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A farm level comparative study was conducted to determine the extend to which the production component of the tomato industry of Panama is competitive with its American producer counterparts in California. In addition, processing costs, and marketing conditions/costs are factors that determine a competitive potential. The objective of this study was to examine the role and importance of the farm production cost component as an initial stage.

A comparison of representative farm cost budgets was made between San Joaquin Valley, California, and Los Santos, a Panama province. Data for California production was obtained from publications of the University of California and the Cooperative Extension Service for Contra Costa, San Joaquin and Stanislaus Counties. Data for Los Santos was obtained from publications by the Agricultural Research Institute of Panama (IDIAP), a governmental Panamanian institution, and the agricultural technical service of Nestle. The data provided levels of input use and their cost for field operation practices commonly or typically found in each setting. Average total cost per ton was used as the standard for comparing competitiveness between United

States and Panamanian producers. Initial examination showed Los Santos growers to have considerably lower production costs per acre but considerably lower yields per acre as well. Nevertheless some one-half of the Los Santos growers appear to be competitive. Recognition that 25-30% of all labor reported is unpaid operator and family made fully two-third of Los Santos growers competitive with their California counterparts. This left some one-third of Los Santos producers with low yields and resulting high unit costs/acre such as to be non-competitive.

In comparing resource use influences, it was found that Los Santos growers use considerably higher levels of fertilizers, pesticides, and insecticides than growers in California, a probable consequence of Panamanian government subsidy of these materials. Some Panamanian reports suggest overuse of those materials.

A marked contrast exists between the California and the Panama cases in relative resource mix. For Panama, labor was the dominant resource with a use level of 508 hours/acre at an average wage of 62.5 cents/hour. This contrasts with California where Capital intensive, labor saving machinery dominates resulting in only some 40 labor hours/acre at an average wage of $9.80/hour. Los Santos used 13 times more labor/acre in part because its wage structure is less than one-tenth as expensive as in California. The results suggest that, based upon the induced innovation hypothesis of Hayami/Ruttan, further agricultural research in Panama to improve agricultural productivity in processing tomatoes should continue to be labor using as the most abundant resource and land and capital saving which are relatively more scarce. This suggests biological research to improve yield and intensify land productivity while continuing with a labor, rather than machine, intensive mode.

Finally, this study reviewed briefly the current two-price policy for domestic tomato production and for export. It found it to serve as a major inducement to increase domestic production while conversely serving as a major deterrent to produce for export. Major costs of this system are borne by the public sector for the producer subsidy and Panamanian consumers of processed tomato products who subsidize Nestle's loss of revenue in the export market through higher retail prices for processed tomatoes products.

Industrial Tomatoes in Panama: A Comparative Analysis of its Competitive Potential in the United States Market For Panamanian Producers

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CHAPTER I

INTRODUCTION

Statement of the Problem

The Republic of Panama is located in the southern tip of Central America. By World Bank criteria, Panama is classified as an upper middle income country with per capita GNP of $ 2330 in 1985. The economy of Panama, given its strategic geographic location and the Panama Canal, is service sector driven. Some 69 percent of GDP is generated by transportation, communications, banking, insurance, commerce, tourism and the public sector which includes government services. Collectively, the service sector utilizes about 60 percent of the country's employed labor force. Agriculture production and processing as a combined sector ranks second in importance and utilizes some 10 percent of the employed labor force (1985). Underemployment, unemployment and disguised unemployment were estimated in excess of 25 percent in 1987 and subsequent to the United States invasion in December 1989, likely has risen to over 30 percent (Kurian, 1987).

Agriculture, which includes production agriculture, coastal fisheries and forestry production, employed some 26 percent of the labor force in 1985. This reflects a major decline from 46 percent during the previous 20 year period. Several government policies have influenced this decline. These include major government expansion of public employment since 1970 in which the state has provided 80 percent of all new jobs; introduction of costly and inefficient state production and marketing activities in agriculture; labor market distortion favoring the urban sector; deferred labor market entry by free education through the university level; major price and production controls in agriculture which subsidized consumers; and labor substitution in production agriculture through subsidized mechanization schemes. The result has been major migration from the country side to urban areas. However, agriculture continues as the major source of export earnings, contributing 85 percent of merchandise exports and 70 percent of total exports in 1984 (Dirección de Estadística, 1988; Federal Research Division, 1989; and Conklin, 1986).

By the early 1980's Panama was suffering serious balance of payments deficits as were other third world countries due in part to dependency upon oil imports for energy requirements and declining export revenues. Additionally, the government's use of external financing and deficit spending to implement its costly domestic program led Panama's public debt to grow to 92 percent of GDP in

1983, an untenable condition. This mobilized the World Bank to institute structural adjustment reforms as preconditions for restructuring existing loans and eligibility for new loans. One consideration for reducing Panama's economic crisis is through enhanced export earnings. In this context the agricultural sector is viewed as having considerable potential for expanding its contribution to Panama's international trade. Governmental policies to encourage agricultural exports through reduced trade restrictions and improved productivity are expected to facilitate this change.

The principal agricultural commodities produced in Panama for domestic consumption are food crops (rice, beans, corn, yucca), livestock (beef, chicken, pork), fish, horticultural crops and tropical fruits. Agricultural commodities produced for export include bananas, sugar cane, coffee, shrimp, fish meal, fruits extracts, hides and beef. Small but increasing amounts of specialty crops including melons and cut flowers are being exported. Horticultural crops grown for domestic consumption include potatoes, onions, carrots, cole crops and tomatoes (Conklin, 1986 and Kurian, 1987).

Tomatoes are the most important horticultural crop in terms of land use. They are produced on about 2000 hectares and account for nearly half of total hectarage devoted to horticultural crops. Essentially all tomatoes are grown for industrial processing. Tomatoes are processed into paste, sauce, juice and ketchup products. For unknown reason very few are produced for the fresh market.

Tomato production was introduced in the late 1930's. It developed with government support and protection to both producer and the sole processing company, Panamanian Food Company (CPA), a subsidiary of Nestlè International. The government has a total ban on tomato imports. The government has encouraged Nestle to pay growers high prices under specific production quota limits. Growers are paid 7-8 cents per pound, about three times the world price, which creates strong producer incentive to increase production. Since 1984 production has exceeded domestic demand. As a consequence Nestlè implemented a two-price system to permit excess production to enter export markets (MIDA-DNPS, 1985).

It is evident that further expansion of tomato production for industrial processing and sale will require reliance upon external markets. Whether Panama can compete in those markets, thereby effectively expanding domestic production potential, is not known. To answer this question requires an understanding and analysis of three separate but important components of production and marketing in Panama. These components are (a) farm level production and efficiency, (b) processing cost efficiency and value added, and (c) transportation / distribution charges for entry into international markets. This study initiates that process by focusing upon the production component. The objective is to compare production efficiency of Panama producers with producers in California, both of which produce tomatoes for the industrial processing market. Processing and distribution studies will need to be conducted following this study to complete the analysis.

Method of Study

The purpose of this thesis is to compare the technological and economic characteristics of tomato production, at farm level, between Los Santos, a province of the Republic of Panama, and central California. Both regions produce tomatoes for industrial use.

Several objectives will be met in conducting the comparison. They are to a) determine the level of competitiveness of the Panamanian tomato producers in international markets, b) the level of factor use intensity for each location, and c) the sort of technological changes that might be suggested for Panama given its level of comparative efficiency.

Statement of the problem, the method of study, and literature as a theoretical base for the procedure used in this comparative study will be reviewed in Chapter I. Description of field operations of tomato production in each region is conducted in Chapter II. Comparative analysis of cost components and relative factor intensity is conducted in Chapter III. Chapter IV covers conclusions and recommendations and study limitations.

Review of Literature

According to John Ikerd et. al, 1989, international competition may be defined as the effort of two or more countries, acting independently, to secure a share of a specific world market by offering more favorable prices and / or other conditions of trade. But many differences in international trade such as government policies, world politics and many economic considerations such as currency exchange rates, import and export restrictions, credit policies, shipping rates and regulations and many other factors normally play a very important role and may outweigh price differences in the short run. However, competitive commodity costs are required for a sustained high level of export trade.

Comparative advantage is linked with the concept of opportunity cost. Opportunity cost is the value of production of a commodity which is foregone, having chosen the production of another commodity instead. With appropriate efficiency selection under Pareto optimality, the opportunity cost of a commodity foregone is always less than that actually chosen. Opportunity cost is measured as the inverse of the efficiency ratio. It is the ratio between the number of units of the commodity that are given up divided by the amount of units of the commodity which will be produced instead, using the same set of resources. Comparing economic efficiency between two countries and same two commodities, the country with the greatest efficiency ratio in one commodity has the lowest opportunity cost and it is said to have a comparative advantage in that product.

Translating comparative advantage into competitive advantage it is done in terms of marginal production for both commodities to better utilize a given set of resources. Then, a concept of marginal opportunity cost is used and it is defined by Ikerd, et al, 1989, as the potential increase in production of one commodity or its positive marginal product divided by the associated decrease, or negative marginal product of the alternative. Competitive advantage will reflect the ability of one country to compete with other countries for a given international market. The country with the lower marginal opportunity cost will have the greater competitive advantage at any given market price.

Among nations that may hold a competitive advantage in the same market for the same commodity at any given point of time only one country will be realizing a greater return over its opportunity cost and thus will be more competitive than the other. This nation with the stronger competitive advantage will be able to compete for that market under less favorable market and cost conditions than will competing nations. Therefore, this nation, other things equal, will be more likely to maintain and increase its share of that market than will the less competitive countries.

Limitations in competitive analysis exist using production cost comparisons across nations. John Ikerd et.

al, 1989, states them as:

> ...Comparisons of production cost across countries have limitations in competitive analysis which should be noted. First, alternative uses of resources are not specifically considered, thus there is no unique way to translate budgeted cost into opportunity cost. Second, components of production cost in one country may be different from those included in production cost in another. Third, exchange rate changes affect relative costs, even though the absolute level of cost has no changed.

In this sense this study considers some aspects that might minimize two of these limitations. For the first limitation, it is unknown what the specific opportunity cost of growing crops other than tomatoes in Panama. However, tomatoes are grown in rotation with other crops and because of high prices tomato acreage expansion has been desired in Panama, suggesting a high historic opportunity cost. Such an opportunity cost under world market prices is unknown. For the second limitation, in order to compare production costs between countries, cost components are classified by four general resource categories, land (R), labor (L), machinery/equipment/buildings (M/E/B), and materials (M), for each country in the attempt to differentiate relative resource endowment influences upon the input mix in each case. In addition, Chapter II describes the characteristics of tomato production for each country, Panama and the United States, which affect, directly or indirectly, the resources and technologies used within each resource category. Ikerd's limitation is a non-issue since Panama's currency is the United States dollar. Consequently cost comparisons between the United States and Panama do not require currency correction (Federal Research Division, 1989).

However, John Ikerd et. al, 1989, mentions that in spite of these limitations, an examination of cost and returns still grants some insight into a country's competitive position. Relating these average variable costs to the level of prices results in an incentive to produce either more or less, and their interpretation will serve as an indicator of competitive potential.

The induced innovation model is applied as a mechanism to define the sort of technologies that might be suggested for future Panamanian research on tomatoes for processing to enhance its current level of comparative efficiency. Induced innovation theory introduced by Hayami and Ruttan, 1985, suggests that technology is developed to facilitate the substitution of relative abundant (hence cheap) factors for relatively scarce (hence expensive) factors in agricultural production. For example, in an economy characterized by a relative scarcity of labor and a relative abundance of land and capital such as the United States, substitution of land and capital for labor is made possible (induced) by improving agricultural implement and machinery technology which saves on scarce labor and more effectively utilizes cheap land and capital. Likewise, in an economy with relative scarcity of land and capital and relative abundance of labor such as Panama, new technology in the form of improved crop varieties serve to facilitate (induce) the substitution of fertilizer (or other inputs) for scarce land and capital while permitting continued intensive use of labor.

New techniques such as new husbandry practices or new varieties are not substitutes for labor, land or capital by themselves; but they are inputs which behave as catalysts to facilitate the substitution of the relatively scarce factors for the less scarce factors. Some other authors such as Steven and Jabara, 1988, call these techniques as "neutral factors" or "complementary factors".

Using the original definition of John R. Hicks, 1966, it seems reasonable to call technique designed to facilitate the substitution of other inputs for labor as "labor saving", for land as "land saving", and for capital as "capital saving".

Using the Hayami and Ruttan, 1985 taxonomy in furtherance of biological technology is suggested as it is both "land saving" is related with "capital saving". In this sense, biological technology is designed to facilitate the substitution of labor and/ or industrial inputs for land. As is mentioned by Hayami and Ruttan this substitution may be established through increased recycling of soil fertility by more labor-intensive conservation system; through use of chemical fertilizer; and through husbandry practices, management system, and inputs (insecticides) that permit an economically optimal resource mix.

CHAPTER II

CHARACTERISTICS OF TOMATO PRODUCTION IN CENTRAL CALIFORNIA AND LOS SANTOS, PANAMA

This chapter describes the characteristics of tomato production in each country. These characteristics include field operation practices, cost components, prices, and yields. Field operations are treated first followed by a construction of cost components which permit a cross country comparison.

Field operations are presented in the following order:

1. Land preparation
2. Planting
   a. Plant varieties
   b. Planting methods
3. Growing
   a. Thinning
   b. Cultivation - weed control
   c. Fertilization
   d. Irrigation
   e. Pest / disease control
4. Harvest

Characteristics are presented first for California and second for Los Santos.

CALIFORNIA

In the United states, during the past 100 years the location of the production of tomatoes for processing has changed drastically. Maryland was the state where the tomato industry was first established. Then it moved to Indiana. Currently California dominates United States tomato production (Gould, 1983).

By 1983, over 7 millions tons were available for processing. California produced over 85 % of the total volume, Ohio generated 6%, and other states produced the remainder of 9%. The raw product was valued at nearly U.S.$ 500 millions (Gould, 1983).

California was selected for the comparative analysis since 1) California is the dominant producer of tomatoes for processing in the United States and hence the most representative region (Gould, 1983), 2) California's climate is more suitable for tomato production having a longer period of clear and dry weather and uniformly moderate temperature, 65 to 85 F (Gould, 1983), and 3) California's tomato growing season is 250 to 300 days while for east and midwest states is 150 to 190 days (Angell, 1970, Anom 1967, Holles, 1970).

California data used for this study come from representative budgets prepared by the Cooperative Extension Service of the University of California. Budget information for tomato production is available in fifteen (15)

California counties. Producers across California counties use similar techniques with more than 95% of them producing and harvesting mechanically. Harvest methods to a large degree, dictate the land preparation and cultivation practices required for tomato production.

This study uses combined data for Contra Costa, San Joaquin, and Stanislaus counties for production year 1983. These counties were chosen because 1) their cost budgets are representative of the other counties, 2) data for three consecutive years was available, 3) they are in one of the two principal region in production of tomatoes for processing in the United States, the San Joaquin Valley, and 4) cross county comparisons showed comparable field operations and costs.

Land Preparation

The requirements for land preparation are influenced by the mechanized nature of planting and harvesting operations.

Desired field characteristics to facilitate mechanical operations include: 1) level or those with minimum slope, 2) free of stones, large soil clods, high weed population, and trashy residues, and 3) long thereby minimizing time loss from equipment turn around on headlands.

Land preparation generally involves chiseling or plowing, disking and harrowing combined, and land leveling. The topsoil is pulverized to a depth of 3 to 4 inches.

Commercial fertilizer is incorporated during land preparation. Furrows are made of uniform depth. Headlands at the end of the field are required to be smooth, level, and dry and at least 30 feet long to permit turning of machinery (Duarte, 1966). The equipment used includes large land planes, seedbed shape maker, large tractors with trained operators, large chisel, plows, disks, and harrows.

Planting

Plant varieties

Tomato varieties selected for industrial use and processing are those suitable for mechanical harvesting (determinate). They are selected to include the following important characteristics :

1. The fruit sets and ripens homogeneously to permit a single harvest.

2. Plants have moderate vegetative growth to facilitate vine and fruit separation during harvest.

3. The fruit is easily separated from its stem, is firm, and is crack-resistant from machine handling.

4. The fruit is drop resistant; ie. adheres to the vine at maturity.

5. Fruit is resistant to transportation damage in transit.

6. The varieties are resistant to major debilitative diseases including fusarium wilt and verticillium wilt

(Gould, 1983).

Planting method

In California, most of the crop is direct-seeded as opposed to the alternative of seedling transplant. Seeds are sown directly in the field with a mechanical seeder. Seeding dates are staggered across fields to coincide with sequenced delivery of tomatoes to the processor at harvest. To achieve this, fields are block planted in ten day intervals, the longest time that fruit can remain at maximum harvest maturity (Lingle, 1965 and Duarte, 1965). The number and size of blocks will depend on the amount of land available, the number of harvesting machines to be used, and the overall length of the harvest season.

Seeds are sown either in a single or double-rows in 60 inch wide beds to facilitate mechanical harvest. For single-row seeding, seeds are sown in clusters of 4 to 7 seeds every 8 to 10 in. with a seeding rate of about 0.5 lb of seed per acre with resulting populations of 10,000 to 20,000 plants per acre. Double row seeding involves two rows 16 to 24 inches apart on 6-ft. centers and a seeding rate of about one pound of seed per acre with resulting population comparable to single row seeding (Gould, 1983).

Direct-seeding planters also band starter fertilizer and crust-reducing soil additive at time of seeding (Johnson and Wilcox 1971).

Growing

Thinning

Plant thinning reduces plant competition and minimizes root damage. Thinning is done as soon as the second or third true leaf appears. Thinning may be done either by hand or mechanically with a machine thinner. The counties considered in this study thin mechanically. An irrigation is followed after thinning if the weather is dry and hot (Gould, 1983 and Duarte, 1965).

Cultivation-weed control

Cultivation is done 1) to control weeds, 2) to re-build and maintain the furrows for irrigation, and 3) to loosen compacted soil to permit better water absorption and soil aeration.

In cultivation, soil clods are pulverized by mechanical means before the soil is moved into the area around the plants.

Weed control is conducted to minimize uneven tomato plant growth and competition which reduces crop yield. Mechanical cultivation is used with single row seeding. For twin row seeding, mechanical weed control is difficult. Chemical weed control with herbicides then is used with some supplemental manual weed control where necessary.

Fertilization

The amount and formula of fertilizers applied in a soil is a direct result of soil analysis. A generally accepted method of tomato fertilization is to apply a complete N-P-K formula of liquid fertilizer as starter fertilizer at planting time along with a crust-retarding soil additive. If additional nitrogen is applied, it is side dressed at the time of thinning (Gould, 1980; Angell, 1970; Lingle, 1965; and Duarte, 1965). Phosphorous is the most important nutrient that influences fruit quality and yield. Phosphorous fertilization is applied as a basic or starter fertilizer. Potassium fertilization is not necessary in the California counties (Mullen and Osterli, 1983).

Irrigation

Irrigation is important especially during bloom and fruit ripening stages. In general, tomato varieties used for mechanical harvesting require low volume but frequent irrigations. Irrigation is reduced or eliminated as the crop approaches maturity to avoid fruit rot and cracks (Gould, 1983). The average number of irrigations performed is ten per acre (Mullen and Osterli, 1983). Furrow irrigation with ditch siphons are employed. Irrigation sets are changed by hand.

Pest and Disease Control

Pesticides are the dominant means for pest and disease control. They include use of insecticides, acaricides, fungicides, bactericides and nematicides. Disease and insect resistant varieties are used to the extent of their availability. The different kind and pesticide doses depend on the regional pest problems, availability of products, and the recommendations made by the different manufactures and local research/extension institutions (Gould, 1983).

Pesticides normally are applied by ground equipment, until field conditions preclude their use. As vines increase in size then air applications become necessary (Duarte, 1966 and Mullen and Osterli, 1983).

Harvest

Just prior to harvest, manual vine training and spraying of a fruit ripening agent, Ethephon, are employed to facilitate harvest operations (Gould, 1983 and Muller and Osterli, 1983).

Harvest commences when fields are 65 percent ripe. This requires experienced personnel as ripe fruit tend to be hidden by foliage making the field appear to be less mature than actuality. Harvesting is undertaken both during daylight and nighttime hours.

Harvest equipment used include 1) a mechanical harvester, 2) Bulk bins for in field fruit transport, 3) bin trailers or gondola trailers pulled by 4) a wheel tractor equipped with a hydraulic loading device, and 5) a forklift truck to handle the loaded bins in a loading area. Auxiliary equipment for personnel include 6) portable toilets, 7) water source for washing the machine, and 8) a source of drinking water carried on the mechanical harvester (Gould, 1983; O'Brien, 1980; and Duarte, 1966).

Personnel involved in harvesting operations include (1) harvest machine operator and helper, (2) sorters, (3) supervisor, (4) drivers of tractors pulling the bin trailers, and (5) forklift operator (Gould, 1983; O'Brien, 1980; and Duarte, 1966).

Cost/Return Considerations

Cost/return information for California, is displayed in Table 1. This table present total cost per acre of tomato production in the field. Transportation to the processing plant is treated as a marketing cost and not considered here. Cost categories are presented in a two way matrix. Columns represent resource use categories of land, labor, machine/equipment/buildings (M/E/B), and purchased materials such as seed, fertilizer, pesticides, and water costs.

The second column presents hours per acre for the field operations. Columns three and four present cost per hour and total cost for labor. Column five presents machine / equipment and building cost/acre/operation with the cost calculations taken from table 2. Table 2 is an equipment inventory and cost list which derives the overhead cost of depreciation and interest on investment and operating (cash) costs per hour for equipment with various implements used in different field operations. The sixth, seventh, and eighth columns describe the kind, quantity (lb) per acre, and cost per acre respectively for purchased materials. Column nine presents land cost as an average rate for land rent in the area.

A sub total per acre cost column contains the total cost per acre of each field operation cost component and a total per acre cost column represents the total cost per acre for each principal field operation category. The last column specifies the percent of total cost per acre for each principal field operation category.

The rows present cost by sequential field operation categories of seedbed preparation, seeding, growing, and harvest. Additional rows are assigned for rent, non-cash (overhead), and per acre total cost. Overhead costs are substantial on capital intensive operations like California tomato production. The overhead costs of depreciation and interest on investment for the machinery / Equipment / buildings category are presented in Table 2. Note the $597800 investment for the 1200 acre farm of which 300 acres are in tomatoes. Table 2 is used to prorate the overhead costs to tomatoes by field operation categories.

The bottom of the table expresses cost per ton at different yield levels per acre. The range in yields attempts to reflect in some measure the variability in yield which might be expected and its effect upon unit production costs. Actual production cost variation by field operation across growers is not reflected in the averaged representative farm costs presented in this study which are generated by convening a group of farmers and having them, through a consensus generating process, concur on cost components and their magnitudes. Such data is not available but its reality needs to be kept in mind in assessing the competitive potential of Panama producers with their California counterparts.

An additional foot note page describes basic conditions upon which operation costs are calculated. Reference to the footnotes is made in table 2 using a lower case letter notation.

Table 1: Sample cost of tomato production - tomatoes for processing -
Contra Costa, San Joaquin, and Stanislaus counties, 1983

Operation	Hours per Acre	Labor Cost (a) Cost/hour	Labor Cost (a) Total	Machine/Equip./ Bldg. Costs(b)	Materials Kind	Materials Quantity lb	Materials Cost	Land Cost	SUB TOTAL PER ACRE	TOTAL PER ACRE	%
SEEDBED PREPARATION											
Fall (c)										89.30	6
Disc, plow & subsoil											
(120 acres) 2/5 of 1.4	0.56	5.00	2.80	20.66					23.46		
Disc 2x, sub soil 2x											
(180 acres)3/5 of .8 x 2	0.96	5.00	4.80	25.35					30.15		
Landplane 2x (300 acres)	0.64	5.00	3.20	10.36					13.56		
Spring											
Disc 2x	0.52	5.00	2.60	9.61					12.21		
Springtooth	0.10	5.00	0.50	1.30					1.80		
Harrow & roll	0.15	5.00	0.75	1.59					2.34		
List or ridge (fumi.) (d)	0.22	5.00	1.10	3.58					4.68		
Move equipment, set-up, and											
service at 7% of oper. time	0.22	5.00	1.10						1.10		
SEEDING										148.25	10
Sled, shape, incorporate	0.34	5.00	1.70	6.37					8.07		
herbicide ($10.67/lb)					Tillam	6.00	64.00		64.00		
Sow (2 men)	0.56	5.00	2.80	4.23					7.03		
Seed					Seed	1.00	32.00		32.00		
Starter fertilizer					10-34-0	160.87	37.00		37.00		
Move equipment, set-up, and											
service at 10% of oper. time	0.03	5.00	0.15						0.15		
GROWING										354.15	24
Roll, cultivate-sled & Imp.	0.86	5.00	4.30	11.35					15.65		
Thin-machine blocker	0.26	5.00	1.30	3.19					4.49		
Tiller & weed control	0.43	5.00	2.15	8.06					10.21		
Herbicide					Lay-by	n/a	10.50		10.50		
Cultivate & Furrow 1x	0.22	5.00	1.10	2.84					3.94		
Hoe (trim & hoe)	13.12	3.75	49.20						49.20		
Irrigation 10x (e)	12.90	4.00	51.60						51.60		
Ditch-open & close 3x	0.10	5.00	0.50	1.57					2.07		
Irrigation water($12/ac.ft.)					water	4.00	48.00		48.00		
Siphon, dams, shovels					siphon, etc.		3.25		3.25		

Table 1 (cont'd): Sample cost of tomato production - tomatoes for processing - Contra Costa, San Joaquin, and Stanislaus counties, 1983

Operation	Hours per Acre	Labor Cost (a) Cost/hour	Labor Cost (a) Total	Machine/Equip./ Bldg. Costs(b)	Materials Kind	Materials Quantity lb	Materials Cost	Land Cost	SUB TOTAL PER ACRE	TOTAL PER ACRE	%
Fertilization(side-dress)											
Tractor & sled	0.22	5.00	1.10	2.70					3.80		
fertilizer ($0.27/lb)					UN32	100.00	27.00		27.00		
Pest Control, seeding stage											
Ground rig application				5.00	n/a	n/a	15.00		20.00		
Worm control-Air appl. 2x				13.00	mtl.	n/a	36.00		49.00		
Fungic.-appl.+ worm cont.					n/a	n/a	15.20		15.20		
Ethephon(e) air appl.				6.50	Ethephon	n/a	19.35		25.85		
Vine train (f)	0.28	5.00	1.40	1.69					3.09		
Whitener-contract (f)				11.30					11.30		
MISC. OPERATING & GROWING											
Labor Transprotation, supervision, records, office, pick-up truck, interest on operating capital & roadways(calculated at 22% of cash cost shown above).			41.48	24.74			64.17		130.39	159.90	11
MISC. LABOR COSTS											
Soc. Sec., workmen's compensation, transportation, bonuses, unemployment, housing, medical. Calculated at 22% of cash wages.			29.51						29.51		
LAND RENT (g)								225.00		225.00	15
TOTAL CULTURAL COSTS	32.69		205.14	174.99			371.47	225.00		976.60	66
BULK HARVEST (h)										200.66	13
Harvester machine $29/hr	1.44			41.76					41.76		
Harvester driver	1.72	5.00	8.60						8.60		
Electronic sorters, #6,(i)	1.44	3.75	32.40						32.40		
Sorter, supervisor	1.44	5.00	7.20						7.20		
Driver, over time 1-1/2	1.72	7.50	12.90						12.90		
'5th wheel dolly 1-1/2	1.44			2.38					2.38		
Tractor, 1-1/2 (j)	1.44			18.12					18.12		
Mechanic & supervisor	1.72	8.00	13.76						13.76		
Misc. equip., disc, scraper water trailer, pick-up truck	1.44			5.76					5.76		

Table 1 (cont'd): Sample cost of tomato production - tomatoes for processing - Contra Costa, San Joaquin, and Stanislaus counties, 1983

Operation	Hours per Acre	Labor Cost (a) Cost/hour	Labor Cost (a) Total	Machine/Equip./ Bldg. Costs (b)	Materials Kind	Materials Quantity lb	Materials Cost	Land Cost	SUB TOTAL PER ACRE	TOTAL PER ACRE	%
Misc. supplies, drinks, goggles, etc.			3.80						3.80		
Inspection (per ton) 25tons (k)			4.25						4.25		
Unemployment, Soc. Security Workmen's Comp., bonus, etc. of steady employees (l)			9.34						9.34		
Unemployment, Soc. security, Workmen's Comp., insurance on sorters			7.13						7.13		
Addit. charges for seasonal labor, bookkeeping, etc.			4.00						4.00		
Toilets			2.00						2.00		
Taxes on bulk harvest equip. San Joaquin Co. tax rate (m)				21.23					21.23		
Assessments (Association dues, CTRI, leafhopper, etc.) $0.241/ton			6.03						6.03		
<u>TOTAL CASH COSTS</u>--Preharvest + Bulk Harvest			316.55	264.24			371.47	225.00		1177.26	79
<u>OVERHEAD COSTS</u>										307.82	21
Management --5% of 25 tons at $56.00			70.00						70.00		
Depreciation on Equip. and Buildings				152.34					152.34		
Interest on Equip. and Buildings				85.48					85.48		
<u>TOTAL COST PER ACRE</u>	40.73		386.55	502.06			371.47	225.00		1485.08	100
COST PER SHORT TON											
AT 20 TONS/ACRE YIELD	74.00										
AT 25 TONS/ACRE YIELD	59.00										
AT 30 TONS/ACRE YIELD	50.00										

Table 2: Investment cost for tomatoes - 1982 - California
Based on 300 acres of tomatoes on 1200-acre farm

Item	Cost incl. 6% Tax	Annual Use (acres)	Cost per Acre	Life (yrs)	Depre.	Interest @ 15%	Cash Costs per Hour Fuel	Repairs	Total
BUILDING									
Shop, 40' x 60'	35000.00	1200.00	29.17	30.00	0.97	2.19			
Shed, 4,000 sq. feet	20000.00	1200.00	16.67	30.00	0.56	1.25			
TOTAL BUILDING	55000.00		45.84		1.53	3.44			
EQUIPMENT INVENTORY									
Tractor 125 C.D. H.P. (D6DSA)	103000.00	1000.00	103.00	10.00	10.30	7.73	7.70	8.25	15.95
Tractor 90 C.D. Used (HT 11)	12000.00	1000.00	12.00	10.00	1.20	0.90	6.05	6.50	12.55
Tractor 90 W.D. H.P. (2040) used	12000.00	1000.00	12.00	10.00	1.20	0.90	4.40	3.85	8.25
Tractor 125 W.D. H.P.	40000.00	1000.00	40.00	10.00	4.00	3.00	6.60	4.59	11.19
Tractor, used (60 H.P. for bulk trail.)	10000.00	1000.00	10.00	4.00	2.50	0.75	2.75	2.98	5.73
Landplane 12 x 60	13000.00	1200.00	10.83	20.00	0.54	0.81		5.00	5.00
Plow 4 - 16's 2-way	8000.00	700.00	11.42	8.00	1.43	0.86		9.45	9.45
Disc, 18' 24"-blade	12000.00	1200.00	10.00	10.00	1.00	0.75		7.30	7.30
Bed harrow, 3-bed	3000.00	1200.00	2.50	10.00	0.25	0.19		0.55	0.55
Smizer roller, 18' (1)	9600.00	1200.00	8.00	12.00	0.67	0.60		1.80	1.80
Roller (flat)	2200.00	600.00	3.67	10.00	0.37	0.27		0.30	0.30
Sled (plant) incorporator	15500.00	300.00	51.67	10.00	5.17	3.87		6.75	6.75
Sled (cultivating)	4500.00	300.00	15.00	10.00	1.50	1.13		4.65	4.65
Planters (sled)	9000.00	300.00	30.00	10.00	3.00	2.26		3.10	3.10
Ditcher, 54"	5000.00	1000.00	5.00	20.00	0.25	0.38		0.60	0.60
Bedding Tool Bar with fertilizer/ Fumigation Shanks	5000.00	300.00	16.67	10.00	1.67	1.25		0.30	0.30
Saddle tanks and associated equipment for fert. & herbicide rigs (3)	7500.00	700.00	10.71	10.00	1.07	0.80		2.40	2.40
Harvester, new with electronic sort.	185000.00	300.00	616.67	7.00	88.09	46.25	5.50	23.50	29.00
Pick-up, 3/4 ton (4 x 4)	13000.00	1200.00	10.83	3.00	3.61	0.81			
Pick-up, 1/2 ton (3 used)	12000.00	600.00	20.00	2.00	10.00	1.50			
Springtooth, 24' (transport type)	9000.00	1200.00	7.50	10.00	0.75	0.56		4.75	4.75
Siphons, (600) var. sizes @ $2.50	1500.00	300.00	5.00	10.00	0.50	0.38			
Tarps, 200 @ $24.00	4800.00	1200.00	4.00	2.00	2.00	0.30			
Truck with water tank	8000.00	600.00	13.33	8.00	1.67	1.00			
Electronic (blocker) thinner 6 row (3 bed)	10500.00	400.00	26.25	6.00	4.38	1.97		4.03	4.03
5th wheel convertible trailers (2) used	2400.00	300.00	8.00	10.00	0.80	0.60		1.10	1.10
Subsoiler, 10' (ripper)	7500.00	600.00	12.50	10.00	1.25	0.94		4.20	4.20
Ditch closer	5600.00	1000.00	5.60	15.00	0.37	0.42		2.50	2.50
Sprayer-300 gal tank, 10gpm pump	3100.00	1200.00	2.58	10.00	0.26	0.19			
Toilets (3)	1600.00	600.00	2.67	7.00	0.38	0.20			
Tool carrier	2500.00	1200.00	2.08	10.00	0.21	0.16			
Heavy tilt-bed trailer (used)	5000.00	1200.00	4.17	10.00	0.42	0.31			
TOTAL EQUIPMENT	542800.00		1093.65		150.81	82.04			
TOTALS	597800.00		1139.49		152.34	85.48			

FOOTNOTES

(*) This table has been prepared directly from the study "Sample Cost of Tomato Production in Contra Costa, San Joaquin, and Stanislaus Counties in California, April 1983. The study was conducted by the Cooperative extension Work in Agriculture and Home Economics, U.S. Department of Agriculture, University of California and Counties of Contra Costa, San Joaquin and Stanislaus Cooperating.

a) Labor rates - Hourly labor rates are: Supervisor $8.00, Harvester operator $5.00, Skilled $5.00, Irrigator $4.00, Regular $3.75 (includes overtime for part of the year).

b) Fuel and repairs are calculated as the total of the tractor and the implement as taken from the equipment list multiplied by the hours per acre. Fuel cost are based on a charge of $1.10/gal diesel and $1.25/gal unleaded gasoline.

c) Fall operations are calculated on the basis of 300 acres total of tomatoes, (2/5 of 300 acres is 120 acres, etc.). Soil amendments,(gypsum or manure), will add approximately $36 per acre cost to the fall operation.

d) Fumigation should only be practiced if there is a serious nematode population and/or if weed infestation is quite a problem.

e) Irrigation water cost ranges from approximately $5 per acre foot to $17 per acre foot, depending on the location within the area. The figure used in this study ($12) is within this range and represents a typical cost in the major tomato-growing areas of the three counties.

f) Cost for Ethephon, vine training and whitener are pro-rated over the entire 300 acres of tomatoes.

g) Various rent arrangements are common in the area: cash figures are used for the study; share rents vary from 18% to 20% of the gross.

h) Harvest costs are calculated based on bulk handling. Harvest costs are based on good harvest conditions; circumstances which lead to overripe and mold conditions can effectively double costs of harvest.

i) Harvest costs are based on an average of 6 sorters for a machine equipped with an electronic sorter. However, some growers use a manual sort harvester at an approximate cost of $125,000 and employing from 10 to 12 sorters. Cash costs for fuel and repairs for an older harvester would be approximately $61.75/acre.

j) Cost per hour on tractors for bulk harvest was an average of three large tractors (11.19 + 8.25 + 5.73 / 3 = 8.39 x 1-1/2 = 12.58).

k) Approximately 1.0% of delivered loads are rejected at the inspection station, incurring losses from return freight, harvest costs and, in some instances, reconditioning of the loads.

l) Health insurance for full-time employees is included in the 22% charge for benefits.

m) The tax rate will vary with the location; for example, Stanislaus County will average $10/1000 assessed value.

LOS SANTOS

In Panama, tomato production was initiated in 1936 near the town of Nata, province of Cocle, by the Nestle corporation which constructed the first Panamanian tomato processing plant at that site. Since then, Nestle has promoted tomato crop production for industrial processing and provided technical assistance to Cocle producers who are contracted with Nestle to produce industrial tomatoes.

By the 1950's, tomato production shifted from Cocle province to Herrera and Los Santos provinces in the Azuero peninsula, a region which enjoys an extended dry season. The reason for the relocation was to produce tomatoes on lands which were not infected with bacterial wilt, Pseudomona solanacearum, a disease which jeopardized the industry at that time. Industrial tomatoes are grown under irrigation during the dry season from October to May to avoid major disease problems. Tomatoes are not produced during the rainy season from June to September. Growers produce tomatoes within a crop rotation. In general, crops rotated with tomatoes are corn, rice or sorghum; also sugar cane and pasture, but at longer intervals (Herrera, 1988).

In 1966, results of agricultural research in Panama produced the first of several resistant varieties. Today, more than 80% of total production is concentrated in Los Santos province where Nestle has constructed a large modern processing plant at the town of Las Tablas. Representative farm production cost for this study are those from Los

Santos province.

This study uses data for Los Santos for production year 1983 from three sources. Most of the data come from a representative budget prepared by Nestlè agricultural services. Missing data for land rent, fix to variable cost proportion and investment costs were provided from Herrera's study. Some minor adjustment of these data were done using De León, Lasso, and Name, 1988, IDIAP's publication. Cross comparisons among these sources showed consistency on unit production costs and average yields.

Land preparation

Land preparation is initiated two months before planting on fields generally with less than 8% slope. Fields are plowed by tractor followed by discing then furrowing. Leveling operations are not employed as tomato plants are hand planted and harvest is by hand. Furrows are placed 60 inches apart and on the contour with no more than a 0.5 percent slope to facilitate furrow (rill) irrigation (De Leon, Lasso, and Name, 1984).

Planting

Plant varieties

Tomato varieties selected for industrial use and processing are those suitable for manual harvesting (indeterminate). Varieties used are those that fruit continually over an extended period of time permitting fruit to be picked and re-picked in stages. In a labor intensive environment like Panama, this characteristic permits labor utilization over an extended harvest period. Selected plant varieties are those which are tolerant to bacterial wilt, Pseudomona solanacearum, and nematode Meloidogyne sp damage. Additionally, fruit is firm, crack-resistant, and resistant to transportation damage during transit (De Leon, Lasso, and Name, 1984).

Planting Method

In Los Santos, two planting stages are involved. Initially, the seed is sown in a small nursery at a high seeding rate. After germination, plants are transplanted from the nursery to the field. Seedbeds are prepared 21 to 24 days before seeding. Nurseries are established in a small area where tomatoes have not been planted for a long time and in a location where they may be attended to easily. The seedbed can be prepared by hand, using hoe and mattock, or mechanically by using a small garden rototiller to assure a smooth seedbed free from trash and clods. The seedbed is chemically treated for soil insects, nematodes, weeds, fungi and bacteria, and is fertilized as well. The amount of seed required is about 6.5 oz per acre (De Leon, Lasso, and Name, 1984).

Nursery seeding minimizes use of field irrigation during the first stage of the crop in the nursery. Non specialized labor and no special equipment are required for nursery seeding.

Transplanting from the nursery to the field occurs when plants are 3 weeks old and 6 to 8 inches tall. The process is simple and relies upon a large labor force. Simple hand tools are used to remove plants from seedbeds and be transplanted to the field. The strongest and healthiest plants are selected. A second transplant operation is conducted to replace plants that do not survive initial transplanting (De Leon, Lasso, and Name, 1984). Thinning is an integral part of the transplanting process.

Growing

Cultivation-Weed Control

Weed control is done by combining chemical, and manual control methods depending on the vegetative stage of the crop. Weed control combined with cultivation and side dressing of fertilizer is done manually. It is done when necessary to assure vine coverage on clean land. Three manual weeding operations normally are required (De Leon, Lasso, and Name, 1984).

Chemical weed control with selective pre-emergence herbicides and non-selective post-emergence spraying is conducted using knapsack sprayers. Applications are generally done twice, the first between the fifth and the seventh day after transplanting, and the second 15 to 20 days after first application if necessary (De Leon, Lasso, and Name, 1984).

Fertilization

Fertilizer application rates are based on soil analysis. However, an initial application of a complete fertilizer such as 12-24-12 or 15-30-8 side dressed, on the fifth day after transplanting, is common. Additional nitrogen is side dressed in two applications, the 20th day and the 35th day, after transplanting (De Leon, Lasso, and Name, 1984).

Phosphorous application is heavy reflecting a soil problem that fixes phosphorous to soil particles resulting in slow phosphorous release. Phosphorous application has the greatest influence upon fruit yield if all other nutrient elements are well balanced. Although, phosphorous fertilizer cost is charged totally to the tomato crop to which it is applied, its slow release benefits other crops used in rotation including corn, rice or sorghum.

Foliar fertilizer application is not practiced. Liquid fertilizer is used to supply specific micronutrients. If applied, it is done in combination with pesticide applications (De Leon, Lasso, and Name, 1984).

Irrigation

Furrow irrigation is used to supply water to the tomato crop. Portable gasoline powered pumps are used to draw water from a river or stream adjacent to the field. A few large growers and cooperatives have built irrigation systems to supply water to several producers. Irrigation is done about four days after each cultivation to avoid entry of bacteria and fungus through injured plant roots. Some 14 irrigations are applied throughout the season. For Los Santos, irrigation is divided into two phases. The first phase is between 5 days and 51 days after the transplanting when irrigations are more frequent, every 6 days to 8 days, with low volume application. The second phase is between 51 days and 81 days after the transplanting when each irrigation is every 8 days to 12 days, but with high volume (De Leon, Lasso, and Name, 1984).

Pest and Disease Control

Chemicals are the principal means for pest control. Dosage recommendations depend on local pest problems, availability of commercial products, application recommendation by product manufacture, and local research institution recommendations.

Harvest

Harvest is by hand and continuous for about one month, usually with about four pickings at intervals of about nine days and followed by an irrigation after each picking. The total harvest season demands nearly 200 hours of labor per acre, or 6 to 9 workers per harvest day per acre. Pickers also serve as sorters (De Leon, Lasso, and Name, 1984).

The tomatoes are picked by hand and gathered into boxes. Boxes are plastic with a capacity of about 40 to 50 pounds of tomatoes. Boxed tomatoes are transported by truck from the field to the canneries. Fields are small enough and surrounded by provisional roads to make trucks easily accessible to them.

Equipment is limited to boxes and trucks. Portable toilets and water containers are not supplied by the growers to their pickers.

Cost/Return Considerations

Cost return information for Los Santos is exhibited in Table 3. This table presents total cost per acre of tomato production in the field. To facilitate comparison, this table is set up in the same format as Table 1. Cost categories are presented in a two way matrix. Columns represent resource use categories of land, labor, machine/equip./bldg., and purchased materials (seed, fertilizer, pesticides, and water costs).

The second column presents hours per acre for the field operations. Columns three and four present cost per hour and total cost for labor. Column five present machine / equipment and building cost/acre/operation. The sixth, seventh, and eighth columns describe the kind, quantity (lb) per acre, and cost/acre respectively for purchased materials.

A sub total per acre cost column contains the total cost per acre of each field operation cost component and a total per acre cost column represents the total cost per acre for each principal field operation category. The last column specifies the percent of total cost per acre for each principal field operation category.

The rows present cost by sequential field operation categories of nursery preparation, field preparation, transplanting, growing, and harvest. Additional rows are assigned for land rent, non-cash (overhead), and per acre total cost. Overhead costs of depreciation and interest on investment are limited almost entirely to irrigation equipment and a backpack sprayer. It is calculated on an initial investment of $1409.00, for a base of 4 acres of tomatoes and interest on investment of 18%.

The bottom of the table expresses cost per ton at an average yield per acre of 15 tons. Variability in yield and production costs is not reflected in the averaged sample data cost presented in this study. However, the bottom right of the table presents information about cost and yield variability reported by Herrera's 1988 study. This information provides the average cost/acre, yield/acre, and cost/ton for the upper, middle, and lower third of sample producers in that study on the basis of cost/ton. The Herrera study is the only data source available which presents variability in yield, costs, prices, income, and returns. Resource use and field operation costs were not available from Herrera's study.

Accompanying the table is a footnote page which describes basic conditions upon which operation costs are calculated. Reference to the footnotes is made in table 3 using a lower case letter notation.

Table 3: Sample cost of tomato production - tomatoes for processing - Los Santos, Panama, 1983

Operation	Hours per Acre	Labor Cost (a) Cost/hour	Total	Machine/Eqbip./ Bldg.cost (b)	Materials(c) Kind	Quantity lb	Price(lb)	Cost	Land cost (d)	SUB TOTAL	TOTAL PER ACRE	%
FIELD PREPARATION											80.72	8.00
Cleaning	13.00	0.63	8.13							8.13		
Soil Preparation										72.60		
Disc 1x(1.21hr x $20/hr)				24.20								
Disc 1x(1.21hr x $20/hr)				24.20								
Plow 1x(1.21hr x $20/hr)				24.20								
NURSERY PREPARATION											33.10	4.00
Soil Preparation	13.00	0.63	8.13							8.13		
Fertilizer					12-24-12	3.24	0.15	0.49		0.49		
Seed					Seed	0.20	36.00	7.31		7.31		
Pest, disease, and Weed Control										17.18		
					Brom-o-Gas	0.16	33.00	5.28				
					Furadan	0.41	1.75	0.72				
					Rodomil	0.02	8.00	0.16				
					Orthocide	0.04	3.50	0.14				
					Agrimicin	0.01	17.14	0.12				
					Vidate L	0.01	10.00	0.13				
					Pirimor	0.03	24.34	0.73				
					Polyethi	10.10	0.98	9.90				
TRANSPLANTING											24.28	2.00
Manual Planting	38.85	0.63	24.28							24.28		
GROWING											477.44	47.00
Cultivation & Fertilization	48.56	0.63	30.35					122.90		153.25		
Fertilizers												
					12-24-12	607.33	0.15	91.10				
					Urea 32	161.85	0.14	22.66				
					N-Fix	0.87	8.18	7.12				
					Servi-Nut.	2.02	1.00	2.02				
Irrigation	100.36	0.63	62.73	38.45						101.18		
Weed Control	67.75	0.63	42.34					75.90		118.24		
Herbicides												
					Round-up	3.61	9.10	32.85				
					Fusilade	0.81	41.50	33.62				
					Gramoxone	3.56	2.65	9.43				

Table 3 (cont'd): Sample cost of tomato production - tomatoes for processing - Los Santos, Panama, 1983

Operation	Hours per Acre	Labor Cost (a) Cost/hour	Labor Cost (a) Total	Machine/Equip./ Bldg.cost (b)	Materials (c) Kind	Materials (c) Quantity lb	Materials (c) Price (lb)	Materials (c) Cost	Land cost (d)	SUB TOTAL	TOTAL PER ACRE	%
Pest Control	48.56	0.63	30.35					74.42		104.77		
Pesticides												
					Ambush	0.40	82.00	32.80				
					Decis	0.88	9.89	8.70				
					vidate-L	1.78	8.65	15.40				
					Curacrom	0.40	13.50	5.40				
					Pedan	0.40	9.65	3.86				
					Pirimor	0.81	10.20	8.26				
LAND RENT (d)									102.79		102.79	10.00
TOTAL CULTURAL COSTS	330.08		206.30	111.05				298.20	102.79	718.34	718.34	71.00
HARVEST											135.59	13.00
Pickers	178.10	0.63	111.31							111.31		
Boxes				24.28						24.28		
MISC. OPERATING COSTS (g)											64.65	6.00
(Insurance and Interest)			27.34	11.65				25.66				
TOTAL CASH COSTS			344.95	146.98				323.86	102.79		918.58	90.00
OVERHEAD COSTS - Depreciation											102.13	10.00
Water pump, pipe, others (h)				102.13								
Sprayers (i)												
TOTAL COST PER ACRE	508.18		344.95	249.11				323.86	102.79		1020.71	100.00

COST PER SHORT TON

AT 15.0 TONS/ACRE YIELD 68.00

Cost and Yield Variability *

	Cost/acre	Yield/acre	Cost/ton
Upper 1/3 of Growers	1387.00	22.50	62.00
Middle 1/3 of growers	1082.00	16.00	68.00
Lower 1/3 of Growers	864.00	6.50	133.00
Average of Growers	1111.00	15.00	74.00

* Data from Herrera, 1988, study

FOOTNOTES

(*) This table makes reference to a sample cost of canning tomato production in Los Santos, a central province of Panama Republic. The data were combined using three basic information sources. The three sources are : (1) "Budget for canning tomato production in Los Santos", prepared by Juan B. Diaz B.Sc., Head of Agricultural Service Department of Nestle Co., (2) Technique Bulletin # 20, IDIAP -Panama 1988- "Study of Production Cost, Rent and Resource Utilization in the Production of Canning Tomato During the Dry Season in Los Santos- Republic of Panama., (3) Producer Guide for Canning Tomato- Published by IDIAP. The data were specified on a per hectare basis and into per acre costs with the conversion of 1 hectare = 2.471 acres.

a) Labor rate is calculated on the basis of an 8 hour per day per farm worker. The rate is $5.00/day/8 hrs or $0.625/hour for a regular farm worker. This rate is imputed for all labor. A considerable but unknown amount of labor is unpaid operator and family labor which receives the residual claimants for returns over cash costs.

b) Machine costs are calculated using custom rental rates for tractors and implements as most producers do not own equipment. Equipment is available for rent in the area from larger producers of corn, rice and sorghum who rent out the excess capacity of their own equipment. The rental rate of a 90 W.D. H.P (JD 2040) with implements is $20.00/hr. This rate covers fuel, repair, operator, depreciation, and interest charges associated with equipment ownership.

c) Refers to chemical products used to control weed, pest and diseases and materials such as seed, polyethylene, sacks, and other items used in the field and harvest operations.

d) Tomato for processing is grown on small farms, with an average size of 4 acres. Some two thirds of the producers rent their tomato land because irrigation water source do not exist on their own farm. The average rental rate is $102.79/acre.

e) Fertilizer use is common. Some producers use 12-24-12 while others use 15-30-8S where sulfur problems exist. Unit costs among them are similar.

f) Irrigation is supplied by pumping water from local rivers or other water source using a small electric or gasoline or diesel fuel powered pumps. Irrigations costs include fuel, oil, repairs, depreciation and interest charges.

g) Tomato growers obtain operating loans from the Agricultural Development Bank (BDA). A BDA requirement for loans is that crop insurance must accompany the loan. Interest rate for short term loans is about 18%.

h) In Los Santos pesticides are applied using backpack sprayers. This and the irrigation pump are the only equipment owned by growers. Fix cost of ownership is calculated on an initial investment of $1409 of a base of 4 acres of tomatoes, 5 years of life, and interest on investment of 18%. $1409 / 4 acres = $352.25/acre / 5 years life = $70.45/acre/year + $31.7(interest) = $102.15 of overhead costs. Interest = $352.25/2*.18

i) Yield contemplated in this study reflect a typical range reported by Herrera, 1988, in her tomato cost study.

CHAPTER III

A COMPARATIVE ANALYSIS OF TOMATO PRODUCTION BETWEEN CALIFORNIA AND PANAMA PRODUCERS

Chapter III provides a comparative analysis of tomato production cost in California with that in Panamá. The analysis examines factors influencing production costs and returns including yield/acre, labor structure, field operation components, resource use levels, proportion of fixed to variable costs, resource endowments, and the price system in Los Santos. This cost analysis and influence comparisons provides the analytical framework in deriving conclusions and recommendations presented in chapter IV.

Total Costs

Cost comparisons between California and Los Santos show average total costs of production on a per acre basis between countries to be different. Costs reported for Los Santos are lower than those reported for California. Tables 1 and 3 show an average total cost of $1485/acre for California and $1023/acre for Los Santos, a difference of more than $450/acre.

Herrera's 1988 study also supports this finding. She reports for the middle third of growers (in terms of yield) an average total cost of $1082/acre with a range from

$1387/acre for the upper third of growers to $864/acre for the lower third of producers. Table 4 shows summary data from Herrera's 1988 study. The average total cost shown in table 3 is similar to that for the middle third of growers reported by Herrera lending credibility to the representative farm cost data for Panama used in this study.

Table 4 : Summary data from Herrera's 1988 study -tomatoes for processing- Los Santos, 1983.

Growers Proportion	Cost/acre	Yield/acre	Cost/ton
Upper 1/3 of Growers	1387.00	22.50	62.00
Middle 1/3 of growers	1082.00	16.00	68.00
Lower 1/3 of Growers	864.00	6.50	133.00
Average of Growers	1111.00	15.00	74.00

The upper third of growers of Los Santos have similar average total cost as reported in table 2 for California growers. Further analysis is necessary as yield is a major factor influencing unit production cost.

Yield Influences

Although the Herrera study, summarized in table 4 above, shows essentially all Panamanian growers to have lower average total costs/acre than that found in California, it is the unit cost/ton which determines competitiveness and yield can be a determining factor. Note columns 3 and 4 in table 4. With a unit cost range of

$50/ton - $74/ton reported for California in table 1, Herrera's 1988 report suggest that some 50 percent of Los Santos producers might be viewed as competitive as those producers in California. For the third of growers with low yields their unit cost/ton of $133 is about double that for California, clearly a non-competitive situation. Other factors also are involved.

Labor Influences

Herrera reports that in Los Santos some 20% to 30% of the 500 plus hours of labor used per acre is unpaid operator and family labor. It is provided by growers and their family. Based on this, further analysis considering unpaid labor of 0%, 20%, 25%, and 30% of total labor requirements was conducted and presented in table 5.

Table 5: Cost per ton at different levels of unpaid labor -tomatoes for processing - Los Santos, Panamá - 1983

Grower Proportion	Tons/acre Yield	Cost/ton - Unpaid labor at 0%	20%	25%	30%
Upper 1/3	22.5	62.0	58.0	57.0	56.0
Middle 1/3	16.0	68.0	63.0	62.0	61.0
Lower 1/3	6.5	133.0	125.0	123.0	121.0

The assumption made is that the opportunity cost of unpaid family labor is valued at its residual economic rent, in this case a zero market value. With unpaid labor accounting for more than 25% of total labor requirements, some two-third of the Los Santos growers appear competitive with their Californian counterparts. Again, the lower one-third of growers are not competitive because of low yields.

Based on this analysis, some two third of Los Santos producers can be viewed as competitive with those in California in the short run where a low or zero wage rate prevails for operator and family labor. Even with prevailing wage rates for operator/family labor at least one-half of the growers appear competitive.

Field Operation Influences

A review of costs by specific field operations is conducted next. Its intent is to distinguish cost components which are proportionally larger as it is here where technological cost/reducing changes would appear to have the

Table 6: Cost by resource input & field operation categories - tomatoes for processing-California, U.S.A., 1983

Field operations	Resource components								TOTAL	
	Labor Cost		M/E/B Costs		Material Costs		Land Cost			
	$	%	$	%	$	%	$	%	$	%
Land Preparation	24	2	144	10			25	2	193	14
Seeding	7	0	21	1	133	9	42	3	202	13
Growing	200	13	159	11	238	16	100	7	697	47
Harvest	157	10	178	12			56	4	391	26
TOTAL	388	25	502	34	371	25	225	16	1485	100

Table 7: Cost by resource input & field operation categories -tomatoes for processing - Los Santos, Panamá, 1983

Field operations	Labor Cost $	Labor Cost %	M/E/B Costs $	M/E/B Costs %	Material cost $	Material cost %	Land Cost $	Land Cost %	TOTAL $	TOTAL %
Land Preparation										
Nursery prep.	9	1			27	3	5	0	40	4
Field prep.	9	1	76	7			11	1	97	9
Planting	26	3					3	0	30	3
Growing	180	18	148	15	297	29	65	6	689	68
Harvest	121	12	25	2			19	2	165	16
TOTAL	345	35	249	24	324	32	103	9	1021	100

(Resource components: Labor Cost, M/E/B Costs, Material cost, Land Cost)

Note: Overhead cost is limited to investment in irrigation and spraying equipment hence included only in the "growing" category of field operation.

greatest potential in cost reductions.

Table 6 presents a summary of cost by field operation and input (resource) cost categories for California. Table 7 provides a comparable summary for Los Santos. Input (resource) cost categories will be discussed in a later section.

Among field operations for California, the growing category, has the greatest percentage of total cost, some 47%. Harvest is second in order representing 26% of total costs. Both account for about three-fourths of total costs.

For Los Santos, among field operations, the growing category has the highest percentage of total costs accounting for 68% of total costs. While Los Santos is similar to California in that the growing category reflects the highest percentage of total cost, its level of cost is proportionally much higher, so warrants additional investigation. Thus we turn to a resource use comparison between California and Los Santos which compares the resource use columns of Tables 6 and 7 to get a better perspective on the resource components which make up cost for each field operation with a special focus upon the resource make up of the growing category.

Resource Use Influences

In the California case, shown in table 6, the combined capital costs of M/E/B, materials, and land account for 75% of total costs. The M/E/B component is the largest sub-category accounting for about 34% of total costs. This reflects the machine intensive nature of tomato production in California with similar proportions across field

Table 8: Materials Cost and their relative importance -tomatoes for processing-California, U.S.A., 1983

Material Category	Materials				
	kind	Quantity(lb)	Price	Total Cost	%
Insecticide/fungicide	Various	n/a	n/a	86	26
Herbicides/weed control	Tilam	6.01	10.67	75	23
	Lay-by	n/a	n/a		
Fertilizer	10-34-0	160.87	0.23	64	19
	Ur-32	100.00	0.27		
Irrigation	Water	4 a.f.	12.00	51	16
	siphon	n/a	n/a		
Seed	seed	1.00	32.00	32	10
Fruit repiner	Ethephon	n/a	n/a	19	6
TOTALS				327	100

operation categories (land preparation - 10%; growing - 11%; harvest - 12%).

Material costs follows in relative importance, representing 25% of total costs. Table 8 is added to obtain a better picture of the importance of specific material input components. Nearly one-half of total material costs of $160/acre are expended on controlling insect pests and weeds. Fertilizer and irrigation water collectively are the next largest material sub-category accounting for 35% of materials costs. These four material components totaling some $275/acre account for about 40% of total growing costs.

Land represents the smallest capital input component accounting for 15% of total costs.

Labor represents the remaining input and accounted for 25% of total costs. About half of total labor cost is for cultivation and irrigation activities and the other half for sorter and machine labor operations during harvest.

In the Los Santos case, from table 7, the combined capital costs of M/E/B, materials, and land account for 65% of total costs. The land component was smallest, accounting for only 9% of total input (resource) cost. The M/E/B category accounted for about 1/4 of total input costs, dominated by irrigation investment costs.

Material cost was the largest capital input component accounting for one third of total production costs. Being so large, this component deserves further scrutiny.

Table 9 shows material cost by specific material components for Los Santos. Fertilizer is the largest single item accounting for more than 40% of all material costs, some $123/acre a level nearly twice that for fertilization in California. Herbicides / insecticides / fungicides combined account for over half of total material costs with a dollar level of about $160 per acre. This is similar to that found in California. Thus, relative to California, the combined materials costs of fertilizer, herbicides, insecticides, and fungicides appear to be excessive and deserve further analysis.

Table 9: Materials costs and their relative importance -tomatoes for processing- Los Santos, Panamá. 1983

Material	Materials				
Category	kind	Quantity(lb)	Price	Total Cost	%
Fertilizer	12-24-12	610.57	0.15	123.39	41
	Urea-32	161.85	0.14		
	N-Fix	0.87	8.18		
	Servi-Nut	2.02	1.00		
Herbicides	Round-up	3.61	9.10	85.80	29
	Fusilade	0.81	41.50		
	Gramoxone	3.56	2.65		
	Polyethylene		9.90		
Insecticide/fungicide	Ambush	0.40	82.00	81.67	27
	Decis	0.88	9.89		
	Vidate-L	1.79	8.65		
	Curacrom	0.40	13.50		
	Pedan	0.40	9.65		
	Pirimor	0.84	10.20		
	Rodomil	0.02	8.00		
	Furadan	0.41	1.75		
	Orthocide	0.04	3.50		
	Agrimicin	0.01	17.14		
	Brom-O-Gas	0.16	33.00		
Seed	seed	0.21	36.00	7.22	2
TOTALS				298.08	100

Table 7 shows labor as an input category representing

35% of total costs expended primarily for field operations such as irrigation, cultivation, and weed and pest control (50% of total labor costs). Some 34% of total labor costs are expended for hand harvest.

Fixed and Variable Cost Influences

Table 10 compares variable and fixed costs between California and Los Santos tomato production costs.

California has a higher proportion of fixed to variable costs (31%) than for Los Santos (20%). The fixed cost component for Los Santos increases only to 22% when incorporating on unpaid labor component as discussed on pages 42-43.

Table 10: Comparative variable, fixed, & total cost per acre California versus Los Santos -tomatoes for processing- 1983.

	California			Los Santos	
	%		U.S.$/acre	%	U.S.$/acre
VARIABLE COSTS					
Various	(69%)		$1022	(80%)	$ 815
FIX COSTS					
Land Rent	(15%)	$ 225		(10%)	$ 102
Others	(16%)	$ 238	$ 462	(10%)	$ 102
TOTAL COST			$1485		$1020

Proportion of fixed to variable costs is an important consideration in risk management and enterprise organization. As is discussed by Barry, Hopkin, and Barker, 1988, risk in agriculture comes mainly from (1) production and yield variation, (2) market and price variability, and (3) financial organization of the farm business. The first two occur as unanticipated variation in agricultural production and in commodity and resource prices over time, uncertainties about personnel performance, technological change, and change in the firm's legal environment. In the production and farm yield category, risk responses include enterprise diversification, informal insurance (pesticides, reserve equipment, supplemental irrigation), organization flexibility, among others. The proportion of fixed to variable costs is related to farm organization flexibility. Lower fixed costs relative to variable costs, as the case for Los Santos, is one way to increase organization flexibility. Flexibility provides a mean of struggling with risk. Variable costs mainly composed by short-lived assets can be changed more easily than long-lived assets, hence providing greater resource flexibility. For Los Santos producers it is less costly to diversify their production or to switch their enterprises.

Resource Endowment Influences

Table 11 compares resource use between California and Los Santos. Data were transferred from tables 1, 3, 8, and 9.

For Los Santos, labor is the dominant resource with a use level of 508 hours/acre with an average wage rate of

Table 11: Comparative resource use. California vs Los Santos -tomatoes for processing-. 1983

	California			Los Santos		
Resources	Units/acre	Cost/unit	Cost/acre	Units/acre	Cost/unit	Cost/acre
LABOR						
All operations	40.73	8.47	345	508.18	0.63	318
Interest						
Operating Capt.@22%			42			
Insurance and interest						27
Sub-Total	40.73	9.50	387	508.18	0.68	345
M/E/B						
All Cultural Oper.	6.42	23.40	150	3.60	20.00	73
Harvest	5.76	15.50	89			24
Overhead			238			102
Interest						
Operating Capt.@22%			25			
Insurance and interest						12
Sub-Total	12.18	41.22	502			211
MATERIALS						
Seed	1.00	32.00	32	0.20	36.00	7
Irrigation water	4.00	12.81	51			38
Fertilizer			64			123
N	48.00	0.84		125.00	0.44	
P_2O_5	55.00	0.43		147.00	0.31	
K_2O				73.00	0.31	
Herbicides	6.00	10.67	64	7.98	10.75	86
Other			11			
Insecticides			66	5.35	15.27	82
Growth Regulator			19			
Interest						
Operating Capt.@22%			64			
insurance and interest						26
Sub-Total			371			362
LAND (rent)	1.00	225.00	225	1.00	102.79	103
TOTAL			1485			1021

$0.625/hr. The labor expended in California was 40 hours per acre at an average wage of $9.80/hr. The contrast between Los Santos and California in labor use is great. Los

Santos use 13 times more labor per acre than California largely due to the fact its wage structure is 15 times less expensive than that in California.

M/E/B is the dominant capital category for California, M/E/B is used intensively with machine costs representing one-third of total cost. The M/E/B category represents one-fifth of total costs, for Los Santos. However, Los Santos M/E/B use intensity is very low since category components are limited to a rudimentary irrigation system, custom machine hire of three field preparations, and boxes for harvest.

Comparison of the materials category in use levels and input prices between California and Los Santos shows major differences. For fertilizer, the unit cost in Los Santos is about half that for California and the level of use is more than double that shown for California. For pesticide and herbicide use the data is less revealing as the unit cost is not reported for insecticides in the California case. However, for herbicides it appears that unit costs are similar between Los Santos and California. The level of use in dollar terms however is considerably higher in Los Santos for herbicide and insecticide use. The Herrera study reports that fertilizers, herbicides, and insecticides are government subsidized. This supports the comparatively higher use of materials in Los Santos. Both, Herrera and IDIAP report overuse of fertilizer and pesticides by tomatoes growers in Los Santos, a condition supported by this study.

Comparing land costs, it appears to reflect land productivity factors which include both qualitative as well as quantitative elements rather than absolute land endowment. In the comparison of land between California and Los Santos, land rent is used as the proxy. Land rent in California is somewhat more than twice that in Los Santos. While a cursory observation might suggest that California is a land abundant environment compared to Panama, the land rent differences suggest otherwise. Qualitative factors, as reflected in part by major yield differences, likely are imbedded in the rent differences. Consequently, while land in the California context is relative inexpensive as an input when compared with other inputs used in California, a cross-country comparison suggests that high quality agricultural land in California is costly, may be becoming more of a premium, and definitely includes major land improvements that have not yet been incorporated into Panamanian land. Conversely, demand for land for industrial tomato production in Panama appears to be low. The producer price system in Panama may be a factor here, a topic covered in the next section.

Further analysis of relative resource use among inputs within the separate cases of Los Santos and California is presented in table 12. The approach used is that taken by Hayami and Ruttan, 1988, to show relative resource endowment within each country. Resource use relationship for labor, land, fertilizer, and machinery are presented.

Table 12: Comparison of relative cost of labor,land, fertilizer and machinery between California and Los Santos-tomatoes for processing- 1983.

Items	California	Los Santos
COST		
Labor wage rate per hr.	8.470	0.625
Land rent (per Acre)	225.000	102.790
Nitrogen price per pound	0.840	0.440
Machinery cost/hr for cultural operations	23.400	20.000
RATIOS		
Land price to Labor wage	26.560	164.500
Fertilizer price to Land price	0.004	0.004
Machine price to Labor wage	2.800	32.000

In Los Santos, land price relative to labor cost is about 165 times greater. This reflects the higher land cost relative to labor wage. Since relative price reflects endowment, it appears that in Los Santos land is scarce relative to labor when compared with California. The same observation can be made for machinery price relative to labor wage which is 32 times greater. As in the above relationship, this ratio reflects the scarcity of machinery relative to labor for Los Santos when compared with California. Fertilizer price relative to land price is about 0.004 reflecting the effect of a strong fertilizer subsidy in Panama.

Price System Influence

The market price system for producers is an aspect that influences the incentive to produce hence can affect the structure of producer cost and hence the competitiveness of Los Santos producers in international market. While its in depth consideration is beyond the scope of this study a preliminary assessment of its influences in the Panama case is conducted here.

Historically the Panamanian government has encouraged Nestle to pay specific contract prices to its growers under specific production quota limits. Price and quota levels were negotiated between Nestle, the processor with monopsonistic and monopolistic power, and MIDA which purports to represented the growers. To maintain the monopoly environment industrial tomato imports were prohibited. Growers quotas were distributed according to producer performance, the higher the yield and/or lower the unit cost, the higher the quota. The price averaged 7-8 cents per pound, about three times the world price. The result has been a strong producer incentive to increase production and the addition of high unit cost producers to the producer pool.

Since 1984 total production has exceeded domestic demand. As a consequence, in 1985 Nestle with agreement from MIDA, implemented a two-price system to permit excess domestic production to enter export markets. One price is the weighted annual price set for producers. The second price is the retail price for industrial tomato products set for the domestic market.

Grower prices are set according to delivery date within the harvest season. The harvest season is from January through May. The prices shown in Table 13 represent prices

Table 13: Producer prices during the harvest season. -Tomatoes for processing-. Panama - 1985

Period	Price per ton
January and February	U.S.$ 155.00 per ton
March	U.S.$ 140.00 per ton
April and May	U.S.$ 130.00 per ton
Extra Quota	
Within harvest season for efficient producers	U.S.$ 100.00 per ton
Out of harvest season for all producers (residual harvest after May)	U.S.$ 56.00 per ton

Source : MIDA/DNPS report. 1986 page 4

paid at the cannery for a normal quota.

There is an extra (excess) quota of $100/ton that Nestle distributes among the most efficient producers for excess production. For these growers, it is normal strategy to plant more acreage than normal quota in anticipation of receiving an extra quota.

Some residual production occurs each year for, unlike California varieties, Panama varieties continue production after the fourth or last normal harvest without additional irrigation or other care. This residual production occurring after May is purchased by Nestle for all growers at U.S.$ 56 per ton. This price exceeds considerably the incremental cost of fruit picking and field transportation of $22/ton, a strong inducement for harvest of residual production (MIDA/DNPS report).

The second price system (1) sets the national internal retail price for industrial tomato products and (2) indirectly the tax base to the government through the Certificate of a tributary Bonus (CAT), on export tax for processed industrial tomatoes charged to Nestlè.

The internal retail price for industrial tomato products is established by the following formula:

$$p.i. = \frac{p.n. - p.e. (0.15)}{.85}$$

Where:

p.i. = internal retail price for processed tomatoes.

p.n. =Average producers' tomato price. It represents the average seasonal price weighted by the price and quantity purchased in each harvest period.

p.e. =Exported tomato price. This price is fixed by Nestle as a producer price. It is calculated using an average of producer prices given in four countries which compete in international tomato markets in the current year. These countries are chosen at random. For example, Greece = U.S.$53.00 per ton; Turkey = U.S.$44.80 per ton; U.S.A., California = U.S.$ 48.40 per ton; Italy = U.S.$76.20 per ton. giving an average of

U.S.$56.00.

0.85 and 0.15 = These numbers represent the percentage of tomato volume that will be consumed internally (0.85) and the percentage that will be exported (0.15). The proportion of each is negotiated annually by Nestle and MIDA.

As an example, let us assume that:

p.n. = U.S.$ 140.00/ton and p.e. = U.S.$ 56.00/ton then

$$p.i. = \frac{140.00 - 56.00(0.15)}{.85} = U.S.\$154.82/ton$$

The price of $154.82/ton obtained in the example represents the price consumers in Panama pay for their industrial tomato products. Panamanian consumers who buy Nestlè tomato products are subsidizing processed tomato product exports. The more tomato products Panama exports, the higher the price of tomato products in the domestic (Panama) market.

Because of government protection against international competition for processed tomatoes in Panama and a monopoly market that characterizes the tomato industry in Panama major market distortions occur. On the one hand, this price system encourages excess production with special incentives to efficient growers and little disincentive to inefficient growers. On the other hand, it penalizes exports in two ways. First, it makes exports determinate upon domestic demand, in this case a declining element. Increased exports mean increased prices for processed tomatoes sold in the domestic market, hence lower domestic demand. Secondly, the government export tax serves as a disincentive to export. The retail price scheme contrived by Nestle appears to be an attempt to capture, through high retail prices in the domestic market, the export losses for that portion of production destined for dumping in the export market. Processing inefficiency by Nestlè may be a contributing factor, an issue which transcends this study.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on this comparative analysis of California and Los Santos' tomato production, it is concluded that most Los Santos tomato producers are competitive with their counterpart producers in California. A major factor which contributes to Los Santos producers competitive position is the extensive use of low-priced labor. Existence of some 20-30 percent of total labor as unpaid operator and family labor further enhances this competitive position. Review of existing information suggests the probable overuse of fertilizers, pesticides, and herbicides, a reflection of Panamanian government policy which subsidizes such agricultural materials and hence provides an incentive to producers to apply excessive amounts.

The resource mix used in Los Santos is different from that found in California. Los Santos producers use much greater proportions of labor relative to capital resources, except for material resources explained above. California growers use much more capital relative to labor resources. The reason is that each country is using a resource mix according to its relative resource endowment. Labor is 14 times more expensive in California than in Los Santos which is using 13 times the number of hours of labor per acre. For California growers machine use is cheaper when used intensively. Relative land abundance permit California growers to gain size economies with large equipment. California growers use machinery for essentially all field operations with much lower unit costs than that reported for machine use in Los Santos. In Los Santos, materials prices are lower than those found for California reflecting its government subsidy. Land rent in California is double of land rent in Los Santos reflecting much greater land improvements and twice the yields as that found in Los Santos.

Los Santos' land price relative to labor price ratio is about 6 times greater than that found for California and machine price relative to labor cost ratio is about eleven times greater than that found for California. These results imply that Panamanian research on tomatoes for processing should focus on technological development which conserves on capital resources such as land and machine technology i.e. "capital saving" and utilize labor more intensively, i.e. "labor using" technologies.

The producer price system established jointly by the Panamanian government and Nestle is another factor. Such prices historically have been 2 to 3 times the international market prices, a major incentive to increase production with little inducement to penalize the least efficient producers. Additionally, there is a major disincentive to produce for the export market as the export price system is linked to an escalating domestic retail price/volume relationship in the domestic market, an apparent plan by Nestle to compensate itself for industrial tomato export losses by passing on such losses to Panamanian consumers of its tomato products. While the basis for such losses are speculative at this point and the subject for further analysis, it appears likely to be from government export taxes and processing plant inefficiencies.

Recommendations

Since most Los Santos producers are competitive with producers in California, it is recommended that the tomato pricing system in Panama be revised to eliminate disincentives to export. This in turn would introduce an additional demand for tomatoes for processing in Panama through the incremental effect on retail prices for processed tomato products in the Panamanian market. Modification of the producer price system to induce least efficient producers to improve their efficiency and eliminate the quota system which restricts the number of producers who would participate on those markets is also suggested.

The subsidy policy for agricultural materials such as fertilizers, herbicides, and pesticides should be eliminated. Its removal would eliminate market distortion, which in turn may assist to induce agricultural research institution in Panama to focus on technology development that would tend to minimize the use of scarce capital resources, permitting, thus, a reduction of their imports. This suggest focus on biological technologies to improve tomato yields. Some key inputs under the classification of biological technologies that are suggested for greater focus include development of new varieties that facilitate a) manipulation of plant density and spacial arrangement in the field and b) the application of foliar fertilizers. California growers are using double row on beds and high plant density. This technique is not exclusively linked with mechanical harvest; it can be used by either mechanical or manual harvest. This technology also involves changes in other technologies such as the redesign of the furrows and the development of manual or simple mechanical devices to make holes in the furrows with the proper arrangement for the transplanting operation. Arguments supporting the use of foliar fertilizer includes foliar absorption capability of tomato plants, reduce effects of fertilizer fixation in the soil, and reduce nutrient loss from leaching.

A further important aspect related with the development and successful use of new high yield varieties is the availability of irrigation. Herrera and IDIAP report that low yields in tomato production are associated with poor irrigation facilities and techniques. In the case of Los Santos, capital investment to date has been limited solely to irrigation pumps and limited pipe equipment for flood irrigation. It is possible that labor for irrigation may serve as a resource bottle neck since other crops such as onion, bell pepper, water melon, and cantaloupe also compete for irrigation labor at the same time. This issue deserves further investigation.

A final recommendation is to provide economic investigation into the cost and efficiency of processing and marketing components of the Panamanian tomato industry to answer definitively whether the Panamanian industry can or can not compete in the United States market and the factors which influence that capability.

Limitations

The nature of this study is subject to a number of limitations of which the reader should be aware. Such limitations are specified below.

1) The ability of Panama to compete in the production, processing, and export of processed tomatoes into the United States market is a function not only of competitive ability in production efficiency, upon which this study was based, but also upon processing and exporting components. The latter two were beyond the scope of this study but need to be conducted to complete the assessment.

2) Mexican production of processing tomatoes and their export to the United States has been increasing over the

past decade. This might suggest that a number of conditions may exist in Mexico which makes it as competitive or even more competitive than California producers. If so, Mexican producers could become the standard of efficiency upon which production efficiency of other countries such as Panama could be judged. The standard of comparison in this study involved California producers.

3) The Induced Innovation framework used in this study was used to contrast, rather than evaluate, the resource mixes used in Panama and California in production of processing tomatoes. In so doing the assumption is made, with the exception of the Herrera input for Panama, that the representative farm used in each case represents the predominant and most efficient producers.

4) No extrapolation of the results of this study to the production of fresh market tomatoes in Panama should be made. However, it does suggest that an assessment of why so little production of fresh market tomatoes for local Panama markets exists given the technical capability and likely strong consumer demand for such tomatoes.

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