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AN ASSESSMENT OF OPTIONS FOR IMPROVING THE COST COMPETITIVENESS OF THE ONTARIO POTATO CHIP INDUSTRY

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1. Introduction

The bulk of Canada's potato chip processing capacity is located in central and southwestern Ontario, close to the high population density areas of Ontario and New York State. Hostess Frito-Lay, a division of Pepsico, and Humpty-Dumpty, a unit of Borden, are the dominant firms in this market which contains only a handful of small firms. Miss Vickies, the key niche player with its "kettle fry chips" was recently acquired by Hostess Frito Lay, which leaves only handful of small firms (eg, Small Fry, Conestoga Valley Farms and Olde York). The potato chip industry is largely driven by price, although marketing and promotion efforts are extensive. Several package sizes are popular and the product itself is differentiated mainly by textures (smooth versus ripple), flavourings (plain, salt and vinegar, ketchup etc.) and more recently cooking method (conventional versus kettle frying).

Given that the Ontario potato chip industry is located within an area of North America that would allow its markets to be supplied by U.S. product, the industry has felt considerable pressure to be price competitive with its U.S. counterpart since the passage of the Canada-U.S. Trade Agreement. One cost lever they wanted to exploit was the price of potatoes, not an easy task given that the Ontario's Potato Growers' Marketing Board (OPGMB) has several legal powers that can affect the price and quality of potatoes. The seriousness of this issue was recognized by the growers, the processors as well as the provincial government in Ontario, as evidenced by the following quote: "If Ontario processors do not believe that they will be able to procure raw products at prices and with supply terms that are competitive with those firms with whom they compete, capacity will move to more favourable conditions".[1]

To determine whether the Ontario potato chip processing industry could compete with

its U.S. counterpart under the new trade rules resulting from CUSTA, this study examined; first, what potato chip processors require in terms of the technical and economic characteristics of potatoes in order to be price competitive with their U.S. counterparts, and second, whether Ontario growers can produce, store and otherwise supply potatoes on these terms. This paper reports on the results of this study by providing a research framework, a set of procedures, presenting the key results of our analysis and recommendations.

2. Research Framework

Potatoes are the essential ingredient in potato chips, and along with more costly inputs such as packaging, labour, spices and flavouring[2], chip processors must be able to access potatoes with the appropriate technical characteristics, at a *competitive price*, in order to stay in business. Figure 1 is used to explain how this competitive price can be determined in a regional market such as the one facing Ontario's potato chip industry. It assumes a homogenous product, but as is explained later, this assumption can be relaxed and the model will remain valid.

The competitive price of processed and raw product in a regional market is determined by applying the transfer cost model depicted in Figure 1 to the level of the market with the lowest transfer costs and then working up or down to the other level of the market. In the potato chip industry, chips are relatively cheaper to transfer and therefore the analysis begins at the processing level of the industry.

Dd is the normal domestic demand curve indicating the quantities demanded of a product at various prices, and similarly Sd is the normal domestic supply curve. However, as it becomes possible to import product from another market at a lower price, parts of the domestic demand curve become irrelevant. Instead, the import ceiling (Ic), which indicates the

net price of imported product, becomes the relevant demand curve. This import ceiling is determined by adding the relevant transfer costs such as transportation costs, tariffs, inspection fees and other costs resulting from technical regulations to the price that the product can be purchased in the major market for the product (the reference price). Given that many of these costs increase as smaller quantities of products are demanded, the import ceiling is expected to be downward sloping.

Similarly, as it becomes possible to export product to another market, it no longer makes sense to sell at a price below the export floor (Ef). The export floor is determined by subtracting transfer costs from the reference price, and is also expected to be downward sloping.

The determinants of supply, demand, and the transfer costs which play the key role in the import ceiling and export floor, are controlled to varying degrees by various participants in the industry, and this locus of control is important in determining options for improving the industry's cost competitiveness.

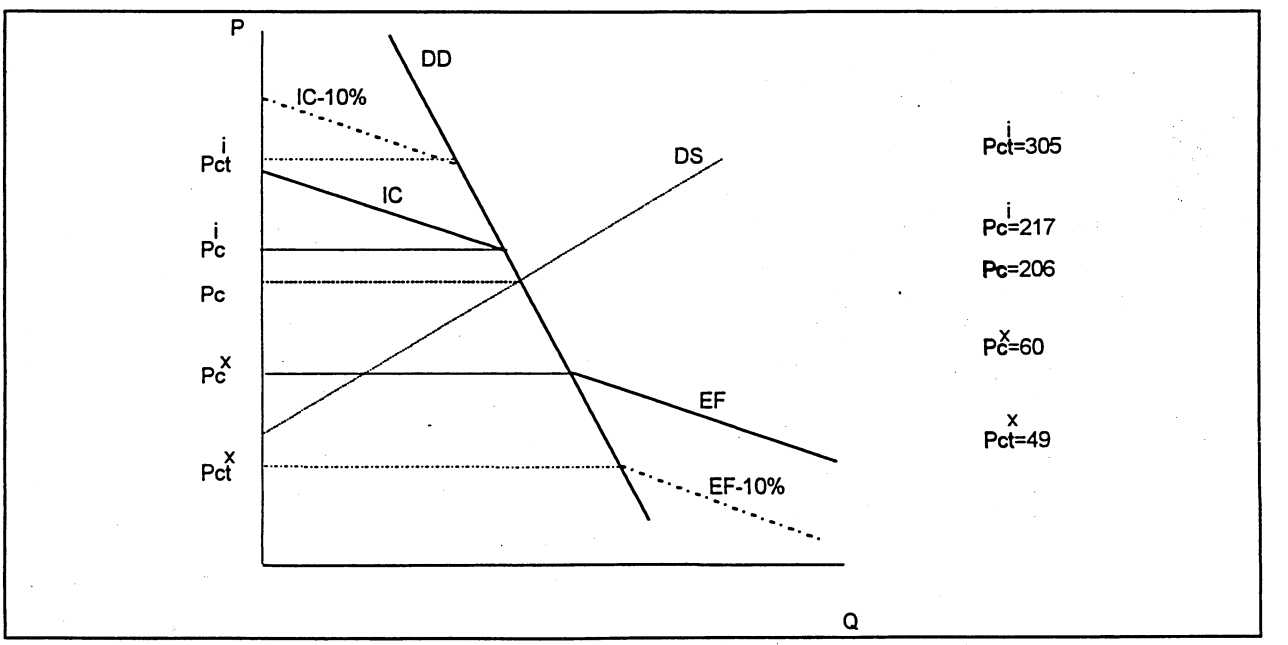
Since the model for competitive prices is theoretically valid only for a homogenous product, it is necessary to determine the technical characteristics of the potatoes that are used for potato chips. The potatoes that are used do not have to be identical, but they must have characteristics that allow them to be substitutable for each other and result in sufficiently similar potato chips. The variables that influence or determine these technical characteristics also need to be identified to determine which participants in the industry can influence or make any required changes.

Table 1 contains a summary of the technical and economic variables that affect the

Table 1: Classification of Variables Affecting the Characteristics of Potatoes and Potato Chips by Type and Degree of Control By Industry Participants

TYPE OF VARIABLE	INDUSTRY PARTICIPANT			
	PROCESSORS	GROWERS	JOINT	GOVERNMENT
TECHNICAL				
Controllable	- technology - plant capacity	- soil conditions	- cultural practices - sorting - genetic material	- technical regulations
Quasi-Controllable			- storage / raw product shrinkage and other aspects of quality	
Uncontrollable	climatic and environmental conditions			
ECONOMIC				
Controllable	- plant throughput / production schedule - desired profit	- volume planted	- negotiation procedures for prices and terms of exchange	- tariffs - various non-tariff barriers
Quasi-controllable	- cost of other inputs (packaging, spices, transportation, labour)	- volume and quality harvested		- supply from other sources
Uncontrollable	aspects of the business environment (aspects of consumer preferences)			

Figure 1: Framework for Determining Competitive Product Prices



potato chip industry's ability to be competitive, and the degree of control that processors alone, growers alone, processors and growers jointly and the government have over that variable. This table was developed from an extensive literature review, and through interviews with food scientists and industry contacts.

The next step was to determine the details on the economic and technical characteristics of potatoes that processors require and whether Ontario growers could produce, store and otherwise supply such potatoes. This part of the research was conducted through case studies with the four largest chip processors, and an analysis of available secondary data. More detail on the use of these types of data follows.

Information on many of the economic and technical variables that were identified as important to the technical and economic characteristics of potatoes and potato chips could be obtained from public sources. Volumes of potatoes planted, harvested, stored, the varieties planted and their prices were obtained from government and industry publications, while primary data were used otherwise. An interview guide was used to conduct the case studies of the processing firms, as well as the case study of the OPGMB, which represents all growers in the province. The case studies were used to obtain information on variables such as processors' specific requirements in terms of the technical characteristics of potatoes (ie. sugar content, specific gravity etc.), volumes purchased by variety over the course of the year, chipping technology, raw product availability among others. Table 2 summarizes the information that was obtained from secondary sources and through case studies with processors and the OPGMB. All data are for 1990 and 1991.

Table 2: Information Obtained Through Secondary Data Sources and Case Studies

Variable	Secondary Data Source	Case Studies
Quantity of Production		
- potatoes	X	
- chips		X
Quantity Stored - Potatoes	X	
Quantity Traded - Potatoes	X	
Varieties - Potatoes		
- Planted / Harvested (volumes)	X	
- Purchased		X
Prices	X	
Tariffs	X	
Plant Size, Capacity, Number of Workers	some	X
Products and Markets	some	X
Raw Potato Technical Requirements (size, shape, eye depth, colour, appearance, specific gravity, sugar content, grade, cultivar/variety etc.)		X
Raw Product Sources (locations, purchase proportions and trends, fresh versus storage)		X
Processing		
- Scheduling		X
- Cost Components	some	X
- Technology		X
Relationships With Growers		
- Negotiation Process	some	X

3. Results

Potato chip processors require access to potatoes with certain technical and economic characteristics in order to be price competitive with their U.S. counterparts. Ontario growers are capable of supplying potatoes with these characteristics, but do not so consistently. The technical and economic characteristics are discussed in the following subsections.

3.1 Technical Characteristics of Potatoes for Chips

Ontario chip processors use several varieties of potatoes, including Atlantic. Norchip, Monona, Superior, Norwich and Kennebec, of which the first four are most popular. According to the case studies, processors require potatoes with minimal reducing sugar, white tubers and flesh and minimal eye depth. Potatoes should also be round, oblong or oval. Size and specific gravity can vary somewhat as indicated by Table 3. Table 3 also ranks these characteristics from most important to least important to processors.

Table 4 summarizes to what degree the top four potato varieties that are used in processing in Ontario meet processors' required technical characteristics. On this basis the Atlantic and Norchip varieties are best.

Ontario potato producers grow each of the these four varieties on a commercial scale, but according to processors these potatoes do not meet their required technical characteristics consistently, and it is the most important characteristics which are not met. Sugar content is particularly important, and is difficult to control because it is heavily influenced by storage conditions (time, temperature).[3] Since potato chips have a shelf life of only ten to twelve weeks, they must be manufactured continuously throughout the year while potatoes are stored. The peak of the processing year occurs from May to July and from September to December, Processors vary in the proportion of annual production that occurs in any given

Table 3: Technical Characteristics of Potatoes Required by Ontario Chip Processors

Technical Characteristic (Ranked in Order of Importance to Processors)	Processors' Requirements	Reasons for Importance
1. Sugar Content	low or minimal	colour, taste and texture of chips
2. Specific Gravity	ranges across the case study firms 1.070 and higher 1.070 to 1.100 1.080 and higher over 1.090	processing efficiency, fry time oil absorption chip yield quality of chips
Appearance and Absence of Defects - eg. eyes	minimal eye depth	efficiency - length of time required for eye removal
3.Size	ranges across the case study firms small - 1 7/8 " medium - 2 1/2 " large - 3 3/4 "	number of slices per tuber chip yield peel loss bulk density
4. Shape	round, oblong or oval	
5. Flesh Colour	white	colour of chips
6. Surface Texture	lightly netted to fairly flaked	amount of peel waste (yield) efficiency / fry time

Table 4: Rating of Technical Characteristics of the Four Most Popular Chipping Varieties of Potatoes in Ontario[4]

Technical Characteristic (Ranked in Order of Importance)	Variety			
	Atlantic	Norchip	Monona	Superior
1. Sugar Content	varies	varies	varies	varies
2. Specific Gravity	high	medium to high	medium	high
Appearance and Absence of Defects	shallow, white eyes; white skin	shallow eyes; creamy white skin	shallow eyes of the same light creamy colour as the skin	moderately deep eyes of white, white skin
3. Size	varies	medium	varies	medium
4. Shape	oval to round	round to oblong	oblong to ovate	oval to oblong
5. Flesh Colour	white	white	white	white
6. Surface Texture	lightly netted to heavily flaked	smooth	smooth	smooth to fairly flaked

month; it ranges from a low of 7 percent to a high of 10 percent. Atlantic potatoes account for 40 to 50 percent of individual processors' requirements, while Norchip, Monona and Superior account for approximately 30, 15 and 4 percent of annual use respectively.

Processors also indicated that they cannot get the sizes of potatoes they need, and that the specific gravity is also not what it should be. While all of the above problems manifest themselves as technical deficiencies, they are influenced significantly by economic factors. as is discussed in the next section.

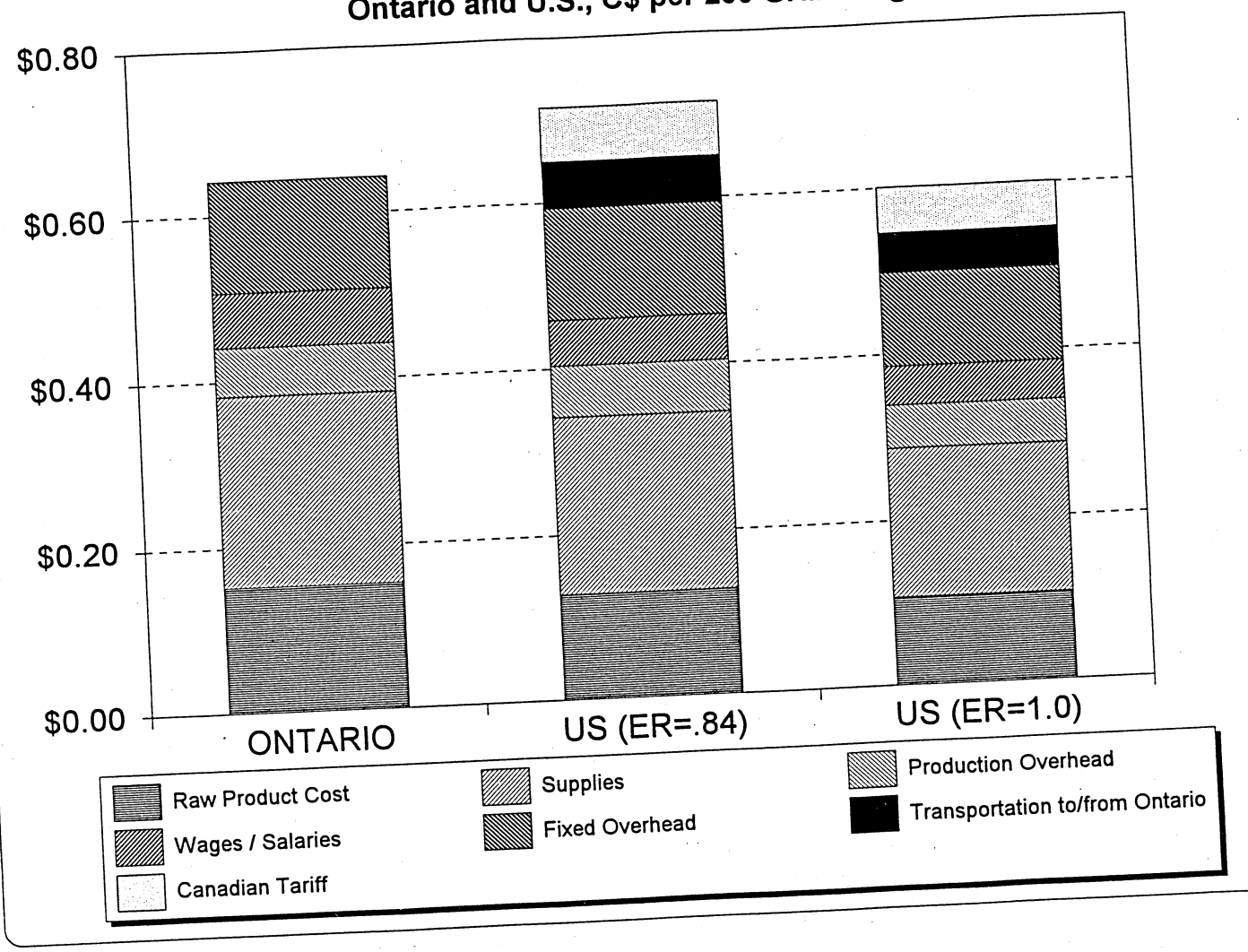
3.2 Economic Characteristics of Potatoes for Chips

Potatoes with the appropriate technical characteristics have to be available in sufficient quantities at a price that allow potato chips that are produced in Ontario to be sold on a price competitive basis. This condition implies that the Ontario industry has to have the ability to produce, store and market the raw product on terms that allow this condition to be met or that raw product can be imported to supplement domestic product.

The quantities of potatoes that chip processors needed was determined through the case studies, as were the proportions obtained from domestic and imported sources, the proportion of annual requirements used each month and the varieties used. The results indicate that Ontario potato producers are able to supply 90 percent of processors' total requirements, and during the months of August and September they can do so directly from the farm, while from October to some point in May they do so from stored potatoes. Availability of domestic product is only a problem during the months of May to July. In the past, potatoes for chip processing have been imported during these months. In May and July, 25 to 70 percent of processors' requirements are imported, while 75 to 100 percent are during June.

The issue of whether Ontario potato growers can supply raw product on a price

Figure 2: Potato Chip Cost Components
Ontario and U.S., C$ per 200 Gram Bag



competitive basis is considerably more complicated. It requires an analysis of both processors' and producers' cost components, the cost of storing potatoes, and comparing the total cost of supplying Ontario potatoes throughout the year to the price that they could be imported from U.S. sources.

Producers' Costs: Potato production requires several variable inputs which vary in their proportion of total cost; seedstock (15 to 20 percent), chemicals (21 to 23 percent), fuel (4 to 9 percent), labour (11 to 15 percent) and fixed inputs (machinery 22 to 27 percent), percent) and land (6 to 8 percent).[5] Producers have to be able to cover these costs, plus earn an acceptable profit to remain in the business, while selling potatoes at a price that allows the chip processors to be cost competitive with their U.S. counterparts.

Processors' Costs: Chip processing involves several inputs which contribute more to total cost than potatoes. The equation below is a standard cost function, and its components for potato chips are briefly described below it.

$$C_{ch} = \sum_{i=1}^{n} K_i P_i Q_i$$

where C_{ch} is the unit cost of potato chips
K_i are the input - output coefficients for the input to potato chips
P_i are the input prices
Q_i are the input quantities and include the following:

- potatoes
- labour
- packaging and other supplies
- production overhead (in plant)
- other overhead (management, office expenses etc.)

Figure 2 indicates that for a 200 gram bag of chips, which was chosen as representative of larger bags - although 180 and 190 gram bags are becoming more common, the total processing cost is C$0.64 in Ontario, compared to C$0.59 for the U.S. For both locations, supplies such as packaging, spices etc. account for a larger proportion of cost than raw product cost; just over 76 percent in Ontario and approximately 79 percent in the U.S.

Raw product cost accounts for more of total cost than fixed overhead in Ontario, while in the U.S. raw product cost accounts for slightly less. In both Ontario and the U.S., wages and salaries and production overhead account for less of total cost than raw product.

Storage Costs: Since potatoes must be stored for processing into chips throughout the year, raw product prices include a storage component which reaches approximately 50 percent of the harvest price in the months immediately preceding the new harvest. Storage cost reflects the cost of the space and time required for storing the potatoes throughout the year as well as inward and outward handling. It also reflects the deterioration of the potatoes which occur as a result of storage, which in turn contributes to increases in chip processing costs due to product shrinkage (causes a lower yield), Storage conditions also affect several other potato characteristics of importance to processors including; specific gravity which increases with time in storage; sugar content which affects the colour of chips, and; discolouration due to general physiological breakdown.

Transfer Costs: Fortunately, for Ontario chip processors, U.S. product cannot move to the Ontario market without cost. Transportation charges, tariffs, and various other potential costs related to inspection and other non-tariff barriers, offer Ontario processors some insulation from U.S. competition, approximately 10 percent of the landed cost at an exchange rate of C$/US$ = 0.84. At this value the exchange rate also offers Ontario chip processors some price insulation, approximately 11 percent. Figure 2 also makes it clear that the tariff protection which is being phased out due to the Canada-U.S. Trade Agreement, is critical to Ontario's processors being able to supply their domestic market on a cost competitive basis with U.S. product; it accounts for 10 percent of the landed price. The figure also illustrates the impact that transportation and tariff charges have on the landed price of potatoes in Ontario for potatoes that are imported from the U.S. southeast (North Carolina, South Carolina

and Florida). Without tariffs and transportation charges, U.S. potatoes are priced at 63 to 78 percent of Ontario potatoes. When only transportation costs are considered, potatoes imported from the U.S. are priced at 97 to 130 percent of Ontario potatoes, and when tariffs are considered this ratio increases to 101 to 136 percent.

Cost Reduction Options for Ontario Processors: Chip processors have several options in their aim to be cost competitive with U.S. product in the Ontario market after tariff protection for chips is eliminated. One option was to press for a reduction in potato prices; a popular option given that there was widespread concern about the horticulture industry's ability to compete with its U.S. counterpart in light of the Canada-U.S. Trade Agreement. This option has several variations depending on the tariff rate, exchange rate, the trade orientation of the potato chip industry (import versus export) and whether the cost reduction applies only to the raw product or is spread equally among all inputs. The results of the analysis of these various cost reduction options are summarized in Table 5. As well, the upper and lower limits of these results is illustrated in terms of potato prices along the right margin of Figure 1.

The results in Table 5 indicate that when Ontario is an import position the raw product costs faced by chip processors can increase and the industry remain cost competitive with U.S. product under several combinations of exchange rates and tariff levels (indicated by positive percentage differences). Fewer combinations of tariff and exchange rates allow for an increase in raw product costs if all input costs increase. For all combinations of exchange rates and tariffs, raw product costs must decline for the Ontario chip industry to be cost competitive when exporting to the U.S. market. Table 5 indicates clearly that if all input costs adjust, the decline in raw product cost required to be export competitive, and import competitive in some scenarios, is substantially less than if only raw product costs decline. These results illustrate amply why Ontario potato growers, as many of their counterparts in

Table 5: Competitive Raw Product Price Scenarios - Percentage Difference from Base Price

Base Price (C$/CWT)	$9.34	Only Raw Product Cost Adjusts		All Input Costs Adjust	
		Import Position	Export Position	Import Position	Export Position
Tariff	10.0%				
Exchange Rate	0.81	65%	-77%	15%	-8%
	0.84	48%	-76%	11%	-8%
	0.87	32%	-75%	8%	-8%
	1.00	-27%	-71%	-6%	-7%
Tariff	0.0%				
Exchange Rate	0.81	21%	-39%	-4%	-9%
	0.84	5%	-38%	-8%	-9%
	0.87	-9%	-36%	-11%	-9%
	1.00	-63%	-32%	-22%	-7%

other of the province's horticultural industries, resent the implication, which is do often drawn, that raw product prices are to blame for the processing end of the industry's difficulty in competing with the U.S. However, since they are one component of cost, the OPGMB agreed it could benefit from an analysis of how the raw product cost component of chip could be reduced, and this is examined in detail in the next section.

3.3 Raw Product Cost Reduction Options

As suggested by the unit cost equation for chips there are several routes to reducing cost, and within these there are also several approaches to reducing raw product cost; reducing prices and various methods of improving productivity. If only price reductions are used to reduce raw product cost, the percentage reductions required are obviously the same as for costs, as summarized in Table 5. Fortunately for the growers, there are several productivity oriented approaches that also had not been exploited by the industry. Several of the more promising approaches combine economic and technical improvement components, and all can be achieved through changes to the annual agreement negotiated between the Ontario Potato Growers' Marketing Board and chip processors operating in Ontario. Before turning to this discussion, we briefly discuss the components of this annual agreement, while the specifics are detailed in Table 6.

As Table 6 indicates, nearly all aspects of the sale/purchase of potatoes for processing are negotiable within the agreement between processors and the OPGMB, including: price and financial considerations such as fees for processor licensing and on-farm services; technical aspects such as grades, varieties to be delivered, delivery and inspection schedules and particulars; conditions for non-performance; administrative requirements and government regulatory requirements.

Table 6: Components of the Annual Agreement for Potatoes Negotiated Between the Ontario Potato Growers Marketing Board and Chip Processors[6]

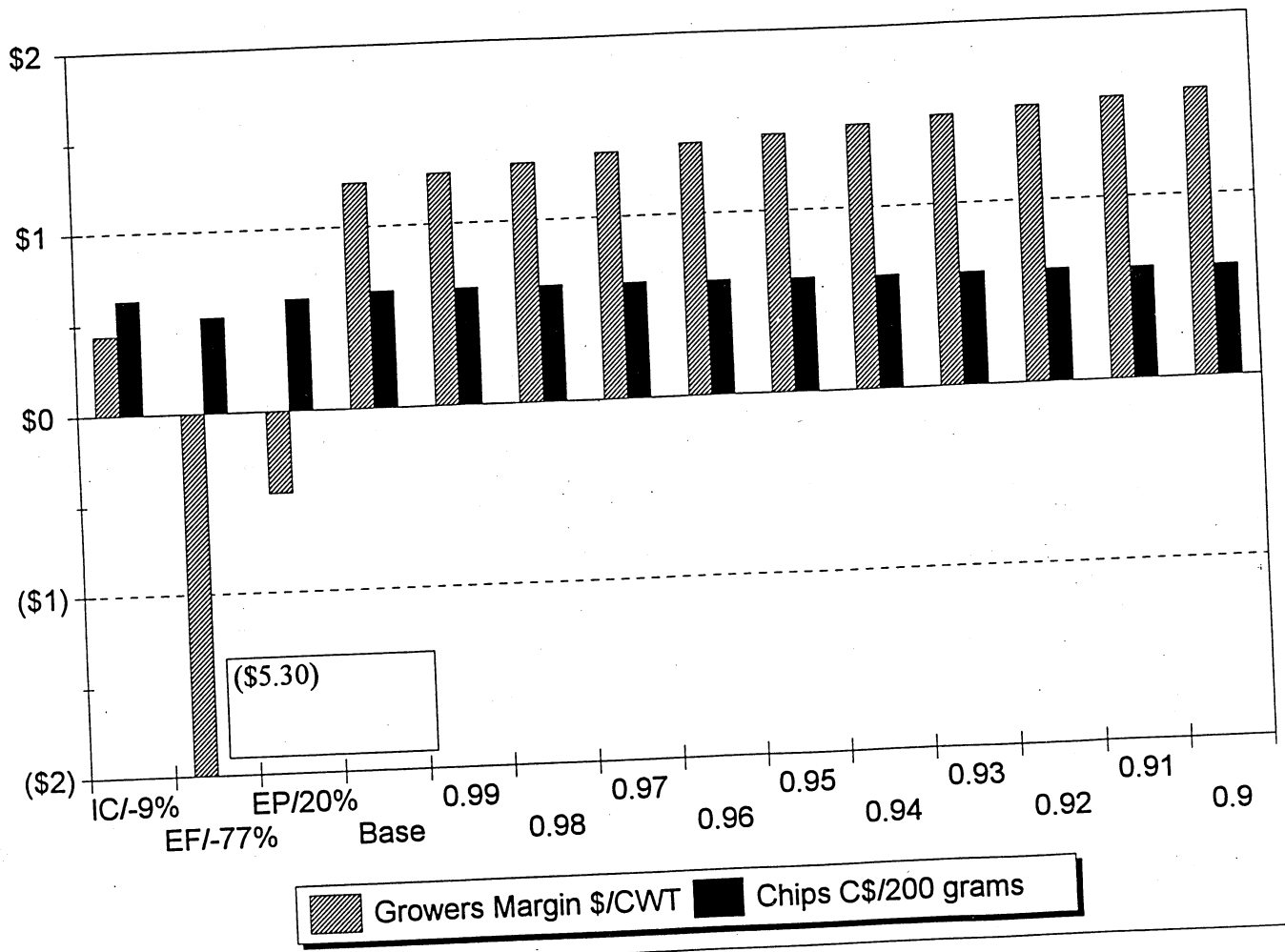
Component	Provisions Typically Included
Price / Financial	- price schedule (minimum price, timing, locations) - processor licensing fees - fees for other services (ie. pallet boxes. sprout inhibitors, seed and fertilizer)
Technical	- grades (must be specified and described on entry into storage) - varieties (must be identified and possibly segregated), quantity and weight of potatoes to be delivered by producers - services provided by producers and processors (ie. provision of containers / pallet boxes, sprout inhibitors, seed and fertilizer) -need, cost and timing of inspection and identification of person who is responsible - recommendation on use of seed potatoes - delivery (time, location, type of container)
Non-Performance	- conditions that enable the producers or processors to be excused from fulfilment of the contract
Administrative	- duplicates of all contracts between individual producers and processors must be sent to the OPGMB (includes price and quantity options used)
Government Regulation	- purchase and sale of all potatoes is done in standard units (CWTs, not metric) - detailed information must be provided on residues from use of agricultural chemical to Federal Food and Drug Directorate, Department of National Health and Welfare

The scope of the annual agreement implies that there are several options for reducing raw product costs that can be developed within the negotiation process and annual agreement. They fall into two broad categories; price reductions and improvement of technical characteristics of potatoes (which may also be encouraged through pricing), and they are analyzed in order of complexity in the following subsections.

Standard Price Reductions: The simplest way for chip processors to achieve a reduction in raw product cost is to pay a lower price for potatoes. This option simply shifts the burden of becoming cost competitive entirely onto to the growers. Based on the range of cost reduction scenarios in Table 5, we calculated the impact of the required price reductions on potato growers' margins as well as chip processing costs. The results for this scenario and the others are illustrated in Figure 3. The minimum impact, a decline from a margin of C$1.24 to C$0.44, is associated with the scenario in which Canada is an importer, the Canadian tariff is zero and the exchange rate is 0.87 C$/US$. The maximum impact, a decline from C$1.24 to a loss of C$5.30, is associated with Canada being an exporter, facing a tariff of 10% and an exchange rate of C$/US$ 0.87. Potato chip processing costs would decline from C$0.64 to C$0.63 for the import position and to C$0.52 for the export position.

Export Pricing: This option allows chip processors who can demonstrate that they are exporting to the U.S. to pay a reduced price for the potatoes used in the exported product. For example, if a chip processor is able to export 20 percent of its production to the U.S. it would pay the "export competitive" raw product price, such as is indicated in Table 5 on 20% of its potato purchases. This would reduce the average price paid for raw product and reduce processing costs from C$0.64 to C$0.61, while growers' margins would decline from C$1.24 to a loss of C$0.45 as indicated in Figure 3.

Figure 3: Impact of Selected Cost Reduction Options



Improve Technical Characteristics Through Premium Pricing: The chip processors that participated in the case studies indicated that there were several technical characteristics that were important to the quality of potato chips that were not being met consistently by growers. Production of potatoes with the required characteristics could be encouraged through premiums based on distinct categories or a sliding scale. For example, premiums could be paid for potatoes without defects, the appropriate sizes of potatoes and those with the required specific gravity and sugar content as indicated in Table 3. These premiums could also be based on the degree to which potatoes met the requirement. This would reward growers who were making progress towards meeting the processors' requirements, while premiums based on distinct categories would only reward the grower once the requirement was met, while processors would benefit from raw product that approached their requirements. Since we have no quantitative data on the impact of these technical characteristics on the output of potato chips, we cannot estimate the cost impact of these options.

Shared Risk Pricing: With this option growers and processors share in the risk and the financial penalties or rewards associated with raw product deterioration and changes in market prices throughout the year. As with the current system an annual price schedule for potatoes would be negotiated but only the quantity fit for chip processing would be priced, or product that was downgraded in terms of quality would be priced lower. If the market price was higher and potato quality deterioration was less than expected, the processors would gain and growers would lose, while in years in which the opposite conditions occurred, growers would gain and processors would lose. Since we could only model the impact of this option using assumptions about prices and raw product deterioration, we did not estimate the cost impact of this option.

Joint Productivity Pricing: Potato growers and chip processors can both improve their

financial position by improving the productivity of the growing to chipping process, or any portion of it, and sharing the gains. This option will only work for growers and chip processors who are willing to work together on the farm, on delivery and storage and other processes. The simplest variant of this option is for processors to assist growers in choosing the appropriate cultivars, assisting with cultural management of the crop, providing the appropriate chemicals and thereby increasing the output per acre. In Ontario, an interesting twist on this option makes it particularly attractive. In the past, annual marketing agreements in Ontario such as the one negotiated between the OPGMB and the chip processors have specified the amount of product to be delivered to the processor. Often additional potatoes were available, but since the contract specified total delivery through marketings per acre, the harvested quantity per acre could easily surpass marketings per acre. Given that potato yields are quite variable (ranging from 182 to 215 CWT/acre from 1985 to 1990), significant quantities of potatoes were sold to other markets at lower prices, used for other purposes or left in the ground.

Joint productivity pricing allows growers and processors to share from this additional production and aim for it by establishing a multi-year moving average of marketings per acre and allowing excess production to be sold at progressively lower prices. This enables growers to earn additional revenue and processors to process more product at successively lower raw potato prices and cost. As illustrated in Figure 3, as productivity per acre improves prices can be progressively reduced from 100 percent of the current price to 90 percent, but growers can earn higher margins as long as costs decrease faster than revenue. At the same time processors can benefit from lower potato prices and increased throughput. Achieving a 10 percent increase in productivity per acre allows growers' margins to increase from C$1.24 to C$1.59 and chip processing costs to decline from C$0.64 to C$0.61 per 200 gram bag.

4. Conclusions

Ontario's potato chip industry is capable of competing successfully with its U.S. counterpart. Although, Ontario growers currently do not consistently meet the chip processors' requirements, they are capable of doing so at prices that will allow Ontario processors to be cost competitive with imports from the U.S, However, they will need to improve their productivity to do so. Fortunately, there are several options reducing chip processing costs that can also benefit Ontario potato growers, and the most promising one is geared to improving productivity at the farm level and at the processing level of the industry. This option, as well as the others that were examined, can all be achieved within the annual agreement negotiated between the OPGMB and chip processors. Since joint productivity pricing offers the most transparent win-win outcome it has excellent chance of being supported by both level of the industry. However, price premiums for desirable technical characteristics are also a promising approach.

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