight to packing plant	3.6	2.6	4.3	2.6
Freight to U.S. border	53.2	51.8	29.8	---
Freight U.S. border to processor	16.0	21.9	20.9	---
Freight subtotal costs	78.8	76.2	55.0	2.6
Export packing plant cost	12.4	4.9	4.7	---
Border handling and U.S. fee	4.4	6.0	5.8	---
Tariffs	0.0	0.0	14.9	---
Total freight and handling costs	89.7	87.1	80.3	2.6
Total costs before estimated profits	100.0	100.0	100.0	100.0

^zData from Table 1.

^yDominican Republic and Haiti as air freight and Mexican freight by truck.

^xCosts based on conversion ratio to U.S. \$ for the Dominican Republic = 6.28:1, Haiti = 6:1, and Mexico = 3000:1.

located fixed costs among other exported crops [e.g., mangos (*Mangifera indica* L.) from Haiti] (Frenz, 1996).

The absence of a competitive cluster of exporters is both a business and economic development issue according to Porter (1990). Porter's economic development model proposes enhancing the exporter-grower interaction by focusing on the clustering of industries rather than on factor-sensitive industries. A competitive cluster of DR exporters was not identified to coordinate harvest and export ISA plot (Frenz, 1996). The absence of competitive exporters was reflected in the higher costs of export from the DR than from Haiti. Collateral studies provided additional data to support this determination of higher DR export costs (Frenz and Staub, 1999).

INFLUENCES OF PRODUCTION MATERIALS. The relative effect of the fifth critical cost component, production materials, was also a function of material costs and yield potential. Production materials were estimated to cost about \$0.60/bushel in all locations outside of the United States (Tables 1 and 2). This and other cost components are <6% of the total cost. Thus, changes in any one of these components even if adequately managed are not likely to significantly alter investment decisions at any particular production location.

INFLUENCE OF CURRENCY EXCHANGE RATES. The rate of currency exchange can fluctuate significantly, especially in developing countries. The calculations in Tables 1 and 2 were based on bank quoted currency conversions at averaged 1990 rates. The comparisons of costs can alter significantly if the black market is used for currency exchange rates instead of 1990 bank rates. For instance, the DR bank exchange rate used in 1990 was DR \$6.28 to U.S. \$1.00, whereas the 1990 black market rate was DR \$8.00 to U.S. \$1.00 (Frenz, 1996). Exchange rates can also vary significantly over time. The DR bank rate and black market rate (DR 15.00 to U.S. \$1.00) were approximately equal in 1995, however, at a higher than 1990 exchange rate. The Haitian growers and advisors indicated that the anticipated benefit from currency conversion was the major factor that induced them to participate in the study and plan for cucumber production for export. The Haitian currency exchange market appears unregulated

because transactions take place freely among vendors and customers at major street corners in Port-au-Prince. Thus, their interest in currency conversion stemmed primarily from their anticipation of currency devaluation that occurred regularly and the fact that they could barter for better exchange rates in their domestic unregulated market.

INFLUENCE OF FIXED ASSETS AND INTEREST. Fixed assets, interest and profits are other components that are not adequately reflected in Tables 1 and 2. Many U.S. growers have invested significant capital for improvements leading to more efficient and effective cucumber production. The U.S. production cost presented includes approximately \$2.00/bushel to amortize these costs (USDA, 1995). Many of these costs are fixed (e.g., grading and hydrocooling equipment), and benefits from ownership of specialized equipment can only be realized by continued operations.

The U.S. availability of capital and credit differ from the financial conditions in developing countries. Capital shortages and lower labor costs cause Caribbean and Mexican growers to use less capital intensive methods (e.g., mechanical harvesters, sophisticated hydrocooling facilities) (Frenz, 1996). Therefore, production shifting to other crops (e.g., cucumber) may not result in significant capital loss. However, in most instances Caribbean growers would need to acquire some equipment (e.g., irrigation, grading, hydrocooling and washing facilities) in order to deliver quality raw product. This equipment can be used for cucumber and export production of other fruit and vegetables.

INFLUENCES OF GLOBAL PRICING. Costs of products and services constantly change, especially in global markets. Therefore, in order to more accurately evaluate export production feasibility the proceeding cost analysis (Tables 1-3) must be considered in light of global processing cucumber prices and possible substitute product prices. The following are examples of factors that can cause major changes in cucumber prices, but are not reflected in the data presented (Frenz, 1996). Brined cucumber prices are relevant to the study of processing cucumbers because the export-production development process for new growing locations generally begins with salt brined

products. In 1987, the price in Florida of small brined pickles was over \$25.00/bushel. By 1990, Sri Lanka and other countries had flooded the cucumber market with salt brined products. As a result, brined prices dropped (to \$20.00/bushel) and at times cucumbers were destroyed before transport to the United States because market prices were less than transport costs.

Another change in the global market occurred in 1991 when raw product from Honduras entered the U.S. market. Honduras has a competitive advantage for the delivery of processing cucumbers since its sea freight (mainly the banana trade with the United States) is both faster and more frequent than that of Haiti (Frenz, 1996). Even if Haiti has comparative advantages of labor and other cost components, these probably do not overcome the lower costs of Honduras' sea freight as compared to Haitian airfreight. Thus, Haiti may not be competitive as a Caribbean source of processing cucumbers unless its sea freight service improves in frequency and speed.

INFLUENCE OF GOVERNMENT AND POLITICS. The effect of political situations on trade is also a factor that must be considered when determining the feasibility of export production. Haiti's political instability, for example, significantly affected the experiment (Frenz, 1996). The coupe in 1991 occurred on the same date that a follow-up trip for extending the experiment was scheduled. The resulting embargo prevented future trips and all cucumber trade, thus prematurely terminating the project. Although such factors were not considered as components in the study (Tables 1 and 2), they have considerable impact on the feasibility of Caribbean vegetable production.

During this experiment raw product was successfully delivered from Haitian growers to U.S. processors, a participant network was established, production data were collected and causes of variation in the data were identified. Data from variety and export production trials led to the identification of the critical influences of prices, production and export operating costs. An analysis of these operating costs and other financial costs and conditions led to an assessment of the feasibility of establishing a processing

cucumber industry in the Caribbean; most specifically on Hispaniola. Our study is the first published feasibility analysis for processing cucumber production in the Caribbean. Future feasibility analyses can use the cost and price components for production evaluation and comparative cost analyses.

Price and cost components among four countries (Haiti, the DR, Mexico, and the United States) were compared to determine the absolute advantages of cucumber production in each country. The results of this comparison determined that the principle influences of severe variation in total cost were caused by variations in transport, tariffs, and labor cost categories. The causes of variation in transportation costs were distance, method (sea, air, truck), frequency, consistency, capacity and competitive demand. The primary cause of variation in transport costs, labor availability and rate, and tariff was growing location. This study identified the components of purchasing risk for U.S. processors (e.g., potential grower contract forfeiture and delays in shipments). Nevertheless, international strategic alliances caused growers to deliver product to U.S. processors and participants collected data on costs, risks and critical tasks of production and export.

The delivery of a quality product from the Caribbean to U.S. processors and to fresh market distributors as well as the production and transport data (Tables 1 and 2) indicate that sourcing cucumber from the specific locations in the Caribbean is feasible. Nevertheless, given current overall political and economic conditions in Haiti and the DR, cucumber production in Mexico is more attractive. The comparative analysis of component costs, as well as other factors described above, provides an explanation for such an advantage. However, diversified production from Mexico to the Caribbean based on contracts with higher but acceptable costs may provide an attractive investment option to reduce risk (Frenz and Staub, 1999).

The strategic alliances and the participants' consequent ability to overcome unforeseen obstacles were criti-

cal influences of experimental development and success. Thus, U.S. processors only indirectly influence the development of cucumber production in Hispaniola (i.e., through grower contracts).

The evaluation of variations from the planned experiment provides critical lessons on the sustainability of processing cucumber export production on Hispaniola. Mexico currently is more attractive for the U.S. processor. Purchasing is only a component of industry development. Therefore, an evaluation of marketing risk from the growers' viewpoint is required to more fully consider establishment of a processing cucumber industry in the Caribbean (Frenz and Staub, 1999).

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