ECONOMIC FEASIBILITY OF MINIMALLY PROCESSED PORK AND FISH IN QUEBEC

Michael Owusu-Manu

Department of Agricultural Economics

Faculty of Agricultural and Environmental Sciences,

School of Dietetics and Human Nutrition

McGill University, Montreal

March, 1997

A Thesis Submitted to the Faculty of Graduate Studies and Research

in Partial Fulfilment of the Requirements of the Degree of

Master of Science in Agricultural Economics

0-612-29760-8

ABSTRACT

The focus of this thesis was on the economic feasibility of three food processing projects. They involved freezing of pork loin and fish using cryogenic freezing and stored at -18, -12 and -7°C, and modified atmosphere packaging (MAP) of pork loin using the a combination of nitrogen and carbon dioxide gases, chitosan dip and stored at 5, 10, and 15°C. A production plan with similar layout and capacity was adopted for the Montreal area. The benefit-cost analysis (BCA) of each project was carried out assuming that each plant operated approximately 2000 hours per annum at full capacity. Net present value (NPV) and benefit cost ratio (B/C ratio) at 8% discount rate, and internal rate of return (IRR) were determined for each project. The calculations show the NPV of $2.4 million, $1.8 million, and $3.4 million; B/C ratio of 1.09, 1.09, and 1.10; IRR of 15%, 13%, and 18% for frozen pork loin, frozen fish and MAP pork respectively. All IRRs were higher compared to the 1995 return rates of TSE of 9.7% and the average return of capital of 8.8% for some food and beverage industries. These economic values are sensitive to changes in working hours, price of raw materials and finished products. It is also found that MAP products could be stored at temperatures up to 15°C reducing the up to 60%. Frozen products could be stored at temperatures of -12°C and below only if the length of distribution chain can be reduced. This would decrease electricity costs up to 36% at each level of distribution. It can be concluded that the three projects are economically profitable.

RESUME

Cette thèse est basée sur la faisabilité économique de 3 procédés de conservation d'aliments. Ceux-ci consitaient en la congélation de cotelettes de porc et poissons par l'usage de cryogenique aux températures différentes: -18, -12, et -7° C, et en l'emballage à l'atmosphère modifiée (MAP) de cotelettes de porc par l'usage de l'azote et dioxyde de carbone, bain de chitosan puis conservés aux températures de 5, 10, et 15 ° C. L'analyse de coût-bénéfice pour chaque procédé était réalisée en assumant que chaque traitement opérait à sa capacité maximale d'environ 2000 heures par année. Les valeurs présentes nettes (NPV) sont de $2.4, $1.8 et $3.4 million; les ratio B/C sont de 1.09, 1.09 et 1.10 tandis que les taux de rendement internes sont de 15%, 13% et de 18% respectivement pour les cotelettes de porc, poisson congelés et cotelettes de porc emballées à l'atmosphére modifieé. Tous les IRR sont élevés en comparaison avec ceux de l'année 1995 (9.7% taux de TSE) et de 8.8% de rendement moyen du capital pour quelques industries d'aliments et boissons. Ces valeurs économiques sont sensibles aux changements de durée de travail, prix de matières premières et de produits finis. Il est aussi trouvé que les produits MAP pouvaient être conservés à des températures supérieures à 15° C, ce qui réduirait le coût énergétique à 60%. Les produits congélés pouvaient être conservés à des températures de -12° C et même moins que ça si seulement la durée de la chaine de distribution peut être réduite. Ceci décroîtrait le coût de l'électricité 66%. Il peut être conclu que ces 3 procédés sont économiquement profitables.

ACKNOWLEDGEMENT

I take a special pleasure in this opportunity to thank all those who helped me with this thesis. My special thanks to my two supervisors, Dr. Kisan Gunjal who was also my academic advisor, and Dr. H. S. Ramaswamy of the Department of Food Science and Agricultural Chemistry, who also provided financial assistance, for their supervision and guidance.

I would also like to thank Dr. Garth H. Coffin, and all the staff of the Department of Agricultural Economics for their advice, guidance and inspiration throughout my programme at McGill University. To Dr. B.K. Simpson and Dr. J.P. Smith, both of the Department of Food Science and Agricultural Chemistry, I express my special thanks.

I also express special gratitude to my family in Ghana and England and my cousin, Dr. Samuel K. Asiedu of the Nova Scotia Agricultural College, for their encouragement and guidance. As for my friends and colleagues in this Department, especially Medhat El-Helepi, Ramaradj Shanmugam, Kumba Zantoko, Eddy Kabasele, Teklay Messle and Ms Urmi Aneja, I am grateful for your great help. I would also like to thank Mrs. Pat Atkinson who has been a great help in the department and Mr. Kwadwo Appaigyei-Atua (Graduate Student, Faculty of Law, McGill University) for taking the time to review my draft.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The combined effects of moisture, enzymes and microbial activities influence spoilage and contamination of food products over time. As a result of this perishability, the natural shelf life of most food products is short, ranging from a few hours to few days. For example, meat and fish products with high moisture content deteriorate faster than grains that have a lower moisture content at harvest. Food spoilage can lead to losses for firms involved in producing and supplying food products. Contaminated foods can result in illnesses and possible death in human beings. Table 1.1 shows certain food contamination cases and the number that resulted in deaths.

Table 1.1: Food Borne Outbreaks due to *Listeria Monocytogenes*

Location	Number of cases	Number of deaths	Food Associated
Boston, 1979	20	5	Raw vegetables
New Zealand,1980	29	9	Shellfish, raw fish
Maritimes, 1981	41	17	Coleslaw
Massachusetts, 1983	49	14	Pasteurised milk
California, 1985	142	48	Cheese
Philadelphia	36	16	Salami
Connecticut, 1989	9	1	Shrimp
UK, 1987-1989	300+	NA	Pate

Source: Farber and Peterkin, (1991).

Processing and preservation techniques extend the shelf-life of food products and reduce food spoilage and contamination. These techniques include reduction of moisture content, gases, enzymatic or microbial activities or their combinations. Examples of the techniques are drying, freezing, canning, modifying the micro-environment of the packaged product (modified atmosphere packaging and vacuum packaging) and use of chemical preservatives.

Traditionally, minimally processed foods are attractive to both consumers and producers because they maintain the best opportunity for retaining fresh food quality without incurring excessive costs of processing. Consumers today prefer fresh food products with minimum or no chemicals added. Therefore, food processors need to provide products that can meet consumers' preferences. Provision of such products will involve costs but will also provide benefits to both processors and consumers. Costs in this case are represented by the amount it takes to provide the processed products. Benefits represent the expected gains such as shelf-life extension, reduced losses, high product quality, and food safety. For example, the shelf-life of fresh pork would extend from four days (Morris, 1995) to 10 months at -18 ^{O}C (Johnston *et al.*, 1994; F.A.O, and International Institute of Refrigeration, 1984). Changes that take place in this process are minimal. This is because water, the most active component that sustains microbial activities, becomes unavailable in the frozen state.

1.2 Objectives of the Study

The study dealt with the economic aspects of processing and packaging of muscle foods with specific reference to pork and fish. The main objectives of the study were the following:

1) To estimate costs of freezing pork and fish and modified atmosphere packaged pork at the industrial level.
2) To develop models to establish costs and benefits of processing each product using specified techniques.
3) To evaluate the profitability of these processes by calculating the net present value (NPV), the internal rate of return (IRR) and benefit-cost ratio (B/C Ratio) over the required investment on the new technology.

1.3 Organisation of the Study

This study examined the economic feasibility of three food processing procedures. It was based on information provided from the laboratory studies for conventional freezing and storage of muscle foods and modified atmosphere packaging (MAP) for shelf-life extension for pork, seeking to extend the high quality, shelf-life and margin of safety of the products. This chapter provides an overview of issues involved in food storage and states the objectives of the study. The next chapter presents an overview of the distribution network that handles products in the Quebec food industry. It outlines briefly product movement in the pork and fish industry. In chapter 3 literature relevant to the study was reviewed. This helped us to reach conclusions needed for model specification. Chapter 4 describes the methodology selected to identify, quantify and measure costs and benefits. The chapter begins with a discussion of the food processing techniques and processing procedures. This is followed by discussion on how costs and benefits are measured and evaluated. Chapter 5 discusses the findings of the analysis. The final chapter summarises the main findings and conclusions of the study.

CHAPTER 2

OVERVIEW OF THE QUEBEC FOOD INDUSTRY

2.1 Introduction

This section gives a brief overview of the Quebec food industry. The industry consists of six activities (Turcotte, 1994). The food distribution system consists of two sections, one for the domestic market and another for export markets. The domestic market has two arms, one for institutions such as hotels, restaurants and hospitals, and the other for the retail sector. Both the domestic and export market channels were assumed to have the same prices for the products. Total food retail sales in Quebec for 1993 were $13.4 billion, and $18 billion for the domestic and export channels, respectively. Figure 2.1 illustrates the branches and direction of the food distribution network for pork and fish products in Quebec.

2.2 An Overview of the Quebec Pork and Seafood Industry

Food processing is the largest sector of the agri-food industry. Both pork and fish processing activities rank high in importance in the Quebec economy. Quebec is the largest producer of pork in Canada. The proportion of pork production as part of total Canadian production increased from 12% in 1971 to 32% in 1991. Cash receipts for pork products accounted for approximately 23%

of all farm cash receipts in 1991. Exports increased 9% from 1993 to 1994, two-thirds of which was processed pork (Agriculture and Agri-Food Canada, 1996a). The Quebec seafood industry is the third largest after the Atlantic provinces and British Columbia. The Atlantic provinces (including Quebec) accounted for 73% of total Canadian fish landings in 1993. Canada exports about 90% of total fish production (Agriculture and Agri-Food Canada, 1996b).

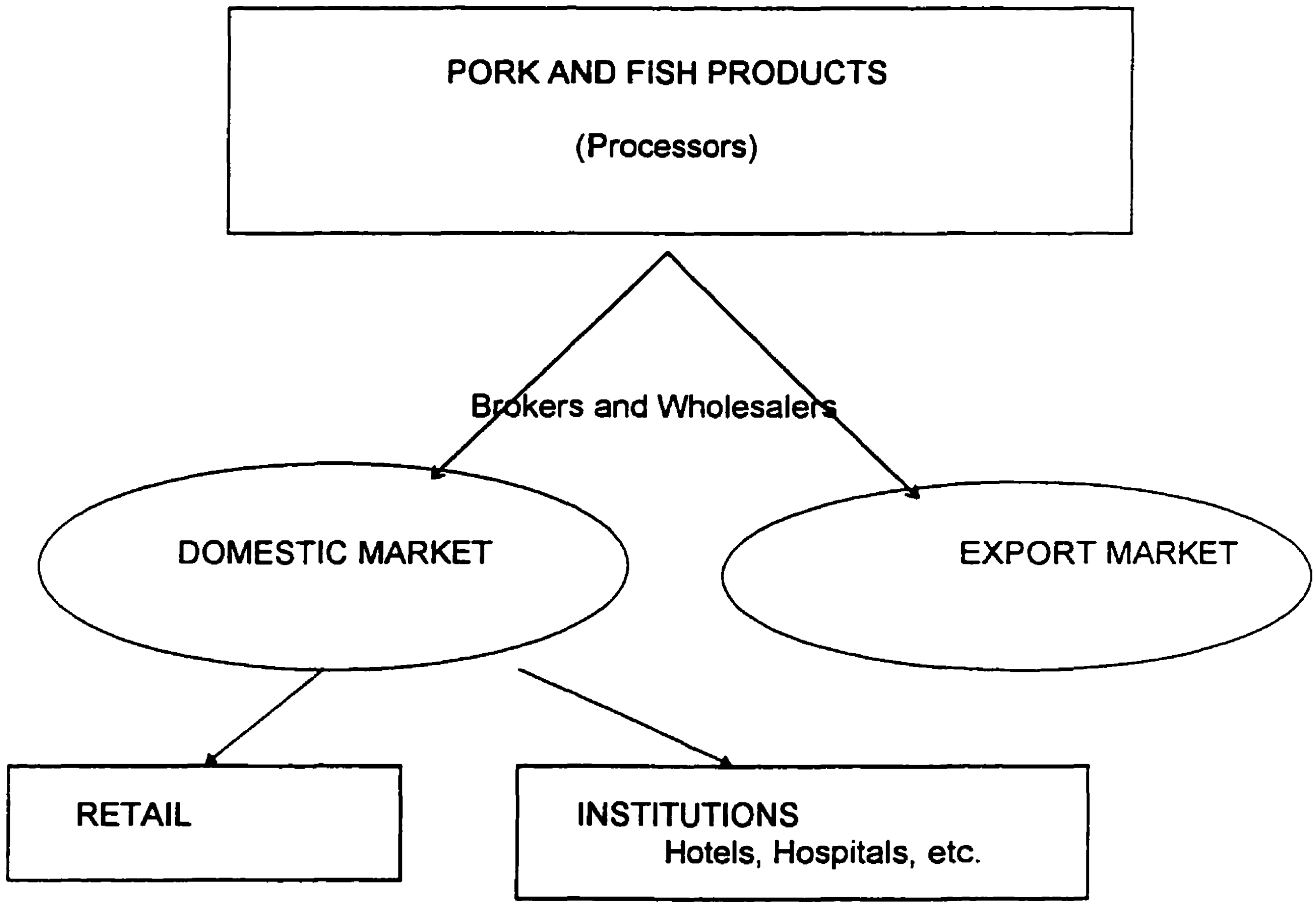

Figure 2.1: A Typical Distribution Channel for Pork and Fish Products

In 1993 both industries employed 20.2% of the total work force in the Quebec food and beverage processing sector (Statistics Canada, 1993). The activities of the manufacturers taken together add value to products as they move from farm gate to the basket of the consumer. The red meat industry accounted for 20% of all this value added of the food and beverage industry with the fish industry accounting for 12%.

Per capita consumption of fish and pork have increased slightly since 1970 as shown in Figure 2.2 (Apparent Per Capita Consumption in Canada, Statistics Canada). Although per capita consumption of red meats has fallen slightly since 1970, pork consumption has been quite stable, and accounts for 30% of all meat consumption.

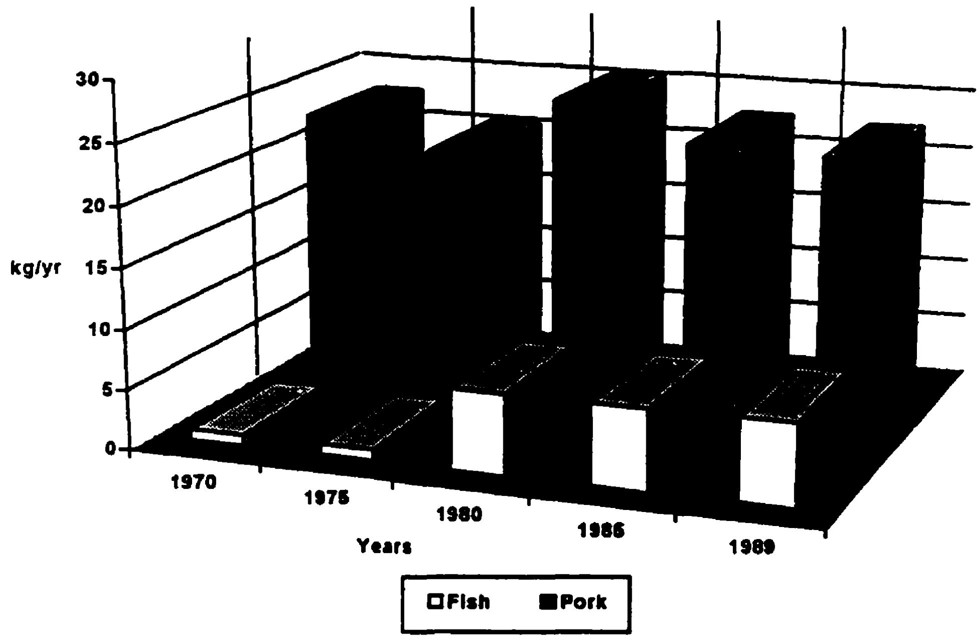

Figure 2.2: Trends in Per Capita Consumption of Fish and Pork in Canada, 1970-1989 (Retail Weight - kg per year)

Source: Robins, (1990).

Following is a brief description of the activities at each level of the distribution network.

2.2.1.1 Manufacturers

Manufacturers or processors produce products aimed at a target market. The products can reach the consumer in one of three ways. The first is by a broker who is responsible for promoting the product into the distribution channel. The product is delivered to the broker or the wholesaler. Furthermore, some processors have a sales department that performs the same activity as the broker. The wholesaler or the retailer in this instance receives the product directly from the processor. Finally, the retailer buys the product.

The basic activities undertaken by the processor are the production of goods and services. The services include: as product development, packaging, product characteristics, product policies for retailers and consumers and promotion.

2.2.1.2 Brokers

Mainly involved in marketing activities, brokers act as commercial representatives of processors. Although sales are their main activity, they also do some storage and distribution. A broker may represent several processors, and is paid a part of sales for activities performed. Some brokers in Quebec are Belgo, Kouri Provincial, Van de Water Raymond, EFFEX Marketing and

Freeman Alimentel. Other activities performed by the sector include offering advice to processors on choice of products, display and promotion.

2.2.1.3 Wholesalers-Distributors

Wholesalers buy products in large quantities to obtain better price deals and resell them to their stores and other affiliates. Provigo, Metro-Richelieu and Hudon & Deaudelin account for approximately 80% of the point-of-sales wholesale activity in Quebec. Wholesalers-distributors perform marketing activities that include offering products and services such as product lists, customer service policy, and training of employees.

2.2.1.4 Retail Stores

Retail outlets are contact points for goods and services and the majority of consumers. There are several types of retail outlets in Quebec. These include supermarkets, maxi-markets, warehouse-clubs, convenience and speciality stores. Some marketing activities performed at the retail level include product display, pricing, offering a variety of products and general services, and promotion.

2.2.2 The Quebec Seafood Industry

Considering the economic activity performed, there are four sectors in the industry (Dupuis, 1994). The primary sector centres on fishing. The secondary sector concentrates mainly on processing and resource delivery to the primary sector. The tertiary sector delivers goods and services to consumers, and finally, the quaternary sector provides services to the entire seafood industry. This section explains briefly the activities of the second and third sectors. These are comprised of processors, wholesalers and retailers. All the sectors interact in serving the economy.

The primary sector, the source of the raw material used by the processors, is concentrated in the Gaspe, Magdalen and North Shore (maritime) regions of the province. The secondary sector (processing) is found in the maritime regions and in the Montreal and Quebec City areas (metropolitan areas). The wholesale and retail sector operate throughout the province, but are concentrated mainly in the urban centres. In 1992, total employment of the industry was approximately 15,600 (9,677 person-years). Fishing accounted for 15 percent of the jobs, while processing accounted for 26 percent (Figure 2.3).

Figure 2.3 Distribution of Employment in the Quebec Seafood Sector

The primary and processing sectors accounted respectively for 18 and 31% of value added (Figure 2.4). The tertiary sector accounted for 52% of all the industry's activities.

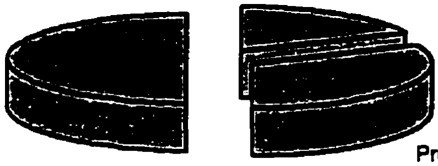

Figure 2.4 Distribution of Value Added in the Quebec Seafood Sector

The volume of total fish landings decreased by 16.9% from 708,000 metric tonnes in 1992 to 585,000 metric tonnes in 1993. All the same, the total value was up 2.9% from $ 88.9 million to $ 1.5 million (nominal dollars). The Gaspe region accounted for nearly half of total fish landings in the same year.

There were 74 establishments involved in some sort of seafood processing[1] in 1992. Eighty seven percent of total fish landings were processed, leaving less than 20% unprocessed. The sector had total sales of $ 250 million, and $ 100 million of value added in the economy, employing approximately 7,000 workers. The majority of the workers were seasonal. Approximately 60% of the manufacturing took place in the maritime region, and was done at 58 plants, which obtained raw materials within the province. The remaining 16 plants

[1] An establishment is categorised as a processing plant if its sales from processing activities accounts for 50% of greater or total sales.

located in the Montreal and Quebec City areas obtained raw materials mainly outside Quebec.

Distribution and trade of seafood products form the third sector. In 1991, there were 75 wholesalers in Quebec, of which 48 obtained their supplies from the province. Total sales from commercial activities in this sector were $361 million in 1991. Profit before taxes increased by 12.4% from 1987 to 1991, despite the 30% increase in wholesale firms over the same period. The wholesale sector has been important as an upstream activity for the primary and secondary sectors, as well as for retail and external trade. The wholesale sector employed approximately 987 people and the retail sector 3092 in 1991. There were about 108 firms involved in seafood retailing in 1991. Both sectors generated $478.5 million in the domestic market and $122.8 in exports from sales in 1991. The retail sector accounted for 20% of domestic sales.

2.2.3 The Quebec Pork Industry

The meat processing industry is the largest sector of the food manufacturing industry in Canada, accounting for $9.5 billion in shipments in 1994. In 1993 there were 128 red meat processing establishments in Quebec, employing approximately 7,000 workers. The sector processes a wide variety of products, including fresh and frozen cuts, cured, smoked, cooked products, sausages and delicatessen foods. Approximately 70 % of all further processed meats, such as cold cuts and sausages, are made with pork. Pork exports went up 9% in 1994 from 1993 to 256,177 tonnes. Total sales of processed pork were approximately 28 million kg in 1994.

Hog processing in Canada, and particularly on Quebec, is an important economic activity (Churches, 1988; Owen, 1984). The sector consists of the slaughtering, processing and further-processing industries, which link hog producers, wholesalers, retailers, and other final users of hog products.

The processed products are sold either as wholesale cuts, such as loins and bellies, or as retail cuts, such as chops or roast. The wholesale cuts are sold to further-processors who convert the products into products such as sausages, bacon, deli and hams. Industrial users buy by-products such as lard and insulin. Each of the three levels of sales participates in both the domestic and export markets. The US is Canada's most important foreign market (Kennedy and Churches, 1984), followed by Japan. About two-thirds of the 28 million kg of processed pork sales in 1994 were exports to the USA (All about Canada's Red Meat Industry, 1996). In 1989, the USA imported 80% of total exports and Japan 12% (Hog Processing, Industry Profile, 1990-1991).

Information on the financial position and performance of hog processing companies in Quebec is not readily available. This is because they are privately owned and publish very little information. Most of the information on the pork industry has to be extrapolated from information about overall performance of the red meat industry.

CHAPTER 3

REVIEW OF LITERATURE

3.1 Introduction

This chapter reviews previous literature related to economic project appraisals, food processing, food safety and storage. The first section looks at previous literature on benefit-cost analysis (BCA) and its role in feasibility studies. The next section reviews at studies related to the food processing industry.

3.2 Previous Studies on the Estimation of Benefits and Costs

Benefit-Cost analysis (BCA) plays an important role in assessing the viability of investment projects (Edgar, 1986; Hacking, 1986; Kohli, 1993; Horton, 1994), national policy issues (Swinbank, 1993), and evaluating projects (Hogg and Vieth, 1977; Horton, 1994). Horton (1994) defines BCA as "a technique for assessing the range of costs and benefits associated with a given option, usually to determine feasibility or to select a preferred course of action from completing ones". It has been used in different fields of study for projects in such areas as: resource and environmental (Klaassen, 1994), social development (Kohli, 1993), economic development (Kohli, 1993), private investments (Huethner, 1974;

Brown, 1977; Edgar, 1986; Bellion, 1988; Gariepy *et al.*, 1989; Duewer and Nelson, 1991) and agricultural (Chaudhary, 1993). For example, Hogg and Vieth (1977) used the method to evaluate irrigation projects. Klaassen (1994) accessed different options of controlling ammonia emissions in Europe. Beierlein *et al.* (1991) evaluated different methods for processing recycling waste paper into animal bedding. Several analysts have compared different the hardware for processing procedures in the food industry. Ruff (1971) and Rasmussen and Olson (1972) evaluated the efficiency of different freezing systems based on the cost of investment, the rate of freezing and product quality. Bellion (1988), Duewer and Nelson (1991) and O'Connor (1978) compared different processing alternatives. Another method found in the literature for evaluating investments in the food industry is energy analysis (Singh, 1986; Poulsen, 1986). Energy is used as the unit of measure.

The method of analysis depends on the objectives sought to be achieved through the implementation of the project (Kohli, 1993). There are two parts to the analysis, estimation of present value of costs and present value of benefits (Valand and Piyarat, 1993). Contingencies create provision for additional inputs required to complete the project or additional financial cost due to price increases during project implementation (Kohli, 1993).

The service life of the project and discount rate are two other variables required for the analysis. Price (1993) describes the discount rate as the interest on borrowed funds when the project is initiated. Usually, especially in the private sector, a risk premium is added to the discount rate in proportion to the degree of risk perceived. The risk value is usually arbitrary chosen (Price, 1993).

3.2.1 Benefit-Cost Analysis in Investment Studies

According to Hacking (1986), project analysis measures the costs and benefits in common terms. Where benefits exceed costs the project can continue; if not, it should be rejected. The initial analysis, he explained, is usually crude because of insufficient data. Hacking argued that costs must include all items and services incurred in research, development, capital, production, marketing, and distribution. The variables most overlooked or underestimated are capital costs, research costs, overhead and the time element involved in their payment. One major limitation to benefit-costs analysis is how to define costs and benefits to society (Hacking, 1986). Governments and industry undertake or support projects for different reasons, this has a major effect on identifying costs and benefits. Some benefits of new technologies may not be perceived and are therefore underestimated. Examples of benefits that are more difficult to quantify include: profits, welfare measures (employment, environmental consequences), appropriate technology and many more.

3.2.2 BCA Models

Different concepts and approaches characterise the description of cost analysis. In project appraisal cases where the objective is to find the least cost alternative, the analysis focuses only on costs, disregarding benefits (Ruff, 1971; Rasmussen and Olson, 1972; Brown, 1977; O'Connor, 1978; Bellion, 1988; Divakaran et al., 1988; Beierlein et al., 1991; Duewer and Nelson, 1991; Chaudhary, 1993). There are two approaches to costing: (1) economic engineering and (2) accounting data for statistical analysis. Statistical analysis is generally used where historical data are available. This is a major handicap of the approach when considering new investments. The economic engineering approach was used by Stephenson and Novakovic (1990) and Mager (1993). Stephenson and Novakovic used the approach to evaluate the establishment of a new dairy processing plant. The authors explained that the method established the necessary resources for production. Mager (1993) mentioned that it is a viable and less expensive approach to value production.

Stephenson and Novakovic (1990) selected the economic engineering approach over the accounting one for statistical estimation for the following reasons. "The accounting approach was not favourable because of the difficulty in obtaining enough detail from existing plants. Still another problem arising from the accounting data is comparability of results between plants. Accounting data include many plant specifications that tend to mask the functional cost relationship of the basic processes". The engineering approach was selected because there was no means of obtaining accounting data. Evaluating the two approaches, the authors contend that using both the economic engineering and statistical analysis of accounting data renders the results inconclusive. The accounting data approach, they claim, is more suited for studies involving the replication of existing plants, while the economic engineering approach is better when dealing with questions of optimality i.e. determining the most profitability or feasibility alternative of set of proposed projects.

Divakaran *et al.* (1988) evaluated four different processing techniques for slaughterhouse blood using a standard budgeting method. Each of the four plants assumed a production capacity of 300 tons per year. Labour, energy, capital costs, equipment, plant maintenance, depreciation, interest and insurance were cost items evaluated by the authors.. They estimated labour costs for each working level, that is, supervisor and additional workers using hourly rates and total plant operating time. Capital costs of equipment were based on the units and size required for each process. Based on operation hours, power ratings and the unit costs of the type of energy used, the authors estimated energy costs for all selected equipment. Depreciation and interest were assumed to be 15%. The authors estimated cost per ton of output from the costs' information derived. Among all processing methods costs were the lowest for acidulated, sun-dried process. They indicated that none of the estimated costs was any where near to the actual cost of processing blood-meal. The cost of production could be very site specific given a situation where some cost components are not clearly identify as in the case of the acidulated solar-drying. The selected alternative may therefore not be the least cost.

3.3 Capital Budgeting

There are several methods of evaluating costs and benefits aimed at the recovery of cost of capital investments. Capital budgeting, an accounting concept, is one of several ways. Discounted cash flow methods are used mostly for feasibility studies (Hacking, 1986; Edgar, 1986; Horton, 1994; Selvavinayagam, 1991). The chapter on methodology gives a detailed description of the method. Discounted cash flow techniques have a major advantage because they incorporate the alternate uses of money, the time factor of development and value (Hacking, 1986; Ray, 1984; Devino, 1981; Lee *et al*, 1980). This method also allows a common basis for comparison to the present value (Hacking, 1986; Horton, 1994).

Two methods are commonly used: (1) net present value (NPV) and (2) internal rate of return (IRR). The first estimates the present value of benefits and the present value of costs at a given discount rate. The difference between the two present values is the NPV. IRR is that discount rate at which the net present value of a project is zero (Kuyvenhoven and Mennes, 1989). The IRR also reflects the efficiency with which investment generate more funds over the life of a project (Price, 1993). When determined, the rate is compared with the required rate of return, including the chances of success or failure (risk prenium). If the estimated IRR is greater than the this rate, then the investment is favourable. Gariepy *et al.*(1984) found the IRR in the range of 17% to 27% for the long term storage of cabbage marketed off season. Hacking (1986) expresses the view that the internal interest rate is determined only by the magnitude of cash flow and not by outside forces. The major advantage of this method is that it does not require a discount rate.

3.4 Economic Studies on Food Processing

Ohlsson (1994) reviewed several methods of minimal food processing as a modern technology, and discussed its application to the present trends in consumer behaviour. The author defined minimal processing as "methods involving processing procedures that change the inherent fresh-like quality attribute of the food as little as possible but at the same time endow the food product with a shelf-life sufficient for its transportation from the processing plant to the consumer". The technique can be applied to a product at any stage of the distribution chain.

Outlining four major trends, Ohlsson discussed modern trends in consumers' food habits, as identified in a study by the Research in Social Changes, Stockholm, Sweden. It was found first that nutritious and healthy foods were a major contributor to a person's well-being. Second, people liked convenience and simplicity of food products. Third, food safety and environmental pollution were major concerns and finally a changing trend towards natural and ethnic foods was noted.

Consumers lean toward more natural and fresh-like products. For example, in the UK market, the most active market segments are the chilled, ready-to-eat packages that are simple and convenient. These products have a limited shelf-life. Therefore we need technologies that can extend the shelf-life. Table 3.1 illustrates some of the applications of minimal processing methods.

Table 3.1 Application of Minimal Processing Methods

Process	Applications
Controlled-atmosphere storage	Bulk-stored: fruits and vegetables
Post-harvest treatments	Fresh vegetables
Clean-room technologies	Fresh meat and fish
Protective microbes	Dairy products; sausages
Non-thermal processing methods	
High-pressure	Many products, fruit products
Gamma irradiation	Fresh fruits, poultry, spices
High electric field pulses	Fruits
New thermal processing methods	Many products; finished meals
Ohmic	
High frequency heating	
Microwaving	
Sous-vide technology	
New packaging technologies	
Modified-atmosphere packaging	Fresh meat and fish, prepared foods, and active packaging baked goods, fresh fruit, vegetables
Edible films	Dry, frozen and semi-moist foods

Source: Ohlsson, (1994).

Johnson *et al* (1994) discussed the technical and economic requirements for fish processing. In Chapter 10 of the publication, they discussed "Costing Freezing Plant Process" and "Costing Cold Storage". There are two types of cost, fixed and variable costs. The fixed costs influence capacity utilisation, whereas variable costs did not determine the size of the operation (Valand and

Piyarat, 1993). The fixed costs were divided into fixed and annual costs (Valand and Piyarat, 1993). The first cost included costs such as land, buildings, service charges, freezer plant, design, installation and delivery charges. The annual fixed costs included costs such as depreciation, insurance, interest on loans, taxes and maintenance charges. Variable costs included items such as electricity and water, labour hours, refrigerant, oil, packaging and other supplies.

The number of working hours for the plant as concluded by Johnson *et al* (1994) can greatly influence the cost pattern. Furthermore, using the building and premises for other purposes can change the method of allocating costs. An example of the distribution of processor's costs for a freezing plant is given below in Table 3.2 as an illustration.

Table 3.2 Distribution of Costs for a Freezing Plant

Cost Items	Percentage of Total Costs
Preparation labour costs	48%
Packaging	10%
Freezing	10%
Overheads	32%

Source: Ohlsson, (1994).

In another example the cost of freezing fish was US $ 0.099/kg, for a 1000 kg per hour capacity, for 2000 working hours a year, for an air blast freezer freezing plant. In the same analysis the cost of freezing would be US $ 0.079 /kg for 3000 working hours per year.

Tables 3.3 and 3.4 show the findings of two studies involving the importance of the food processing industry to the economy. Both tables show high multiplier effects for pork production and meat processing. The multiplier is the income generated for each dollar spent on an economic activity. For example, from Table 3.3, each dollar spent on pork processing generates $5.88 in the economy. Pork products generate a higher return in economic activities as compared to other sectors of the agricultural industry (Table 3.4). Meat processing has a multiplier factor higher than any other activity, as shown in Table 3.4. This suggests that pork production and meat processing are important economic activities.

Table 3.3 Demand Multipliers for Hog Production and Slaughtering in Manitoba: Multiplier Effect of $1.00 Added to Demand

	Direct	Indirect	Total
Hog Production	0.58	1.96	2.54
Slaughtering & Processing	1.42	4.46	5.88

Source: Gilson, (1979)

Table 3.4 Final Demand Multiplies for Livestock and Grain Sectors, 1961

Cattle	Hogs	Feed Grain	Food Grain	Forage Crops	Meat Processing
1.656	2.056	1.322	1.431	1.181	2.161

Source: Yeh and Lie, (1969).

3.4.1 Food Storage

"Storage is the marketing function that matches production patterns with consumption patterns over time" (Oehrtman *et al.*, 1993). It also extends the marketing period with the hope of improving returns, and provide flexibility in supply (Estabrooks, 1972). Most agricultural products with high moisture content, such as, meat products, do not store well for a long time without changing the micro-environment. Storage can be by refrigeration, freezing, modified atmosphere packaging (MAP), vacuum packaging, etc. According to Carlin *et al.* (1990), minimally processed, "ready-to-use" products extensively use MAP. Daun *et al.* (1973) have established that the shelf-life of bananas packaged in MAP doubled, compared to those packaged in air. Lower temperatures usually extend the shelf-life of products during storage. The shelf-life of shrimp was seven hours at 35^{o}C and 13 days at O^{o}C (Shamshad *et al.*, 1990). There is gradual loss of quality following longer storage (Berry, 1990). The economic feasibility of long term storage partly depends on the price of a product and the time of sale (Gariepy *et al.*, 1989). The tables that follow summarise the findings of two surveys. Table 3.5 shows the results of the total residence time of frozen foods in retail display. The survey reported that 50% of the sample was displayed for more than zero days and 5% for more than 180 days (Table 3.6). Many frozen foods must presumably be held in display cabinets at much too high a temperature for a period likely to cause appreciable deterioration in quality. Total residence time in food display on average was 6-9 days, the highest being 24 days as shown in Table 3.6. Residence time on the top layer was on average 2 days, in the middle (colder) layer 4 days and in the worst case, 6 days.

Table 3.5 Distribution Periods between Production and Purchase in Frozen Food Survey

Months	0-1	1-2	2-3	3-4	4-5	5-6	6-12	12-24	24-36
% of sample	20	17	20	16	9	8	10	4	1

Source: Cutting and Malton, (1974).

Table 3.6 Temperatures of Packaged Quick-Frozen Food Purchased Retailed in UK (Fish products)

Temperatures above	% of samples		
Degrees Celsius	1960	Mid-1960s	1970
-15	50	30	18

Source: Cutting and Malton, (1974).

3.4.2 Food Safety

Swinbank (1993) evaluated food processing from the point of balancing costs and benefits for food safety. Consumption of unsafe foods leads to food poisoning and subsequent illnesses and possible death (Ohlsson, 1994). Costs of food safety may include illness and death resulting from contaminated food and food products (Morrison *et al*, 1992). About 4 million people contract diseases primarily from foods in America (Morrison *et al.*, 1992). The real costs involved in preventing all these in absolute terms could be very substantial. The supply of safe food involves the use of scarce resources. Therefore, like any economic decision, there should be a balance between how much costs should be incurred to achieve a certain amount of benefit. The author argues that absolute safety is not achievable and that safer foods will be more expensive to produce.

Ramaswamy (1996), on the other hand, argues that there is no compromise for food safety. He claims there can be different quality levels of a processed product. The price (value) of the product can therefore be an indicator of the level of quality. For example, a low income household may choose lower quality foods due to the price differentials and not because of different safety levels. Food quality is therefore an income elastic good; as incomes increase food items of higher quality can be afforded.

Given the assumption that there is a market for higher quality foods with a rising supply (marginal cost) curve and a downward sloping demand (marginal benefits) curve, there will be a market clearing price at the intersections of the two curves. This scenario assumes a perfectly competitive situation. Other factors such as consumer loyalty to certain brand names, market power and propaganda also influence consumer behaviour and decision-making.

3.5 Conclusion

All expenditure items should be categorised and listed for costing (Hacking, 1986; Horton, 1994). Benefits are more difficult to estimate as some may not be quantifiable (Horton, 1994) or not even be perceived to occur (Hacking, 1986). Horton (1994) establishes the following ten-step process for benefit-cost analysis:

1. determine type of analysis
2. define goals and objectives
3. formulate assumptions
4. identify alternatives
5. estimate benefits and costs
6. evaluate alternatives
7. test analysis of the results
8. present results
9. recommend preferred alternative
10. implement preferred alternative

Overall, the literature shows the requirements for formulating a cash flow for benefit-cost analysis. Some limitations of the approach are expressed. However, clearly stated objectives will establish the framework limits within which all costs and benfits can be reasonably identified and estimated.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 Introduction

Steps taken to determine the economic feasibility of each of the three food processing techniques are outlined in this chapter. It is divided into six sections. The first section presents the technical processes. The second examines costs and the third, benefits. The fourth looks at ways of comparing costs and benefits. The fifth presents project evaluation practices. The final section focuses on sensitivity analysis.

4.2 Technical Processes

Minimal processing of food products involves the conversion of a raw/fresh product into a final marketable product with as little change in its quality as possible. The conversion process involves different managerial and technical skills as well as facilities. This study was limited to freezing of pork and fish at the processing level. It did not involve all the different processing procedures involved in food processing as it is beyond the scope of this work. Although specific products are being used for the study, the approach is applicable to a wide variety of food products.

4.2.1 Conventional Freezing and Storage of Muscle Foods

This process dealt with the use of conventional freezing at different temperatures to retain freshness in muscle products. The investigation predicted that the quality of frozen foods is influenced by several factors. These included pre-treatments, freezing rate, packaging material, storage temperature, length of storage and temperature stability during storage. The first phase examined several of these factors with specific reference to muscle foods to determine operating conditions for further studies in the second phase. The study emphasised the effect of different freezing methods on the freezing rates and quality of muscle products.

The processing technique at the second phase determined changes in quality for specific storage duration. The fresh product (pork loin) packaged in Cryovac barrier bags was vacuum sealed and stored in the carbon dioxide freezer at -60°C. The bags were then placed in cardboard boxes and stored at temperatures of -7°C, -12°C or -18°C. Figure 4.1 is a flow chart illustrating the processing procedure.

The processing of ocean perch followed the same procedure as described above for pork loin. Figure 4.2 shows the procedure for ocean perch processing. The procedure differs for product handling and treatment as shown in Figures 4.1 and 4.2. At the industrial level only one of the three storage temperatures is used.

1. Fresh pork loin arrives on the premises of the plant

↓

2. Inspect

↓

3. Weigh the raw material

↓

4. Debone and cut

↓

5. Chill at 8^{o} C in chillroom

↓

6. Pack into cryovac bags

↓

7. Vacuum pack with heat sealer

↓

8. Freeze at -60^{o}C

↓

9. Pace in cardboard boxes

↓

10. Place in cold storage

↓

11. Distribute to wholesalers

Figure 4.1. Product Flow Diagram: Frozen Pork Loin Processing

1. Fresh ocean perch arrives on the premises of the plant

↓

2. Inspect

↓

3. Accept for processing

↓

4. Weigh the raw material

↓

5. Wash and sort

↓

6. Remove dorsal fins

↓

7. Remove internal organs

↓

8. Chill at 1°C in ice

↓

9. Sort into different sizes

↓

10. Pack into cryovac bags

↓

11. Vacuum pack with heat sealer

↓

12. Freeze at –60°C

↓

13. Place in cardboard boxes

↓

14. Place in cold storage

↓

15. Distribute to wholesalers

Figure 4.2. Product Flow Diagram: Ocean Perch (Fish) Processing

4.2.2 Modified Atmosphere Packaging (MAP) for Shelf-Life Extension of Pork

MAP is "the enclosure of food products in high gas barrier materials, in which the gaseous environment has been changed or modified to slow respiration rates, reduce microbial growth and retard enzymatic spoilage - with the intent of extending shelf-life" (Young *et al.*, 1988). The products in this case were dipped in 0.2% chitosan and placed into cryovac bags. FX Ageless oxygen absorbent was added to each package. The modified atmosphere consisted of 80% carbon dioxide and 20% nitrogen. The modified atmosphere packages were vacuum sealed and refrigerated at 5, 10 or 15 ^{o}C.

The economics of the MAP with pre-treatments (organic acids and novel anti-microbial agents) is analysed in this study. The effects of MAP on the physical, chemical and microbiological changes, and sensory qualities were monitored at refrigerated storage between 0 and 15^{o}C during the laboratory experiments. The procedure is illustrated in the flow chart in Figure 4.4.

4.3 Plant Requirements and Layout

The proposed plant, equipped with a cryogenic freezing system, used liquid carbon dioxide as the refrigerant for freezing processes and a refrigeration system for the modified atmosphere packaging (MAP) process. Appendix A shows the layout of a typical food processing plant. It was adopted from a plant designed by Dr. Juan Silva of the Mississippi State University in the USA.

1. Fresh pork loin arrives on the plant premise

↓

2. Inspect

↓

3. Weigh the raw material

↓

4. Debone and cut

↓

5. Chill at 8°C in chillroom

↓

6. Dip into 0.2% chitosan

↓

7. Pack into cryovac bags

↓

8. Add FX Ageless oxygen absorbent

↓

9. Add carbon dioxide and nitrogen gases and seal

↓

10. Box and refrigerate

↓

12. Place in cold store awaiting dispatch

↓

13. Distribute to wholesalers

Figure 4.3 Product Flow Diagram: Fresh Pork Loin Processing - MAP

The proposed plant required approximately 1,200 square metres of building space. It incorporated a receiving area, a processing or working area, a place for the freezing system and a storage room. The processing area is to the left side of the plant and the storage room is to the right side. The freezing system is placed such that room for further expansion is available. The processing area lies between the receiving area and freezing system.

A CO_2 tank is required outside the building to store the refrigerant for the freezing plant. The plant requires access roads for the delivery of supplies and transportation of finished products. Other requirements on the premises include a delivery point and a loading dock. The delivery point is located near the holding tanks, and the loading docks near the storage room. In all cases, there is space for trucks to be able to manoeuvre in and out of the premises. The building is one storey, with a polished concrete floor to avoid dust.

The plant had a production capacity of 3000 kg per hour of raw material. Each plant is proposed to run a single shift of 8 hours per day, for a total of 2000 hours per annum. There are no operating hours on weekends and public holidays. The average yield of the final product per kg of each raw product was assumed to be 80%. Multiplying the yield by the input capacity gave the output per hour. Multiplying the daily estimates by the annual operating hours of 2000 gave the production capacity and output per annum. Annual input of raw material was 6 million kg, and the annual output was 4. million kg. It was assumed the plant construction was completed in year zero, production began and sales began in Year 1, operating for 20 years. Each plant was assumed to operate at full capacity.

In the study the costs mentioned in the design were in 1986 U.S. dollars. These were converted into 1995 Canadian dollars using the average exchange rate for the Canadian dollar to the U.S. dollar for 1986. These were then converted into the 1995 equivalent using industry price indices. The average exchange rate and industry prices indices were obtained from the Statistics Canada, 1996 (The estimates can be found in Appendix I. Thus prices are in 1995 constant dollars.

4.4 Processing Costs

Production costs are influenced by many factors, such as location of the plant, size of operation, production and managerial skills, local prices, facilities and infrastructure available, supply of raw materials, the distribution network and many others. Costing is an investigative process aimed at determining the viability of a project. The two types of costs identified are investment costs and operating costs. The following were additional assumptions made to simplify costing.

1) The plant's standard operation (processing, transportation and storage) would follow the requirements of the International Institute of Refrigeration, Paris.

2) The extended shelf-life of pork loin in maintaining the High Quality Life is 10 months at -18°C, and 12 months for ocean perch at the same temperature.

3) The standard temperature for the retail display cabinet is -18°C.

4) The estimated life of the project is 20 years. This is in line with the service life of the major processing equipment, the refrigeration system.

5) The discount (interest) rate[2] for the present value analysis was 8%, based on the average interest rate of 9.37% (Long term Canadian Bond) 3.36% inflation rate and 2% risk premium (Price, 1993).

6) Since the shelf-life is increased considerably at the selected temperatures, there is a 100% probability for the sale of all frozen products.

7) The probability of sale for MAP pork is 80%. There is about a 20% probability of losses, mainly due to unsold products given a duration (3 to 5 days) allowed for displaying the product in the store.

8) The processed goods are sold in the domestic and international markets. The price received by the processor is assumed to be the same for the two markets.

4.4.1 Investment

The total investment costs of the plant consisted of equipment, machinery, land, services and engineering charges. The cost of each item was adopted from the plant designed by Dr. Silva. These are shown in Appendix E.

[2] Estimation described in Section 4.5

The initial investment occurred in year zero with subsequent replacements in year 10 of operation. These replacements were equipment and machinery that had service lives shorter than that of the project. It was assumed that the resale value of other items except land would be 15% of the initial investment cost (Gariepy *et al.*, 1989; Chaudhary, 1993). All the costs in each year were added together to derive the total investment costs for that particular year. Below is a brief description of some major investment items.

4.4.1.1 Land

The value of land differs from one location to another. The long-run price of land appreciates overtime. It was assumed that the real value stays the same over the life of the project. A land consulting firm in Montreal, specialised in industrial land sales, provided the unit price of industrial land located on the west of the Montreal island. Multiplying the unit price per metre of land by the required size gave the total cost of land of approximately $ 26,000.

4.4.1.2 Buildings

Buildings deteriorate over time requiring repairs and renovations. The long-run price of a building appreciates over time. A building consulting company in Montreal provided the unit cost of each of the required components of the building. Each unit cost was multiplied by the required size of the building, giving the total cost of each component. Adding all the total component costs gave the total cost of the building. The components included the concrete floor, ventilation (built in funs), a 20 ft ceiling and thermal roofing, lighting, construction materials and construction costs.

4.4.1.3 Refrigeration Systems

As the refrigeration system was the main processing equipment, the service life of the entire investment was determined based on that system. The equipment price was obtained from the adopted plant design. Installation costs, refrigerant usage, processing capacity and the service life of the systems were provided by a manufacturer. The processing capacity-per-hour of the proposed plant determined the size of equipment. The total cost of the unit included the equipment price, installation costs, freight, and insurance. It was important to include all costs directly associated with getting the equipment to the site.

4.4.1.4 Cold Storage Rooms

The finished product is stored in the cold storage room until dispatched for distribution. Temperature storage room determined how long the product could keep without being spoiled. Storage costs increase with lower temperatures. Minimal exposure to ambient temperature is important when loading the finished products into trucks. This is to keep the temperature of the frozen product from increasing excessively. The costs of the cold room included installation charges.

4.4.2 Operating Cost

Operating variables consisted of raw materials, utilities, labour, and other charges. The cost of each item depended on the quantity needed and the market price. Work done in the laboratory provided the required amount of chemicals, gases and packaging materials. The design specifications and the operating size of the plant determined all other operating costs..

4.4.2.1 Raw Material and Supplies

Production materials and supplies included raw materials (fish and pork), chemicals and packaging material. Costs were the obtained from the local. Raw materials accounted for the highest cost in the processing operation. We collected raw material prices from Agri-Food and Agriculture Canada, Statistics Canada, L.N. Reynolds and local seafood distributors in the Montreal area. The average 1995 Montreal price for pork lion (wholesale cuts) from the slaughterhouse to the processing plant was $ 4.00 per kg (L.N. Reynolds). The expected price of fresh fish was $4.25 per kg. Both pork plants obtained their raw material from similar slaughterhouses and therefore had the same cost price.

The average yield per unit of raw material multiplied by the plant capacity per hour and the number of operating hours per year gave the total output per year. The average yield per unit of raw material was obtained from the laboratory work. It was the proportion of a unit (kg) of input raw material that would yield the desired final product.

The annual costs of raw material were estimated using the required amount per hour per annum multiplied by the unit price and annual operating hours. The amounts and costs of other materials and supplies were estimated as above. Based on the amount of raw material utilised in the laboratory, the amount required for the industrial level was extrapolated. Appendix F gives all the raw materials for each processing technique.

4.4.2.2 Refrigerant: Liquid Carbon Dioxide

The operation could use either a liquid nitrogen (N_2) or liquid carbon dioxide (CO_2) system. We selected the CO_2 option because data for the system was available. A cryogenic freezer is more suitable only when the gas supply is readily available and relatively cheap. Appendix C summarises the cost of the system. The required ratio of CO_2 to the processed product was approximately 1:1. A distributor in the Montreal area provided the unit cost of a kg of CO_2. Multiplying the unit cost of CO_2 by the plant capacity gives the required amount of CO_2. Estimation of annual costs is done the same way as it was for raw materials.

4.4.2.3 Fuel and Electricity

The operating equipment and machinery, heating, and other activities, directly and indirectly related to the food processing, required energy. Electricity was the main power used in this study. Electricity costs depended on the quantity of electricity consumed to produce a unit of product and the price of electricity. The local electric company provided the electricity rate, measured in dollars kW per hour.

Since the actual amount of energy consumed was not available, the average energy costs (electricity and fuel) were used as a proxy (Statistics Canada,1993). Also, heating charges had to be included in the energy costs. This seemed to be more reflective of the Montreal area due to the different climatic conditions in Mississippi (warmer most of the year) and Montreal (cold). Therefore the respective average energy costs for each industry was used as the proxy (Appendix F).

4.4.2.4 Water

Just as with fuel and electricity, the cost depended on the quantity of water needed to produce one unit of finished product and the water rate. The municipal authority provided the water rate, measured in dollars per 1000 litres.

4.4.2.5 Packaging Material

The project required two packaging materials, the cryovac bag and 10 kg cardboard boxes. To get the number of bags and boxes required per hour, we divided the quantity of the final output by the size (10kg) of the cardboard boxes. Total cost per year was derived as in the other activities.

4.4.2.6 Labour

Traditionally, the cost of labour depends on the man-hours needed to produce one unit of finished output and the wage rate according to the level of skill. Summing up all the labour costs determined the total labour cost per unit of output. The labour requirements were derived from the total number of employees required to operate the designed processing plant per hour. We multiplied these by the total operating hours for the year to derive the total annual cost of labour. The costs of each skill level were determined by how much a person would earn in a given position per annum.

There were other miscellaneous expenses that did not fall under any of the above categories of operating costs. These include maintenance, telephone, office supplies, etc.

4.4.3 Per Unit Cost of Processing

The amortised value was estimated, and used to determine the annual value of fixed costs, that is the annual investment cost for operating the establishment. It was calculated as the annual costs of capital based on the cost of borrowing money, considering the interest rate. Equation 4.1 was used in the estimation of the annual amortised value.

$$PMT = I_0\left(\frac{i}{1-(1+i)^{-n}}\right)$$ **Equation 4.1**

where:

PMT = annualised uniform cost

I_0 = purchase value of the capital good in year zero (present period)

i = interest rate used as a discount rate

n = expected life of the equipment/machinery

All items with the same service life are summed up, and a total amortised value estimated for that service life group. The total annual value was determined as the sum of all the amortised values for all the items. Appendix E gives a list of all investment costs.

The method of estimating the annual operating costs involved identifying the relevant cost of each item. This usually involved the cost per unit or rate per unit and the quantity used. The costs of all the operating elements were then summed up to derive the total annual operating costs. Total annual operating cost was the sum of all annual operating cost determined for each operating costs' variable. Calculations used in determining the unit costs for all cost items are listed in Appendix F.

4.5 Benefit Analysis

Due to the long storage capabilities, the frozen products could be sold throughout the year. The MAP products could also be sold throughout the year mainly because there is a regular supply of the raw product. For pork there are seasonal fluctuations in the demand and prices. The demand and price are highest in the summer and during the Christmas season. Pork gets frozen to compensate for the high demand during those seasons. No seasonality in fish prices was observed.

Two types of benefits were identified, quantifiable and non-quantifiable. Quantifiable benefits were those that had a monetary or numeric value, whereas non-quantifiable ones were those that could not be valued monetarily or numerically. Two quantifiable benefits (cash inflows) were identified in this case. (1) expected revenue from sale of the finished product and (2) resale of equipment and machinery (salvage value) and land. The expected revenue from sales was a function of extended shelf-life.

Revenues arose from the sales of goods. Expected revenue were derived from an expected price multiplied by the quantity of goods sold. The expected price was a statistical estimation of the probability of getting a price from the retail sales of the product. These were based on the assumption that, as the product ages, the quality and price decrease. Due to the extended shelf-life, the probability of retaining high quality was increased. The pricing and range of the prices also depended on the pricing policy of each establishment.

The two required prices for both pork plants were obtained form the data sources; no further estimations were required. The requires prices of fish had to be estimated from the average retail price. The value of the expected price at the processor's level involved several steps. The first step estimated the expected price at the retail level of the distribution channel as follows:

$$PR_R{*} = PR_R x PB(PR_R) \qquad \textbf{Equation 4.2}$$

where:

$PR_R{*}$	=	expected retail price
PR_R	=	average retail price
PB	=	probability of sales at average retail price.

Having derived the expected price at the retail level, we determined the processor's price by deducting various price mark-ups along the distribution channel. Using percentage mark-ups at both the retail and wholesale levels, the second step ascertained both the wholesaler's price and the processor's price. The final step determined the expected revenue to the processor.

Thus, working backwards, the percentage mark-up at the retail level was deducted from the derived expected price to get the wholesale price. The wholesalers price mark-up was then deducted from the price at that level to arrive at the processors' price. Given the new processing procedure and another step in the distribution and marketing chain, the new mark-ups had to be assumed. Some of the work previously performed by the retailer (retail cuts) were now undertaken by the processor. The mark-ups are not all profits, but includes marketing and distribution charges such as transportation costs. This also applies to the pork prices. The formula is given by Equation 4.3.

$$PR_P* = [(PR_R * \times (1 - m_R)) \times (1 - m_W)]$$ **Equation 4.3**

where

PR_R* = expected wholesalers' price

m_R = retailer's percent mark-up

m_W = wholesaler's percent mark-up

Therefore, the expected revenue that was the product of the expected processor's price and the volume of sales was determined by the following formula given in Equation 4.4.

$$R* = PR_p * \times Q$$ **Equation 4.4**

where

R* = Expected revenue

Q = Quantity

The value E(R*), was used in formulating the cash flow to estimate the present value of benefits.

5.4.1 Practical Storage Life

Tables 4.1 and 4.2 below show the practical storage life of frozen ocean perch and pork products. The storage temperature, the longer the product can be stored. It should be remembered that storage occurs after all processing is completed, and includes the life of the product throughout the distribution chain.

Table 4.1 Practical Storage Life of Frozen Products

Product	Storage Life (months)		
	-7^{O}C	-12^{O}C	-18^{O}C
Pork[1]	1	4	10
Fatty fish[2] (ocean perch)	2	6	12

1. Extracted from: International Institute of Refrigeration, 1964
2. Extracted from: Johnson *et al.*, 1994

Table 4.2 Practical Storage Life of MAP Products

Product	Storage Life (days)		
	15^{O}C	10^{O}C	5^{O}C
Pork[1]	11	20	24

Adopted from: Morris J. (1994)

For example, pork stored at -18°C can be kept frozen for approximately 10 months. The 10 month period includes storage from the manufacturer down to the consumer. The storage life of a product was expected to influence the expected revenue through the expected price. This was because the probability of sales for any given period would be different. A longer storage life will spread the storage period out more than a shorter storage period. This would result in a difference in the distribution of sales, and, consequently, the expected price. This assumption was used for the sensitivity analysis. The salvage value was assumed to be 15% (Gareipy *et al*, 1989) of the initial value. All equipment, buildings and land were saleable at the end of the project at their book values.

5.4.2 Shelf-life Extension

Shelf-life extension is how much longer the product can be stored under various processing alternatives or a situation where no processing occurs. This was evaluated for the three storage temperatures used at the experiment level. This result was expected to influence the quality of the stored product, as well as the expected price to be derived from the analysis. The probability of sale increases as the shelf-life of a product increases.

5.4.3 Non-quantifiable Benefits

Non-quantifiable benefits include the gains expected from fewer illnesses and deaths related to food contamination. It would be easier to distribute products. Those concerned with the environment would be pleased as chemical usage has been reduced.

The non-quantifiable benefits should be recognised in the final decision as to the choice of the project. Depending on the objectives set, they could influence the final decision of the project to be implemented. As mentioned earlier in the "Introduction" of this thesis, a number of illnesses and deaths are the result of contaminated food products. It was also pointed out that properly processed foods could have an impact on safety and quality. Ease of handling and distribution are other gains expected from extended shelf-life.

4.6 Discount Rate

The discount rate is the opportunity cost of an investment, such as the rate of return on money in the next best investment alternative. It is estimated as the nominal interest rate of a risk free investment less the rate of inflation plus a risk premium over the ten year period, 1986 to 1995. Rates used were the Long term Canadian bond of 9.37% (nominal interest rate), average inflation rate of 3.36% and 2% risk premium. This resulted in the expected real discount rate of 8%. Deducting a inflation rate would ensure the discount rate for the estimations is in real terms.

4.7 Evaluating Alternatives

Two techniques were used in evaluating the projects. The first technique involved actual cost and quantifiable benefits and used present value discounting. The second technique involved using amortised values to estimate the annual cost of each processing technique.

After deriving the benefits and costs, a cash flow was constructed using an electronic spreadsheet, to estimate the NPV, B/C ratio and IRR. Both the NPV and B/C ratio are calculated at a given discount rate over the life of the project. NPV and B/C ratio was estimated using Equation 4.5.

$$NPV = \sum_{t=0}^{n} PVB_t - \sum_{t=0}^{n} PVC_t \qquad \textbf{Equation 4.5}$$

where

PVB_t = present value of benefits (revenues)

PVC_t = present value of costs (investment and operating costs)

t = time period (year)

n = project life

The equation states that NPV is the difference between the sum of present value of benefits and the sum of present value of costs. The present values[3] are derived by discounting the cash flow by a given discount rate over

[3] The Microsoft Excel spreadsheet begins discounting from the year 1 of the project .

the life of the project. B/C ratio is calculated by dividing the present value of benefits by the present value of costs.

Using the same cash flow, the internal rate of return was estimated using a simulation from the electronic spreadsheet. An interest rate is arbitrarily chosen as the starting point for the simulation. The objective is to find the interest rate that gives a zero NPV. The spreadsheet did not determine negative IRR's. In such instances the estimation was done manually using trial and error techniques. Different interest rates are manually used to determine a zero NPV.

The annualised uniform cost and annual operating cost were used to estimate the per unit cost of processing. Annual operating costs did not include the costs of raw material. The annualised uniform costs and annual operating costs were added to derive the annual charges. This was divided by the annual processing capacity to derive the unit of processing a kg of raw material using the particular technique.

4.8 Sensitivity Analysis

This section looks at what might happen if certain changes were to take place. The changes were based on the alternatives mentioned in the sub-section on alternatives. Each alternative was evaluated to assess its economic feasibility. Sensitivity analysis was done on expected prices and annual operating hours. The expected benefits or losses (for expected revenue) were determined from earlier established analysis.

Information required for the sensitivity analysis were based on the standard processing procedure, considering the changes that took place. The overall analysis looked at the probability of getting the highest expected revenue.

4.9 Summary

The BCA model was aimed at estimating the economic feasibility of each processing technique. This was undertaken within the limits of the estimated costs and benefits, the processing plant and plant requirements, interest rates, production periods and the distribution channel. The cash flow with both the costs and benefits were generated to determine the NPV, IRR and B/C ratio. The model should also indicate which of the processes is most profitable

Primary data were obtained from the experimental work, and secondary data from the designed food processing plant designed by Dr. Silva, from government agencies, utility companies, and consulting and manufacturing firms.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents a discussion of the results obtained from the benefit-cost analysis model. Discussion of the sensitivity analysis is also presented.

5.2 Costs Results

5.2.1 Total Processing Cost

Costs were estimated for the investment and operating variables. A contingency value of 20% of the estimated initial investment was added to the total plant costs (Appendix E). Equipment with a service life of less than 20 years were assumed to be replaced half-way during the project's life. Table 5.1 shows a summary of the total initial investment (including the contingency value), land and building, and equipment investments for each plant.

All plants had the same investment for land and building. This was because the basic plant requirement were the same in all cases in terms of the land size and building layout. Investment was higher for the two pork plants as these incurred a higher cost in equipment than the fish plant. The difference was reflected by the lower cost of fish processing equipment requirements. Equipment requirements was approximately 30% of total investment, while land and building accounted for approximately 28%. Some items had to be replaced in the 10th year of the plants' operation, and revenue realised in the final year from land, building and equipment (Appendix G).

Table 5.1 Initial Investment to Set-up Food Processing Plants in Quebec

Project	Land & Building	Equipment	Other[a]	Initial Investment [b]
		$'000		
Frozen Pork	$ 1,204	$ 1,285	$1110	$ 4,319
Frozen Fish	$ 1,204	$ 1,267	$ 1110	$ 4,298
MAP-Pork	$ 1,204	$ 1,285	$1110	$ 4,319

a) Includes management, engineering and installation charges, waste treatment (Appendix E)
b) Includes 20% Contingency Value

Table 5.2 shows the operating cost structure (Appendix F). Total operating costs were derived by summing operating cost within each respective year. The raw material represented approximately 95% of all operating costs for the frozen pork and MAP pork plants and 96% for the frozen fish plant. The frozen fish plant had the highest operating costs. This was reflected mainly by the higher costs of the raw products as compared to fresh pork. The difference was also the result of the different processing procedures.

Table 5.2 Annual Operating Costs

Project	Raw Material	Processing Material	Other[c]	Total Operating Cost
		$'000		
Frozen Pork	$ 24,000	$ 504[a]	$ 0.714	$ 25,215
Frozen Fish	$ 25,500	$ 504[a]	$ 0.586	$ 26,590
MAP-Pork	$ 24,000	$ 537[b]	$ 0.666	$ 25,203

a) Includes liquid carbon dioxide
b) Includes nitrogen, carbon dioxide chitosan and oxygen absorbent
c) Includes, labour, packaging material, spare parts and miscellaneous items (Appendix F).

5.2.2 Per Unit Cost Of Processing

The per unit cost of processing was estimated for each process. Raw materials (pork and fish) were excluded from this analysis. This was because the model was set-up to determine how much it would cost to process a unit of product. The estimation was based on the quantities of all other inputs (investment and operating costs) for the operation. Total investment was amortised over the life of the project at a discount rate of 8% to derive annual investment costs.

The salvage value of buildings and equipment were deducted from the annual total investment cost. The annual value of the investment costs was estimated as $281,670 for the two pork plants and $ 279,684 for the frozen fish plant. Table 5.3 shows the total annual investment cost and the total annual charges.

Table 5.3 Total Annual Charges of Cost of Processing per kg of Raw Product

Project	Annual Investment Cost [a]	Annual Operating Cost [b]	Total Annual Costs
Frozen Pork	$ 281,670	$ 11,968,400	$ 1,450,271
Frozen Fish	$ 279,684	$ 13,090,400	$ 1,370,084
MAP-Pork	$ 281,670	$ 12,003,880	$ 1,485,550

a) Does not include costs of raw materials
b) Does not include salvage values of investment items

The per unit costs for the single shift operation of each process are show in Table 5.4. Frozen fish had the lowest per unit cost of processing of $0.23/kg. The cost of frozen and MAP pork were $0.24/kg and $0.25/kg respectively. Though the annual operating costs were higher for frozen fish, it gave the lowest per unit cost of processing due to relatively lower investment costs.

Table 5.4 Per Unit Cost of Processing

Project	Cost per Unit
Frozen Pork	$ 0.24
Frozen Fish	$ 0.23
MAP-Pork	$ 0.25

5.3 Benefit Results

Quantifiable benefits were derived from the sale of the product, equipment, buildings and land. A summary of the unit price, the annual output and the total sales revenue is shown in Table 5.5. Estimation of the unit price per kg is shown in Appendix D. It should be noted that generally fresh products have a slight higher price than frozen products. In accordance with the unit prices (shown in Table 5.5) the frozen fish had the highest annual revenue of $ 27 million followed by MAP pork with $ 26 million and then frozen pork with $ 25.9 million.

Table 5.5 Annual Sales and Revenue

Project	Unit Price per kg	Annual Output (kg)	Total Revenue
Frozen Pork	$ 5.40 [a]	4,200,000	$ 25,920,000
Frozen Fish	$ 5.67 [a]	4,200,000	$ 27,216,000
MAP - Pork	$ 5.42 [a]	4,200,000	$ 26,016,000

a) 100% probability of sale at the processor level

Salvage value for equipment, building and the resale value of land, during and at the end of the project life is shown in Table 5.6. Total annual sales of final products were obtained by multiplying the selling price by the annual output of each product. Fixtures were assumed to have no value at the end of the project as most of those items have no resale value. All other investment items were not saleable at the end of the project's life.

Table 5.6 Revenue from Saleable Investment Items during the Project Life

	Year 10	Year 20
Equipment[a]	$ 32,950	$ 192,760
Building[a]		$ 176,700
Land[b]		$ 26,000

a) salvage value is 15% of the initial value
b) the value of land used for construction of the plant is assumed to remain the same in normal terms

There were a number of benefits from the minimal processing technique that could not be quantified. Among these are, the final products had no chemicals added and maintained the freshness and high quality of the products storing longer, compared to fresh products. The quality of the minimally processed product was maintained over several days compared to fresh product that has a life span of a few hours. The probability of getting a high retail price also declines given the potential loss in quality of the fresh product. Therefore, the processing technique also ensures a higher probability of getting a high retail price by maintaining product quality longer.

5.4 Benefit-Cost Analysis

5.4.1 Base-run Results

Total costs and benefits for each year were discounted at a rate of 8%. This gave the yearly present value of costs and benefits, that were added to derive the total present costs and benefits. Although not shown on the spreadsheet, these were used in estimating the Benefit-Cost Ratio (B/C Ratio).

The formulated cash flows were used in the estimation of NPV, IRR and B/C ratio using an electronic spreadsheet (Microsoft Excel version 7.0). The NPV and IRR calculations were formulated to produce the results using the pre-programmed options of the spreadsheet. The B/C ratio was estimated manually by setting up the formula in the spreadsheet (as there was no pre-programmed option), using the estimated present values discussed previously.

All NPVs were found to be positive and B/C ratios of greater than one which suggests that all the projects are economically feasible with the assumption that the cost of capital is 8% or lower. The return on capital for some food and beverage establishments were estimated as 8.8% (Moody's Industry Review, 1996). Table 5.7 summarises all the estimated results. The MAP pork project had the highest value for both NPV and IRR. The IRR indicates that the project internally generated a rate of return ranging from 13% to 18% over the 20 year period. The results indicate that processing of pork (frozen and MAP) is more profitable than processing of fish. Processing MAP pork is more profitable than processing frozen pork. The IRR also indicates the efficiency with which investment can generate more funds. The IRR values were higher than the average return on other investment alternatives in 1995. For example, Long term Canadian bonds for averaged 8.19%, return on equity averaged 7.94% and return on capital averaged 6.41% (Statistics Canada, 1996). The IRRs were also compared to the average1995 rate of return for the Toronto Stock Exchange (TSE) for all investments of 9.5%. This also indicates that all three projects are profitable given the higher rate of return.

Table 5.7 Summary of Results for Financial Analysis for Single Shift Operation (2000 hours per year)

Project	NPV[a]	IRR	B/C[a]
Frozen Pork	$ 2,404,000	15%	1.09
Frozen Fish	$ 1,766,000	13%	1.09
MAP - Pork	$ 3,382,000	18%	1.10

a) at 8% discount rate

5.4.2 Sensitivity Analysis

Sensitivity analysis was conducted for three main scenarios to outline the effects of (1) changing the annual working hours from a single shift (2000 hours) to a double shift (4000 hours), (2) product of price changes, and (3) alternative storage temperatures on storage cost. Table 5.8 summarises the results obtained for a 4000 hour per annum operation.

5.4.2.1 Single Shift versus Double Shift Operations

The results indicate that working double shift increased the net return of each establishment. The NPV and IRR increased more than two fold for all three plants using the 8% discount rate.

Table 5.8 Financial Analysis for Double Shift (4000 hours per year) Operation as Opposed to the Single Shift in the Base Run.

Project	Results		
	NPV[a]	IRR	B/C Ratio[a]
Frozen Pork	$ 9,982,000	35%	1.10
Frozen Fish	$ 7,771,000	30%	1.10
MAP - Pork	$ 18,501,000	57%	1.12

a) at 8% discount rate

5.4.2.2 Product Price Changes

A case of a 10% change in the price difference (cost price of the raw material and selling price for the final product) was investigated. This analysed change in both the raw and final product prices. The results are presented in Tables 5.9.

The results of this scenario indicated the IRR would range from 11% to 21% for frozen pork, &% to 17% for frozen fish and 13% to 23% for MAP pork. A decrease in prices would lead to a decrease in returns while an increase in price would result in increased returns. Comparing these results to the base-run results, they still indicated that the projects would be profitable given the 10% decrease in product prices.

Table 5.9 Summary of IRR Results of 10% Change in Final Product Prices and Raw Material Prices.

	10% decrease	10% increase
Frozen Pork	11%	21%
Frozen Fish	7%	17%
MAP Pork	13%	23%

5.4.2.3 Storage at Higher Temperatures

Finally the effects of alternative storage temperatures were evaluated. It considered changes in energy cost and how these changes could affect the distribution chain. For every one degree Celsius change in electricity consumption, energy cost changes by 6%.

The standard storage temperature for the products were -18^{o} C for the frozen products and 5^{o} C for the MAP products. The percentage changes in energy costs are summarised in Table 5.10. Tables 4.1 and 4.2 showed the practical storage life of each of the products.

The average time required to distribute frozen products from the processor to the retailer in Quebec is 4 months. As such it would only be possible to store the products at any of the higher temperatures by changing the duration of distribution throughout the chain to suit the individual storage times.

Table 5.10 Changes in Energy Cost for Alternative Storage Temperatures

Storage Temperatures (Degree Celsius)	Energy Saving Compared to the Standard Temperature (%)
Frozen Products	
-7	66
-12	36
Fresh (MAP) Products	
15	60
10	30

Eleven days are required to distribute fresh pork from the processor to the retailer. This makes 15°C an adequate storage temperature for the distribution network. Sixty percent of electricity charges during storage could be saved, as well as getting the product through the chain without changing the distribution arrangements.

5.5 Summary

This chapter reported and evaluated the results of the methodology developed in chapter 4. It focused on NPV, B/C ratio and IRR and factors responsive to changes. The chapter placed emphasis on conditions that make the projects profitable by comparing the results to the annual returns on other major forms of investments in Canada. The final chapter will bring together all the results, draw conclusions and suggestions.

CHAPTER 6

SUMMARY AND CONCLUSIONS

6.1 Introduction

The main objective of the study was to investigate the economic feasibility at the industrial level of three processing techniques by the Food Science and Agricultural Chemistry Department, Macdonald Campus (McGill University). A benefit-cost analysis model was designed and developed to determine the economic feasibility of setting up a processing plant for each of the three techniques in Quebec. The per unit cost of processing was also estimated. The techniques involved the freezing of pork and fish and packaging of pork under the modified atmosphere conditions.

6.2 Summary of Findings

Based on the estimated costs and benefits, interest rates, production periods and the distribution channel the net present value (NPV), internal rate of return (IRR) and benefit- cost ratio (B/C ratio) determined were the following for each operation. The NPVs were $ 9.9 million, $ 7.8 million and $ 18.5 million; 15%,13%, and 18%; B/C ratios were 1.09, 1.09, and 1.10 for frozen pork loin, frozen ocean perch (fish) and MAP pork, respectively for a project life of 20 years. The analysis indicated that all three processes were economically feasible for a 2000 hour per annum operation (i.e. a single 8 hour per day shift), for both the domestic and international markets. A 8% discount rate was used to estimate the NPV and B/C ratio. Based on average 1995 Montreal prices of pork and fish the MAP pork project showed the highest economic returns. Processing of frozen pork was more profitable than processing frozen fish. The cost of freezing fish was $ 0.23/kg for a 3000kg per hour capacity, running for 2000 hours a year. The cost of freezing pork was $ 0.24/kg and $0.25 for MAP packaging for the same plant specification. As much as these estimates can help select the most viable project, the non-quantifiable benefits must be considered and included in the final decision making. Sensitivity analysis showed that increasing the working hours from 2000 per annum to 4000 per annum increased the returns more than two folds. These rates were also found to be very sensitive to the changes in the prices of raw materials and finished products.

It was also found in previous studies that MAP products could be stored at temperatures as high as 15°C instead of the usual 5°C, reducing electricity costs by 60% at each stage of distribution. Frozen products could be stored at temperatures between -12° and -7°C instead of -18°C (standard storage temperature) if the length of the distribution chain was reduced. This would decrease electricity costs between 36% and 66%. The effect of this on the IRR could not be estimated due lack of data on the exact electricity consumption during storage. Thus the economic analysis points out some of the areas where costs can be reduced and the processing made more profitable. Processors can take advantage of the long term storage capabilities to sell in periods of high demand and to take advantage of seasonal fluctuations in the market conditions.

6.3 Implications of the Study

Findings of this study indicate that all three projects can be implemented profitably in Quebec. Given the increased demand for pork, high multiplier effect and the high value added from the processing activities, this project would represent an important economic activity in Quebec. With 90% of all seafood and fish products exported from Canada, the fish processing project would also be an important economic activity within the province.

The findings were responsive to prices, working hours, costs, plant capacities, discount rate and the project life. Changing the plant location could also alter the results as most of the operating cost were specific to the Montreal area. Non-quantifiable benefits which were not considered in this study can also play an important role in the decision making process. These minimal processing techniques ensure freshness and a high quality product.

6.5 Limitations of the Study

Although this study attempted to assess the feasibility of different food processing techniques, there were several limitations. These shortcomings relate mainly to data problems, which have an impact on the depth and relevance of the cost and benefit analysis. These results are based on the data obtained from various sources. As there was a great reluctance on the part of the equipment/machinery industries to providing precise data, the analysis is based on the approximate values of many cost and benefit items. The proposed plant was adopted from a study and plant design by Dr. Juan Silva of the Mississippi State University and was modified for Montreal. Investment costs and some operating costs were adopted from Dr. Silva's study. The prices and production data used in the study were obtained from secondary sources. Although the data were the best available, they may not reflect the actual prices.

Since there were no existing plants involved in any of the processes, the layout and design of a typical frozen plant was the most ideal to adopt for the production plan. The design and plant layout, however, may not be the most accurate for these projects, but it gave a good idea of the expectations of the technologies.

Energy charges were adopted from the average energy cost for meat and fish processing establishments in Quebec for 1993 and are just a representation of the actual costs. These were the most recent available. Charges for the costs of electricity were theoretical estimates and may not be the best representation for the selected equipment. However, improvements in data and estimation techniques may produce better results.

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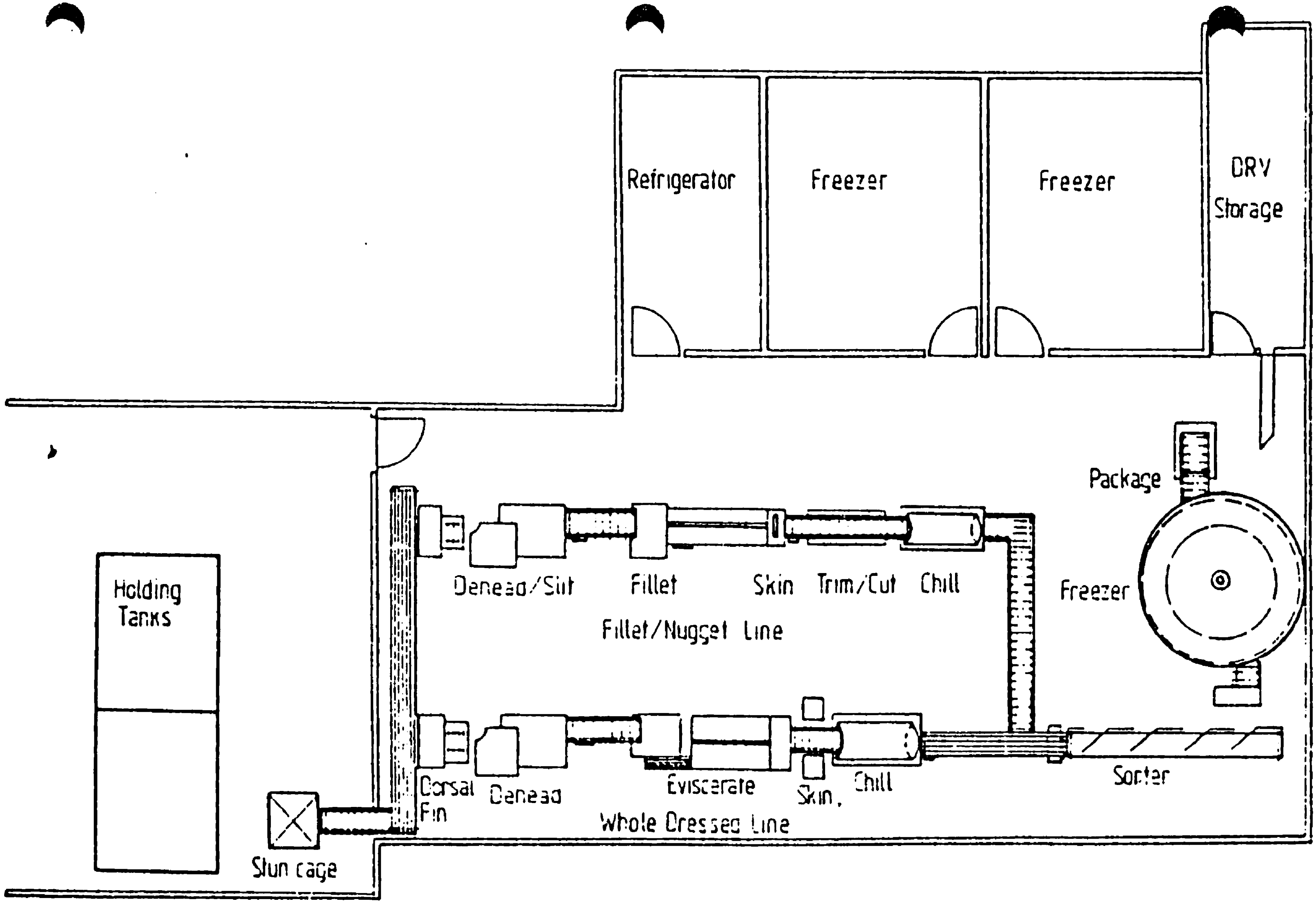
APPENDIX A[4]

PLANT LAYOUT AND DESIGN

[4] Silver, J.L.


Refrigerator
Freezer
Freezer
DRY
Storage
Package
Freezer
Holding
Tanks
Dehead/Slit
Fillet
Skin
Trim/Cut
Chill
Fillet/Nugget Line
Dorsal
Fin
Dehead
Eviscerate
Skin
Chill
Sorter
Whole Dressed Line
Stun cage

APPENDIX B

DATA CATEGORIES

Data Categories

Category	Description
Building	
Total area	Square feet
Ceiling height	Feet
Construction cost	Dollar/square foot
Equipment/machinery	
Installation cost	Dollars/each piece
Repairs/maintenance	Dollars/operating hour
Description	Each piece
Dimension	Each piece
Life-span	Years/each piece
Maintenance cost	Dollars/operating hour/piece
Labour	
Fixed - Administration	Man hours
Variable	Man hours
Supervisory	Man hours
Utilities	
Electricity - fixed	kWh/day
Electricity - variable	kWh/operating hour
Water - fixed	Gallons/day
Water - variable	Gallons/operating hour
Materials	
Raw product	Dollars
Other products - chemicals	Dollar/kg
Cleaning supplies	Dollars/operating day
Packaging	Dollars/operating hour
Other	Dollars/operating day
General Expenses	
Transportation	Dollars
Office supplies	Dollars
Services	Dollars
Telephone	Dollars

APPENDIX C

LIST OF EQUIPMENT[5]

[5] Marabotto, L. and Cattivalli, D.

Silva, J.L.

Pork Plant		Fish Plant	
Item	*Price ($ '000)*	*Item*	*Price*
Belt conveyor	3366	Holding tanks	
Receiving table	1683	Electrical stunning	
		system	
Elevator conveyor	6587	Belt conveyor	
Holding table	1346	Receiving table	
Eviscerator	38277	Elevator conveyor	
Two-tier conveyor	7119	Holding table	
Chiller	90876	Eviscerator	
Receiving table	1683	Two-tier conveyor	
Trim/inspection table	20195	Chiller	
Knife sharpener	7236	Receiving table	
Waste conveyor (2)	21878	Trim/inspection table	
Conveyor	5671	Knife sharpener	
Saws and knives	37024	Waste conveyor (2)	
Cryogenic freezer	459428	Conveyor	
Roller conveyor	1178	Automatic sorter	
Truck scale	6496	Cryogenic freezer	
Electronic scale	8414	Roller conveyor	
Box sealer	8414	Truck scale	
Fork lift truck	33658	Electronic scale	
Pallet truck	841	Box sealer	
Cleaning system	22214	Fork lift truck	
Waste handling/treating	38706	Pallet truck	
quality control		Cleaning system	
laboratory equipment	25243	Waste handling/treating	
Refrigeration/freezing		quality control	
storage equipment	168289	laboratory equipment	
Instrumentation and		Refrigeration/freezing	
control equipment	84144	storage equipment	
Spare parts	42072	Instrumentation and	
Miscellaneous	33658	control equipment	
Skinner	109388	Spare parts	
		Miscellaneous	
Total	$1,285,084	*Total*	$1,2

APPENDIX D

ESTIMATIONS OF EXPECTED PRICE

Expected Price Estimation

Percent mark-up by assumption

	Frozen Pork	Fish	MAP pork
Retail	52%	68%	60%
Wholesale	6.25%	6.25%	6.25%
Processor	35%	33%	36%

Average retail prices for Montreal ($/kg)

Frozen pork	$ 8.75
Frozen fish	$ 10.12
MAP pork	$ 9.19

Expected Processor Prices[6]

	Buying Price ($/kg)	Selling Price ($/kg)
Frozen pork	$ 4.00[a]	$ 5.40
Frozen fish	$ 4.25	$ 5.67
MAP pork	$ 4.00[a]	$ 5.42

a) Source: Reynolds, N.L.

[6] Estimation of expected price can be found in Section 4.4

APPENDIX E[7]

INVESTMENT

Cost of the Plant - Pork Processing	Costs ($)
Civil Works	
Waste treatment	168289
Buildings	1178021
Process, mechanical, electrical works	
Equipment	1285084
Freight	8414
Equipment erection	496452
Piping installation	33658
Electrical power and control wiring	50487
Engineering and project control	
Process equipment layout	168289
Engineering	
Mechanical / electrical wiring drawings and specifications	50487
Start-up and operator training services	67316
Civil engineering	16829
Construction management	16829
Project management	33658
Total Plant Costs (excluding land)	$ 3,573,813

Cost of the Plant - Fish Processing	Costs ($)
Civil Works	
Waste treatment	168289
Buildings	1178021
Process, mechanical, electrical works	
Equipment	1267295
Freight	8414
Equipment erection	496452
Piping installation	33658
Electrical power and control wiring	50487
Engineering and project control	
Process equipment layout	168289
Engineering	
Mechanical / electrical wiring drawings and specifications	50487
Start-up and operator training services	67316
Civil engineering	16829
Construction management	16829
Project management	33658
Total Plant Costs (excluding land)	$ 3,556,024

Labour Requirement[8]

Job description	Number of Employees
skilled operators	28
maintenance mechanic, electrician	1
quality control technician	1
foreman	1
plant manager	1
Total Number of Employees	31

[8] **Silva, J.L.**

APPENDIX F

ANNUAL OPERATING COSTS[9]

[9] [9]Marabotto, L. and Cattivalli,

Silva, J.L.

Assumptions:
2000 hours per year operation
80% yield per unit of fresh product
3000 kg per hour of fresh product

Plant Design Basis

Rate	*Product*	*Size (g)*	*Packaging*
2100 kg/hr	dressed frozen fish	100-500	10 kg box
Operating hours per year	1 shift @ 2000 hr. each =		2000
Annual output	4200000 kg		

Utilities

	Item	*Name*	*Water m3/hr 20 degree C*	*Carbon Dioxide (kg/hr)*	*Electric Power (k*
	9	Eviscerator	1.2		
	12	Chillers	12		
	14	Deheader/slitter	1.8		
	15	Filleter/skinner	1.8		
	22	Freezer		2100	
		Others	7.2		
Total			24	2100	17

	Related Industry	Energy Cost
Project		
Frozen Pork	Frozen Food	$ 167,000
Frozen Fish	Fish Products	$ 89,000
MAP - Pork	Food Industries	$ 169,000

FROZEN PORK LION PROCESSING PLANT

Item	Consumption per hour	Cost per unit	Cost per year
Raw material: Pork loin	3000 kg	$4.00	$ 24,000,0
Fuel and Electricity			1670
Water	48 litres	0.35	336
Liquid Carbon dioxide	2100 kg	0.12	5040
Packaging material			
Cryovac bags	300	0.10	600
Cardboard boxes	300	0.04	240
Labour			3448
Spare parts			150
Miscellaneous			200
Total direct operating cost			$25,215.4

FROZEN FISH (ocean perch) PROCESSING PLANT

Item	Consumption per hour	Cost per unit	Cost per year
Raw material: Ocean perch	3000 kg	$4.25	$ 25,500,0
fuel and Electricity			890
Water	48 litres	0.35	336
Liquid Carbon dioxide	2100 kg	0.12	5040
Packaging material			
Cryovac bags	300	0.10	600
Cardboard boxes	300	0.04	240
Labour			3448
Spare parts			150
Miscellaneous			200
Total direct operating cost			$26,590.4

MODIFIED ATMOSPHERE PACKAGING PLANT: PORK

Item	*Consumption per hour*	*Cost per unit*	*Cost per yea*
Raw material: Pork loin	3000 kg	$ 4.00	$ 24,000,0
Other raw materials			
Gases: Nitrogen	132 kg	0.00	10
Carbon dioxide	132 kg	0.02	42
Chitosan (0.2%, 6.5 pH)	3 kg	88.00	5280
Oxygen absorbent (Ageless FX)	3000		42
Fuel and Electricity			1690
Water	48 litres	0.35	336
Packaging material			
Cardboard boxes	300	0.04	240
Cryovac bags	300	0.10	600
Labour			3448
Spare parts			150
Miscellaneous			200
Total direct operating cost			$ 25,203,8

APPENDIX G

BENEFIT COSTS ANALYSIS - FLOW CHARTS

BENEFIT-COSTS ANALYSIS:	Frozen Pork Processing Plant			(Single Shift)		($'000)															
	Year																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COSTS																					
Investment																					
Land	26.00																				
Waste treatment	168.29																				
Buildings	1178.02																				
Equipment	1285.08										219.64										
Freight	8.41																				
Equipment erection	496.45																				
Piping installation	33.66																				
Electrical power and control wiring	50.49																				
Process equipment layout	168.29																				
Engineering																					
Mechanical / electrical wiring drawings and specifications	50.49																				
Start-up and operator training services	67.32																				
Civil engineering	16.83																				
Construction management	16.83																				
Project management	33.66																				
Contingency	719.96																				
Sub-total (Investment)	4319.77										219.64										
Operating Costs																					
Raw Material @ $4.00 per kg		24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000
Packaging Materials		126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00
Fuel and Electricity		167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00
Water		33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60
Liquid Carbon Dioxide		504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00
Spare Parts		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Salaries and Wages		344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80
Miscellaneous		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
			0.00																		
Sub-total (Operating Costs)		25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40
TOTAL COSTS	4319.77	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25435.04	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40	25215.40
BENEFITS																					
Sales																					
Fresh Pork @ $5.40per kg		25920	25920	25920	25920	25920	25920	25920	25920	25920	25920	25920	25920	25920	25920	25920	25920	25920	25920	25920	25920
Salvage and Resale Value																					
Land																					26.00
Building																					176.70
Equipment											32.95										192.76
TOTAL BENEFITS		25920	25920	25920	25920	25920	25920	25920	25920	25920	25953	25920	25920	25920	25920	25920	25920	25920	25920	25920	26315
Cash Flow	-4319.77	704.60	704.60	704.60	704.60	704.60	704.60	704.60	704.60	704.60	517.90	704.60	704.60	704.60	704.60	704.60	704.60	704.60	704.60	704.60	1100.07
Net Present Value @8% discount rate	$ 2,404																				
Benefit-Cost Ratio @ 8% discount rate	1.09																				
Internal Rate of Return	15%																				

BENEFIT-COSTS ANALYSIS: **Frozen Fish Processing Plant** (Single Shift) ($'000)

		Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COSTS																						
Investment																						
Land		26.00																				
Waste treatment		168.29																				
Buildings		1178.02																				
Equipment		1267.30										53.04										
Freight		8.41																				
Equipment erection		496.45																				
Piping installation		33.66																				
Electrical power and control wiring		50.49																				
Process equipment layout		168.29																				
Engineering																						
Mechanical / electrical wiring drawings and specifications		50.49																				
Start-up and operator training services		67.32																				
Civil engineering		16.83																				
Construction management		16.83																				
Project management		33.66																				
Contingency		716.40																				
Sub-total (Investment)		4298.43										53.04										
Operating Costs																						
Raw Material @ $4.25per kg			25500	25500	25500	25500	25500	25500	25500	25500	25500	25500	25500	25500	25500	25500	25500	25500	25500	25500	25500	25500
Packaging Materials			84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00
Fuel and Electricity			89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00
Water			33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60
Liquid Carbon Dioxide			504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00
Spare Parts			15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Salaries and Wages			344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80
Miscellaneous			20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
				0.00																		
Sub-total (Operating Costs)			26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40
TOTAL COSTS		4298.43	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26643.44	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40	26590.40
BENEFITS																						
Sales																						
Frozen Fish @ $5.67 per kg			27216	27216	27216	27216	27216	27216	27216	27216	27216	27216	27216	27216	27216	27216	27216	27216	27216	27216	27216	27216
Salvage and Resale Value																						
Land																						26.00
Building																						176.70
Equipment												7.96										190.09
TOTAL BENEFITS			27216	27216	27216	27216	27216	27216	27216	27216	27216	27224	27216	27216	27216	27216	27216	27216	27216	27216	27216	27609
Cash Flow		-4298.43	625.60	625.60	625.60	625.60	625.60	625.60	625.60	625.60	625.60	580.52	625.60	625.60	625.60	625.60	625.60	625.60	625.60	625.60	625.60	1018.40
Net Present Value @8% discount rate		$ 1,766																				
Benefit-Cost Ratio @ 8% discount rate		1.09																				
Internal Rate of Return		13%																				

BENEFIT-COSTS ANALYSIS:	**Modified Atmosphere Packaging Plant- Pork**						(Single Shift)		($'000)													
		Year																				
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COSTS																						
Investment																						
Land		26.00																				
Waste treatment		168.29																				
Buildings		1178.02																				
Equipment		1285.08										219.64										
Freight		8.41																				
Equipment erection		496.45																				
Piping installation		33.66																				
Electrical power and control wiring		50.49																				
Process equipment layout		168.29																				
Engineering																						
Mechanical / electrical wiring drawings and specifications		50.49																				
Start-up and operator training services		67.32																				
Civil engineering		16.83																				
Construction management		16.83																				
Project management		33.66																				
Contingency		719.96																				
Sub-total (Investment)		4319.77										219.64										
Operating Costs																						
Raw Material @ $4.00 per kg			24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000	24000
Nitrogen			1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
Carbon Dioxide			4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22
Chitosan (0.2%, 6.5pH)			528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00
Oxygen Absorbent (Ageless FX			4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20
Packaging Materials			84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00
Fuel and Electricity			169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00
Water			33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60
Spare Parts			15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Salaries and Wages			344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80
Miscellaneous			20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Sub-total (Operating Costs)			25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88
TOTAL COSTS		4319.77	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25423.52	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88	25203.88
BENEFITS																						
Sales																						
Fresh Pork @ $5.42 per kg			26016	26016	26016	26016	26016	26016	26016	26016	26016	26016	26016	26016	26016	26016	26016	26016	26016	26016	26016	26016
Salvage and Resale Value																						
Land																						26.00
Building																						176.70
Equipment												32.95										192.76
TOTAL BENEFITS			26016	26016	26016	26016	26016	26016	26016	26016	26016	26049	26016	26016	26016	26016	26016	26016	26016	26016	26016	26411
Cash Flow		-4319.77	812.12	812.12	812.12	812.12	812.12	812.12	812.12	812.12	812.12	625.42	812.12	812.12	812.12	812.12	812.12	812.12	812.12	812.12	812.12	1207.59
Net Present Value @ 8% discount rate		$ 156,426																				
Benefit-Cost Ratio @ 8% discount rate		0.88																				
Internal Rate of Return		18%																				

BENEFIT-COSTS ANALYSIS:	Frozen Pork Processing Plant (Double Shift)						($'000)														
	Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COSTS																					
Investment																					
Land	26.00																				
Waste treatment	168.29																				
Buildings	1178.02																				
Equipment	1285.08										219.64										
Freight	8.41																				
Equipment erection	496.45																				
Piping installation	33.66																				
Electrical power and control wiring	50.49																				
Process equipment layout	168.29																				
Engineering																					
Mechanical / electrical wiring drawings and specifications	50.49																				
Start-up and operator training services	67.32																				
Civil engineering	16.83																				
Construction management	16.83																				
Project management	33.66																				
Contingency	719.96																				
Sub-total (Investment)	4319.77										219.64										
Operating Costs																					
Raw Material @ $4.00per kg		48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000
Packaging Materials		168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00
Fuel and Electricity		334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00	334.00
Water		67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20
Liquid Carbon Dioxide		1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008	1008
Spare Parts		15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Salaries and Wages		689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60
Miscellaneous		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Sub-total (Operating Costs)		50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80	50301.80
TOTAL COSTS	4319.77	50301.8	50301.8	50301.8	50301.8	50301.8	50301.8	50301.8	50301.8	50301.8	50521.4	50301.8	50301.8	50301.8	50301.8	50301.8	50301.8	50301.8	50301.8	50301.8	50301.8
BENEFITS																					
Sales																					
Fresh Pork @ $5.40 per kg		51840	51840	51840	51840	51840	51840	51840	51840	51840	51840	51840	51840	51840	51840	51840	51840	51840	51840	51840	51840
Resale and Salvage Value																					
Land																					26.00
Building																					176.70
Equipment											32.95										192.76
TOTAL BENEFITS		51840	51840	51840	51840	51840	51840	51840	51840	51840	51873	51840	51840	51840	51840	51840	51840	51840	51840	51840	52235
Cash Flow	-4319.77	1538.20	1538.20	1538.20	1538.20	1538.20	1538.20	1538.20	1538.20	1538.20	1351.50	1538.20	1538.20	1538.20	1538.20	1538.20	1538.20	1538.20	1538.20	1538.20	1933.67
Net Present Value @ 8% discount rate	$ 9,982																				
Benefit-Cost Ratio @ 8% discount rate	1.10																				
Internal Rate of Return	35%																				

BENEFIT-COSTS ANALYSIS:	Frozen Fish Processing Plant (Double Shift)						($000)															
		Year																				
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COSTS																						
Investment Costs																						
Land		26.00																				
Waste treatment		168.29																				
Buildings		1178.02																				
Equipment		1267.30										53.04										
Freight		8.41																				
Equipment erection		496.45																				
Piping installation		33.66																				
Electrical power and control wiring		50.49																				
Process equipment layout		168.29																				
Engineering																						
Mechanical / electrical wiring drawings		50.49																				
and specifications																						
Start-up and operator training services		67.32																				
Civil engineering		16.83																				
Construction management		16.83																				
Project management		33.66																				
Contingency		716.40																				
Sub-total (Investment Costs)		4298.43										53.04										
Operating Costs																						
Raw Material @ $4.25 per kg			51000	51000	51000	51000	51000	51000	51000	51000	51000	51000	51000	51000	51000	51000	51000	51000	51000	51000	51000	51000
Packaging Materials			168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00
Fuel and Electricity			178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00	178.00
Water			67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20
Liquid Carbon Dioxide			1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00	1008.00
Spare Parts			15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Salaries and Wages			689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60
Miscellaneous			20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
				0.00																		
Sub-total (Operating Costs)			53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80
TOTAL COSTS		4298.43	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53198.84	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80	53145.80
BENEFITS																						
Sales																						
Frozen Fish @ $5.67 per kg			54432	54432	54432	54432	54432	54432	54432	54432	54432	54432	54432	54432	54432	54432	54432	54432	54432	54432	54432	54432
Resale and Salvage Value																						
Land																						26.00
Building																						176.70
Equipment												7.96										190.09
TOTAL BENEFITS			54432	54432	54432	54432	54432	54432	54432	54432	54432	54440	54432	54432	54432	54432	54432	54432	54432	54432	54432	54825
Cash Flow		-4298.43	1286.20	1286.20	1286.20	1286.20	1286.20	1286.20	1286.20	1286.20	1286.20	1241.12	1286.20	1286.20	1286.20	1286.20	1286.20	1286.20	1286.20	1286.20	1286.20	1679.00
Net Present Value @ 8% discount rate		$ 7,771																				
Benefit-Cost Ratio @8% discount rate		1.10																				
Internal Rate of Return		30%																				

BENEFIT-COSTS ANALYSIS:	Modified Atmosphere Packaging Plant- Pork						(Double Shift)		($'000)												
	Year																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COSTS																					
Investment																					
Land	26.00																				
Waste treatment	168.29																				
Buildings	1178.02																				
Equipment	1285.08										219.64										
Freight	8.41																				
Equipment erection	496.45																				
Piping installation	33.66																				
Electrical power and control wiring	50.49																				
Process equipment layout	168.29																				
Engineering																					
Mechanical / electrical wiring drawings and specifications	50.49																				
Start-up and operator training services	67.32																				
Civil engineering	16.83																				
Construction management	16.83																				
Project management	33.66																				
Contingency	719.96																				
Sub-total (Investment)	4319.77										219.64										
Operating Costs																					
Raw Material @ $4.00 per kg		48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000	48000
Nitrogen		2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11
Carbon Dioxide		8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45
Chitosan (0.2%, 6.5pH)		528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00
Oxygen Absorbent (Ageless FX		8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40	8.40
Packaging Materials		168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00	168.00
Fuel and Electricity		338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00	338.00
Water		67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20
Spare Parts		15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Salaries and Wages		689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60	689.60
Miscellaneous		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Sub-total (Operating Costs)		49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76
TOTAL COSTS	4319.77	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	50064.40	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76	49844.76
BENEFITS																					
Sales																					
Fresh Pork @ $5.42 per kg		52320	52320	52320	52320	52320	52320	52320	52320	52320	52320	52320	52320	52320	52320	52320	52320	52320	52320	52320	52320
Salvage and Resale Value																					
Land																					26.00
Building																					176.70
Equipment											32.95										192.76
TOTAL BENEFITS		52320	52320	52320	52320	52320	52320	52320	52320	52320	52353	52320	52320	52320	52320	52320	52320	52320	52320	52320	52715
Cash Flow	-4319.77	2475.24	2475.24	2475.24	2475.24	2475.24	2475.24	2475.24	2475.24	2475.24	2288.54	2475.24	2475.24	2475.24	2475.24	2475.24	2475.24	2475.24	2475.24	2475.24	2870.71
Net Present Value @ 8% discount rate	$ 18,501																				
Benefit-Cost Ratio @ 8% discount rate	1.12																				
Internal Rate of Return	57%																				

BENEFIT-COSTS ANALYSIS: Frozen Pork Processing Plant (Sensitivity: Price Increase) ($'000)																					
	Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COSTS																					
Investment																					
Land	26.00																				
Waste treatment	168.29																				
Buildings	1178.02																				
Equipment	1285.08										219.64										
Freight	8.41																				
Equipment erection	498.45																				
Piping installation	33.66																				
Electrical power and control wiring	50.49																				
Process equipment layout	168.29																				
Engineering																					
Mechanical / electrical wiring drawings	50.49																				
and specifications																					
Start-up and operator training services	67.32																				
Civil engineering	16.83																				
Construction management	16.83																				
Project management	33.66																				
Contingency	719.96																				
Sub-total (Investment)	4319.78										219.64										
Operating Costs																					
Raw Material @ $4.40 per kg		26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400
Packaging Materials		84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00
Fuel and Electricity		167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00
Water		33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60
Liquid Carbon Dioxide		504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00
Spare Parts		15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Salaries and Wages		344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80
Miscellaneous		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
			0.00																		
Sub-total (Operating Costs)		27568	27568	27568	27568	27568	27568	27568	27568	27568	27568	27568	27568	27568	27568	27568	27568	27568	27568	27568	27568
TOTAL COSTS	4320	27568	27568	27568	27568	27568	27568	27568	27568	27568	27788	27568	27568	27568	27568	27568	27568	27568	27568	27568	27568
BENEFITS																					
Sales																					
Fresh Pork @ $5.94 per kg		28512	28512	28512	28512	28512	28512	28512	28512	28512	28512	28512	28512	28512	28512	28512	28512	28512	28512	28512	28512
Salvage Value																					
Land																					26.00
Building																					176.70
Equipment											32.95										192.76
TOTAL BENEFITS		28512	28512	28512	28512	28512	28512	28512	28512	28512	28545	28512	28512	28512	28512	28512	28512	28512	28512	28512	28907
Cash Flow	-4319.78	943.60	943.60	943.60	943.60	943.60	943.60	943.60	943.60	943.60	756.90	943.60	943.60	943.60	943.60	943.60	943.60	943.60	943.60	943.60	1339.07
Net Present Value @ 9% discount rate	$4,577																				
Benefit-Cost Ratio @ 9% discount rate	1.02																				
Internal Rate of Return	21%																				

BENEFIT-COSTS ANALYSIS:	**Frozen Fish Processing Plant**				(Sensitivity: Price Increase)			($'000)													
	Year																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COSTS																					
Investment																					
Land	26.00																				
Waste treatment	168.29																				
Buildings	1178.02																				
Equipment	1267.30										53.04										
Freight	8.41																				
Equipment erection	496.45																				
Piping installation	33.66																				
Electrical power and control wiring	50.49																				
Process equipment layout	168.29																				
Engineering																					
Mechanical / electrical wiring drawings	50.49																				
and specifications																					
Start-up and operator training services	67.32																				
Civil engineering	16.83																				
Construction management	16.83																				
Project management	33.66																				
Contingency	716.40																				
Sub-total (Investment)	4298.43										53.04										
Operating Costs																					
Raw Material @ 4.68 per kg		28080	28080	28080	28080	28080	28080	28080	28080	28080	28080	28080	28080	28080	28080	28080	28080	28080	28080	28080	28080
Packaging Materials		84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00
Fuel and Electricity		89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00
Water		33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60
Liquid Carbon Dioxide		504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00
Spare Parts		15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Salaries and Wages		344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80
Miscellaneous		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
			0.00																		
Sub-total (Operating Costs)		29170	29170	29170	29170	29170	29170	29170	29170	29170	29170	29170	29170	29170	29170	29170	29170	29170	29170	29170	29170
TOTAL COSTS	4298	29170	29170	29170	29170	29170	29170	29170	29170	29170	29223	29170	29170	29170	29170	29170	29170	29170	29170	29170	29170
BENEFITS																					
Sales																					
Frozen Fish @ $6.24 per kg		29952	29952	29952	29952	29952	29952	29952	29952	29952	29952	29952	29952	29952	29952	29952	29952	29952	29952	29952	29952
Salvage Value																					
Land																					26.00
Building																					176.70
Equipment											7.96										190.09
TOTAL BENEFITS		29952	29952	29952	29952	29952	29952	29952	29952	29952	29960	29952	29952	29952	29952	29952	29952	29952	29952	29952	30345
Cash Flow	-4298.43	781.60	781.60	781.60	781.60	781.60	781.60	781.60	781.60	781.60	736.52	781.60	781.60	781.60	781.60	781.60	781.60	781.60	781.60	781.60	1174.40
Net Present Value @ 9% discount rate	($967)																				
Benefit-Cost Ratio @ 9% discount rate	1.00																				
Internal Rate of Return	17%																				

BENEFIT-COSTS ANALYSIS: **Modified Atmosphere Packaging Plant- Pork** (Sensitivity: Price Increase) ($'000)

	Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COSTS																					
Investment																					
Land	26.00																				
Waste treatment	168.29																				
Buildings	1178.02																				
Equipment	1285.08										219.64										
Freight	8.41																				
Equipment erection	496.45																				
Piping installation	33.66																				
Electrical power and control wiring	50.49																				
Process equipment layout	168.29																				
Engineering																					
Mechanical / electrical wiring drawings and specifications	50.49																				
Start-up and operator training services	67.32																				
Civil engineering	16.83																				
Construction management	16.83																				
Project management	33.66																				
Contingency	719.96																				
Sub-total (Investment)	4319.77										219.64										
Operating Costs																					
Raw Material @ $4.40 per kg		26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400	26400
Nitrogen		1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.00	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
Carbon Dioxide		4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22
Chitosan (0.2%, 6.5pH)		528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00
Oxygen Absorbent (Ageless FX		4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20
Packaging Materials		84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00
Fuel and Electricity		169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00
Water		33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60
Spare Parts		15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Salaries and Wages		344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80
Miscellaneous		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Sub-total (Operating Costs)		27604	27604	27604	27604	27604	27604	27604	27604	27604	27604	27604	27604	27604	27604	27604	27604	27604	27604	27604	27604
TOTAL COSTS	4320	27604	27604	27604	27604	27604	27604	27604	27604	27604	27824	27604	27604	27604	27604	27604	27604	27604	27604	27604	27604
BENEFITS																					
Sales																					
Fresh Pork @ $5.96 per kg		28608	28608	28608	28608	28608	28608	28608	28608	28608	28608	28608	28608	28608	28608	28608	28608	28608	28608	28608	28608
Salvage and Resale Value																					
Land																					26.00
Building																					176.70
Equipment											32.95										192.76
TOTAL BENEFITS		28608	28608	28608	28608	28608	28608	28608	28608	28608	28641	28608	28608	28608	28608	28608	28608	28608	28608	28608	29003
Cash Flow	-4319.77	1004.12	1004.12	1004.12	1004.12	1004.12	1004.12	1004.12	1004.12	1004.12	817.42	1004.12	1004.12	1004.12	1004.12	1004.12	1004.12	1004.12	1004.12	1004.12	1399.59
Net Present Value @ 8% discount rate	$ 192,181																				
Benefit-Cost Ratio @ 8% discount rate	0.88																				
Internal Rate of Return	23%																				

BENEFIT-COSTS ANALYSIS:	Frozen Pork Processing Plant					(Sensitivity. Price Decrease)			($'000)													
		Year																				
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COSTS																						
Investment																						
Land		26.00																				
Waste treatment		168.29																				
Buildings		1178.02																				
Equipment		1285.08										219.64										
Freight		8.41																				
Equipment erection		496.45																				
Piping installation		33.66																				
Electrical power and control wiring		50.49																				
Process equipment layout		168.29																				
Engineering																						
Mechanical / electrical wiring drawings and specifications		50.49																				
Start-up and operator training services		67.32																				
Civil engineering		16.83																				
Construction management		16.83																				
Project management		33.66																				
Contingency		719.96																				
Sub-total (Investment)		4319.78										219.64										
Operating Costs																						
Raw Material @ $3.60 per kg			21600	21600	21600	21600	21600	21600	21600	21600	21600	21600	21600	21600	21600	21600	21600	21600	21600	21600	21600	21600
Packaging Materials			84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00
Fuel and Electricity			167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00
Water			33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60
Liquid Carbon Dioxide			504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00
Spare Parts			15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Salaries and Wages			344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80
Miscellaneous			20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
				0.00																		
Sub-total (Operating Costs)			22768	22768	22768	22768	22768	22768	22768	22768	22768	22768	22768	22768	22768	22768	22768	22768	22768	22768	22768	22768
TOTAL COSTS		4320	22768	22768	22768	22768	22768	22768	22768	22768	22768	22988	22768	22768	22768	22768	22768	22768	22768	22768	22768	22768
BENEFITS																						
Sales																						
Fresh Pork @ $4.86 per kg			23328	23328	23328	23328	23328	23328	23328	23328	23328	23328	23328	23328	23328	23328	23328	23328	23328	23328	23328	23328
Salvage Value																						
Land																						26.00
Building																						176.70
Equipment												32.95										192.76
TOTAL BENEFITS			23328	23328	23328	23328	23328	23328	23328	23328	23328	23361	23328	23328	23328	23328	23328	23328	23328	23328	23328	23723
Cash Flow		-4319.78	559.60	559.60	559.60	559.60	559.60	559.60	559.60	559.60	559.60	372.90	559.60	559.60	559.60	559.60	559.60	559.60	559.60	559.60	559.60	955.07
Net Present Value @ 8% discount rate		$1,086																				
Benefit-Cost Ratio @8% discount rate		1.01																				
Internal Rate of Return		11%																				

BENEFIT-COSTS ANALYSIS:	Frozen Fish Processing Plant				(Sensitivity: Price Decrease)			($'000)													
	Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COSTS																					
Investment																					
Land	26.00																				
Waste treatment	168.29																				
Buildings	1178.02																				
Equipment	1267.30										53.04										
Freight	8.41																				
Equipment erection	496.45																				
Piping installation	33.66																				
Electrical power and control wiring	50.49																				
Process equipment layout	168.29																				
Engineering																					
Mechanical / electrical wiring drawings and specifications	50.49																				
Start-up and operator training services	67.32																				
Civil engineering	16.83																				
Construction management	16.83																				
Project management	33.66																				
Contingency	716.40																				
Sub-total (Investment)	4298.43										53.04										
Operating Costs																					
Raw Material @ 3.83 per kg		22980	22980	22980	22980	22980	22980	22980	22980	22980	22980	22980	22980	22980	22980	22980	22980	22980	22980	22980	22980
Packaging Materials		84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00
Fuel and Electricity		89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00	89.00
Water		33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60
Liquid Carbon Dioxide		504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00	504.00
Spare Parts		15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Salaries and Wages		344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80
Miscellaneous		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
			0.00																		
Sub-total (Operating Costs)		24070	24070	24070	24070	24070	24070	24070	24070	24070	24070	24070	24070	24070	24070	24070	24070	24070	24070	24070	24070
TOTAL COSTS	4298	24070	24070	24070	24070	24070	24070	24070	24070	24070	24123	24070	24070	24070	24070	24070	24070	24070	24070	24070	24070
BENEFITS																					
Sales																					
Frozen Fish @ $5.10 per kg		24480	24480	24480	24480	24480	24480	24480	24480	24480	24480	24480	24480	24480	24480	24480	24480	24480	24480	24480	24480
Salvage Value																					
Land																					26.00
Building																					176.70
Equipment											7.96										190.09
TOTAL BENEFITS		24480	24480	24480	24480	24480	24480	24480	24480	24480	24488	24480	24480	24480	24480	24480	24480	24480	24480	24480	24873
Cash Flow	-4298.43	409.60	409.60	409.60	409.60	409.60	409.60	409.60	409.60	409.60	364.52	409.60	409.60	409.60	409.60	409.60	409.60	409.60	409.60	409.60	802.40
Net Present Value @ 8% discount rate	($2,143)																				
Benefit-Cost Ratio @8% discount rate	0.98																				
Internal Rate of Return	7%																				

BENEFIT-COSTS ANALYSIS: **Modified Atmosphere Packaging Plant- Pork** (Sensitivity: Price Decrease) ($'000)

	Year 0	1	2	3	4	5	6	7	8	9	10
COSTS											
Investment											
Land	26.00										
Waste treatment	168.29										
Buildings	1178.02										
Equipment	1285.08										219.64
Freight	8.41										
Equipment erection	496.45										
Piping installation	33.66										
Electrical power and control wiring	50.49										
Process equipment layout	168.29										
Engineering											
Mechanical / electrical wiring drawings	50.49										
and specifications											
Start-up and operator training services	67.32										
Civil engineering	16.83										
Construction management	16.83										
Project management	33.66										
Contingency	719.96										
Sub-total (Investment)	4319.77										219.64
Operating Costs											
Raw Material @ $3.60 per kg		21600	21600	21600	21600	21600	21600	21600	21600	21600	21600
Nitrogen		1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
Carbon Dioxide		4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22
Chitosan (0.2%, 6.5pH)		528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00
Oxygen Absorbent (Ageless FX		4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20
Packaging Materials		84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00
Fuel and Electricity		169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00
Water		33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60
Spare Parts		15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Salaries and Wages		344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80
Miscellaneous		20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Sub-total (Operating Costs)		22804	22804	22804	22804	22804	22804	22804	22804	22804	22804
TOTAL COSTS	4320	22804	22804	22804	22804	22804	22804	22804	22804	22804	23024
BENEFITS											
Sales											
Fresh Pork @ $4.88 per kg		23424	23424	23424	23424	23424	23424	23424	23424	23424	23424
Salvage and Resale Value											
Land											
Building											
Equipment											32.95
TOTAL BENEFITS		23424	23424	23424	23424	23424	23424	23424	23424	23424	23457
Cash Flow	-4319.77	620.12	620.12	620.12	620.12	620.12	620.12	620.12	620.12	620.12	433.42
Net Present Value @ 8% discount rate	$ 120,671										
Benefit-Cost Ratio @ 8% discount rate	0.88										
Internal Rate of Return	13%										

	11	12	13	14	15	16	17	18	19	20
COSTS										
Investment										
Land										
Waste treatment										
Buildings										
Equipment										
Freight										
Equipment erection										
Piping installation										
Electrical power and control wiring										
Process equipment layout										
Engineering										
Mechanical / electrical wiring drawings										
and specifications										
Start-up and operator training services										
Civil engineering										
Construction management										
Project management										
Contingency										
Sub-total (Investment)										
Operating Costs										
Raw Material @ $3.60 per kg	21600	21600	21600	21600	21600	21600	21600	21600	21600	21600
Nitrogen	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
Carbon Dioxide	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22
Chitosan (0.2%, 6.5pH)	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00
Oxygen Absorbent (Ageless FX	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20	4.20
Packaging Materials	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00	84.00
Fuel and Electricity	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00	169.00
Water	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60	33.60
Spare Parts	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Salaries and Wages	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80	344.80
Miscellaneous	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Sub-total (Operating Costs)	22804	22804	22804	22804	22804	22804	22804	22804	22804	22804
TOTAL COSTS	22804	22804	22804	22804	22804	22804	22804	22804	22804	22804
BENEFITS										
Sales										
Fresh Pork @ $4.88 per kg	23424	23424	23424	23424	23424	23424	23424	23424	23424	23424
Salvage and Resale Value										
Land										26.00
Building										176.70
Equipment										192.76
TOTAL BENEFITS	23424	23424	23424	23424	23424	23424	23424	23424	23424	23819
Cash Flow	620.12	620.12	620.12	620.12	620.12	620.12	620.12	620.12	620.12	1015.59
Net Present Value @ 8% discount rate										
Benefit-Cost Ratio @ 8% discount rate										
Internal Rate of Return										

APPENDIX H[10]

PER UNIT COST OF PROCESSING

[10] For calculations see section 4.4 in Chapter 4

Frozen Pork

Annual Interest Rate (decimal)	8%
Project Life Cycle (years)	20
Amortization Rate (per year)	1

Annual Fixed Cost Estimation

Total Investment	Salvage Value	Amount	Amort. Rate	Annual Value
$ 3,026,270	$ 453,941	$2,572,329	0.1095	$ 281,670

Estimation of Annual Operating Charges

Fixed Costs	$ 281,670
Variable Costs	$ 1,168,400
Total Annual Charges	$ 1,450,271

Estimation of Annual Output of Final Product

Plant Capacity (per hour)	3000
Annual Operating Hours	2000
Annual Input (kg)	6000000

Estimated Cost of Processing (per kg of output)

Total Annual Charges	$ 1,450,271
Annual Output	6000000
Cost of Freezing/kg	$ 0.24

Frozen Fish

Annual Interest Rate (decimal)	8%
Project Life Cycle (years)	20
Amortization Rate (per year)	1

Annual Fixed Cost Estimation

Investment	Salvage Value	Amount	Amort. Rate	Annual Value
$ 3,004,930	$ 450,739	$ 2,554,190	0.1095	$ 279,684

Estimation of Annual Operating Charges

Fixed Costs	$ 279,684
Variable Costs	$ 1,090,400
Total Annual Charges	$ 1,370,084

Estimation of Annual Output of Final Product

Plant Capacity (per hour)	3000
Annual Operating Hours	2000
Annual Input (kg)	6000000

Estimated Cost of Processing (per kg of output)

Total Annual Charges	$ 1,370,084
Annual Output	6000000
Cost of Freezing/kg	$ 0.23

Modified Atmosphere Packaging: Pork

Annual Interest Rate (decimal)	8%
Project Life Cycle (years)	20
Amortization Rate (per year)	1

Annual Fixed Cost Estimation

Investment	Salvage Value	Amount	Amort. Rate	Annual Value
$ 3,026,270	$ 453,941	$2,572,329	0.1095	$ 281,670

Estimation of Annual Operating Charges

Fixed Costs	$ 281,670
Variable Costs	$ 1,203,880
Total Annual Charges	$ 1,485,550

Estimation of Annual Output of Final Product

Plant Capacity (per hour)	3000
Annual Operating Hours	2000
Annual Input (kg)	6000000

Estimated Cost of Processing (per kg of output)

Total Annual Charges	$ 1,485,550
Annual Output	6000000
Cost of Freezing/kg	$ 0.25

APPENDIX I[11]

Converting 1986 US dollars to 1995 Canadian dollars
(Cost of plant and equipment)

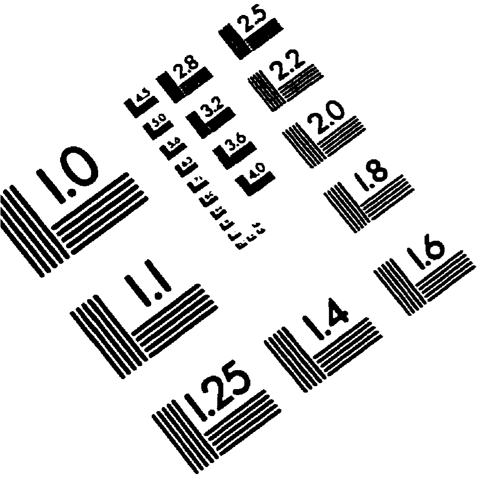
[11] [11]Marabotto, L. and Cattivalli, D.

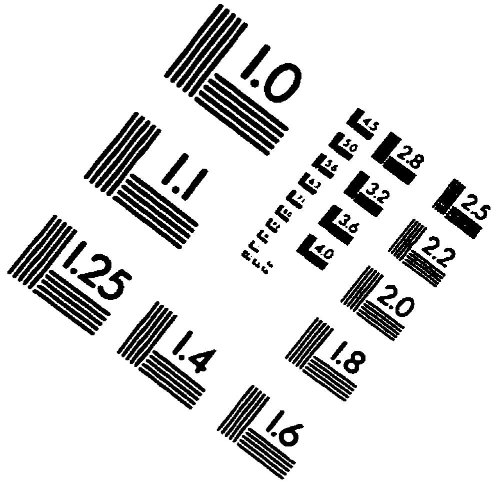
Converting 1986 US dollars to 1995 Cdn

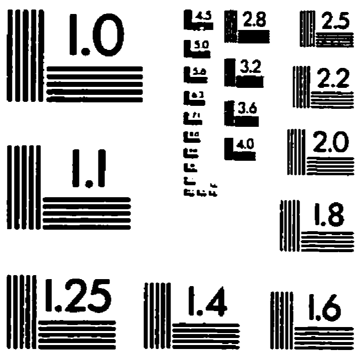
Exchange rate	1.366	0.7199
Price Index (1986 = 100)	123.2	0.8117

Table 1. Cost of the Plant	1986 US $	1986 Cdn $	1995 Cdn $
Civil Works			
Waste treatment	100000	136600	168288.78
Buildings	700000	956200	1178021.4
Process, mechanical, electrical works			
Equipment	1040000	1420640	1750203
Freight	5000	6830	8414
Equipment erection	295000	402970	496452
Piping installation	20000	27320	33658
Electrical power and control wiring	30000	40980	50487
Engineering and project control			
Process equipment layout Engineering	100000	136600	168289
Mechanical / electrical wiring drawings and specifications	30000	40980	50487
Start-up and operator training services	40000	54640	67316
Civil engineering	10000	13660	16829
Construction management	10000	13660	16829
Project management	20000	27320	33658
Total Plant Costs (excluding land)	$2,400,000	$3,278,400	$4,038,931

IMAGE EVALUATION TEST TARGET (QA-3)







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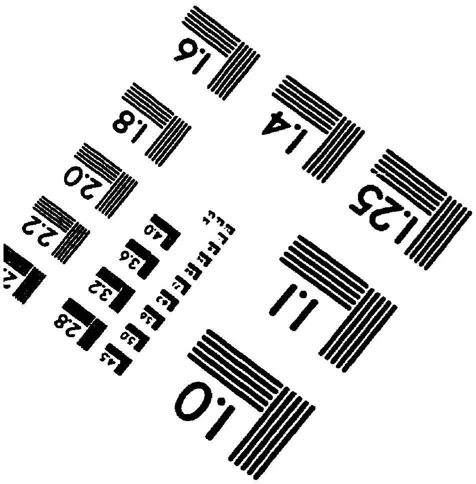
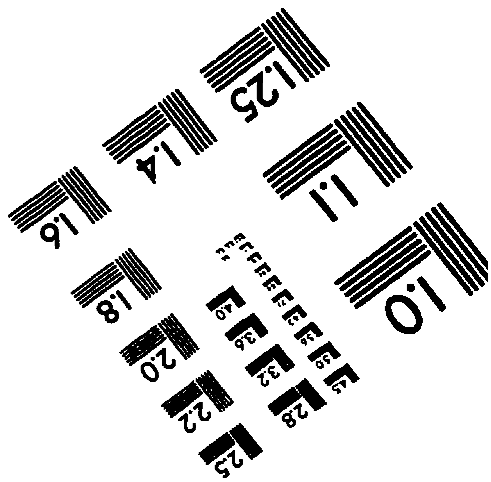
6"





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1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
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