COMPETITIVENESS OF CANOLA OIL AND MEAL IN THE UNITED STATES OILSEED MARKET

By

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CHAPTER I

INTRODUCTION

Sources of change have occurred in the domestic and world oilseed market which will affect the industry for years to come. Greater consumer awareness of saturated fat levels in foods, recent farm and trade policy, and advances in oilseed processing have had major impacts on consumption and production patterns in the United States. Ultimately, the ability of producers and food processors to adapt to these interdependent sources of change will depend upon the feasibility and availability of growing alternative oilseed crops. One such crop of particular significance in the oilseed industry is low erucic acid rapeseed, or canola.

Historically, rapeseed has been a major oilseed overseas. The regions with the largest volume of production in the world are in Canada, Europe, India, and China. In the U.S., rapeseed production is negligible. However, U.S. rapeseed oil consumption, as shown in Table 1, has increased dramatically during the last several years. Worldwide, rapeseed production grew from 6% of world oilseed production in 1977/78 - 1981/82 to 11% of world oilseed production in 1987/88. Record rapeseed plantings and yield in China and Europe, combined with a record yield in Canada, boosted world production to a record 22.5 million tons in 1987/88 (U.S. Department of Agriculture (USDA) 1989). In order to understand the increased imports, it is useful to know how rapeseed and rapeseed products are used.

TABLE 1

ESTIMATED U.S. RAPESEED
OIL CONSUMPTION

	1984/85	1985/86	1986/87	1987/88	1988/89
			metric tons		
Total	12,299	42,033	83,179	126,093	195,892
Edible	6,107	31,391	72,114	118,087	181,071
Inedible	6,192	10,102	11,065	8,006	14,821

1/ consumption equals imports of rapeseed oil plus domestic production.
Source: Dicks and Buckley

Uses

Rapeseed oil has two distinct end product uses: 1) edible oil for human consumption in food products such as salad and cooking oil, margarine, and processed food products; and 2) inedible industrial oil for producing synthetic lubricants, varnishes, and plastic. The desired composition of the fatty acids which make up the oils for these two uses are distinctly different and are predominantly controlled by genetic factors unique to individual varieties. These two oil varieties are not compatible. Thus, the principle characteristic dictating the end product use of rapeseed oil is its erucic acid content.

Erucic acid is a 22 carbon chain fatty acid possessing unique characteristics for use in high temperature synthetic lubricants and as a plasticizer in improved nylons. Inedible varieties of rapeseed are termed industrial rapeseed and contain a minimum of 45% erucic acid content in the fatty acid component of industrial-type rapeseed oils. Erucic acid is not readily digested in laboratory animal diets. It concentrates in smooth muscle tissue and causes physiological disorders when consumed in large quantities. While no adverse effects from consuming high erucic acid oils in the human diet have been reported, the U.S. Food and Drug Administration currently limits the erucic acid content of edible rapeseed varieties to no more than 2% of the oil's fatty acid composition. Rapeseed oils with intermediate levels of erucic acid (between 2 and 45 percent) have little or no commercial value (Kephart and Schermerhorn 1988).

Industrial rapeseed is an oilseed plant yielding seeds comprised of, by weight, approximately 40% oil and 60% high protein meal. Most of the erucic acid oil is currently processed into erucamide and used as a slip agent in the manufacture of plastic films. Other potential uses include nylons, cosmetics, lubricants, paints and coatings, functional fluids, plasticizers, polyesters, surfactants, floatation agents, pharmaceuticals, and dielectric fluids. In addition, erucic acid may be used to substitute for numerous other long-chain fatty acids used in the production of synthetic fibers (Dicks and Buckley 1989).

Canola, an edible variety of rapeseed, has become a very attractive oil substitute in our highly dietary conscious society due to its nutritional characteristics. Canola is the Canadian registered name of a genetically modified product of the traditional rapeseed. In the 1950's parallel plant breeding programs in Canada were directed to improve the nutritional value of the oil and meal. In 1970, as rapeseed became a more popular part of the Canadian diet, their government recommended that the rapeseed industry switch to low-erucic acid varieties whose genotypes were already available.

In 1975, Canadian plant breeders began releasing varieties of rapeseed with low levels of erucic acid and glucosinolates. By 1980, the Canadian rapeseed industry adopted the name, canola, to describe seed and seed products from this new oilseed (Daun 1984, 293). During this period, only fully hydrogenated rapeseed oil had been permitted for use in food products in the United States.

Characteristics of rapeseed oil largely determine the quantity of imports. While canola is a relative newcomer to the U.S. market, its unique fatty acid composition is peaking the interest of domestic refiners, food processors, and plant breeders. Growth in the domestic canola oil market actually began when, in 1985, the FDA granted Generally Recognized As Safe (GRAS) status to canola oil under the name, low erucic acid rapeseed oil. Three years later, in the fall of 1988, the marketability of canola oil was increased significantly following an FDA proposal which allowed low erucic acid rapeseed oil to be referred to as canola oil on food packaging (Jayawickrama 1989, 10).

Additionally, the canola meal remaining after oil extraction is a good source of protein in livestock feeds. Canola meal is especially high in lysine, an essential amino acid. Its high protein content and other characteristics compare favorably with other feedstuffs, especially soybean meal. However, its level of inclusion in various feed rations is highly dependent on price and availability.

The increasing number of food applications and growing consumer interest in the United States has led us to be increasingly dependent upon trade policy. This is because virtually all of the world's rapeseed is produced outside the United States. Although no official surveys have been taken, total domestic acreage is estimated to be between 65,000 and 200,000 acres. Its rate of growth in the U.S. depends on whether base acreage requirements for program crops are eased in subsequent farm legislation. In addition, rapeseed's profitability compared with that of program crops like winter wheat will be of importance (Dicks and Buckley 1989).

Growth

In the future, imports from Canada will face progressively lower U.S. import tariffs under the U.S. - Canada free trade agreement. In making any assessment of the gains from free trade, it is necessary to distinguish between canola seed and canola oil and products. There should be an increase in the exportation of canola seed to the U.S. market.

Refined canola oil possesses bland flavor, a light color, good flow properties, and high stability under heating (frying) conditions. In addition, canola oil is useful for salad dressing applications because of its resistance to clouding under refrigeration (Best 1987, 123). As consumers and processors become more informed of such characteristics, Canadian exports to the U.S. should increase. The extent to which canola oil and oilseed product exports will increase depends on many factors including the efficiency of many of the existing and potentially new crushing plants.

Less restricted trade between the United States and Canada is a positive step in establishing canola as a viable domestic crop. According to Max Polan, Chairman of the Board for the Canola Council of Canada, the American market holds significant potential for both canola oil and meal sales. "The free trade agreement heralds change which can only be viewed as a positive. In addition, the American College of Nutrition (ACN) recently announced that a canola product was awarded the ACN's first product acceptance award. Evolving attitudes in nutrition signify another positive change for the canola industry." Polan added.

Many of the trade implications involving canola or rapeseed are directly affected by the General Agreement on Tariffs and Trade (GATT). Currently, negotiations are underway to liberalize global agricultural commerce during the

Uruguay Round of the GATT. If current levels of intervention were removed, world oilseed sectors would undergo less adjustment than most other agricultural commodity sectors because overall oilseed and oilseed product trade is subject to less government intervention. Nevertheless, elimination of policies and programs that distort agricultural trade would produce significant changes in regional oilseed and oilseed product demand and supply.

The market for canola, or edible rapeseed, is affected by the demand, supply, price, and product characteristics of meal and oil produced from oilseeds, palm kernel, and animal fats. Meal is the primary market for soybean and cottonseed, whereas oil is the primary market for high oil yielding seeds such as canola. Soybeans yield about 18% oil compared to 40% for canola, but the nutritional value of soybean meal is about 33% higher than canola meal (Prato 1988). The market for canola oil is highly driven by the price of the dominant competitor, soybean oil. Slight price differentials among soybean oil and canola oil could be sufficient to switch consumers' and manufacturers' preferences in many markets. Local tastes, nutritional concerns, and relative prices of canola and substitutes will also influence demand.

The joint product nature of oilseeds ties meal and oil markets closely together. For example, higher demand in rapeseed meal markets will upset the existing equilibrium between supply and demand in rapeseed oil markets. The relative substitutability among oilseeds and oilseed products significantly affects demand. Respective meal and oil content as well as degree of digestibility determine the extent to which oilseeds are substitutable (Bickerton and Glauber 1990, 11).

Canada has more crushing capacity than is currently being utilized. Furthermore, the United States has a significant crushing capacity and one that is capable of not only crushing soybeans but also canola. It is possible, with added costs, to convert soybean crushing plants into a structure capable of crushing canola seeds. From a Canadian standpoint, it seems desirable that their industry focus more attention on the crushing part of the industry and the exportation of these oil and oil products than on the exportation of canola seed.

Domestically, dietary trends and government intervention should initiate further processing technology. Several U.S. processing plants currently can process canola, and storage facilities are beginning to show more interest in the crop. As the U.S. canola industry develops, canola processing capacity is expected to increase. Plants equipped to process peanuts, cottonseed, sunflower seed, soybeans, and flaxseed also can process canola with some modifications. The cost of the modification will depend on the technology used in the current plant. High canola processing margins and significant volume to be processed will encourage modifying existing plants (Lowe 1989).

Some available existing oilseed plants have been modified to process canola. Given the low capacity utilization of processing facilities in existing oilseed processing plants and the common processes used by canola, significant increases in U.S. canola production in existing oilseed production areas will likely be served by modifications of existing storage and processing facilities (Dixon 1989).

The demand for canola oil and meal in the United States since the 1985 FDA approval has increased to a level that would warrant production and processing of raw material domestically. The emergence of crushing/refining facilities will play a pivotal role in expansion of the rapeseed market and grower acceptance. Factors such as crush margins, market acceptance, and legislation will determine whether, or the extent to which, rapeseed will move beyond a specialty or contract crop in the United States (USDA 1989).

Objectives

The primary objectives of this study are to: 1) present nutritional characteristics of canola that are likely to determine its acceptance in the U.S. market; 2) estimate the import demand for canola oil; 3) determine the degree to which canola meal could be included in certain feed rations; and 4) outline policy, processing, and economic factors and their likely effect on U.S. production. Market conditions can be described through a conceptual foundation based upon trends in the market and recent research publications. Cross-commodity effects and price differentials will be addressed.

The second objective can be reached through regression of oilseed import prices and quantity. The third objective will be achieved through the use of linear programming models which formulate least cost feed ration based on feed prices and nutrient requirements. Farm bill legislation, processing costs, and production budgets will be evaluated to reach the final objective. Grower adoption will depend on this legislation as well as seed crushing facilities and feed potential.

In the following chapters, sources of change in the canola and oilseed industry and implications will be discussed in further detail. The second chapter will focus on nutrition and competitive factors of canola oil such as characteristics and substitutability in the oilseed market. Industrial promotion of canola and other oilseeds are based on these characteristics and relative prices among substitutable products.

The third chapter will focus on the empirical import demand model. Factors such as price, trend, and a lagged response will be utilized. The model will be formulated as a partial adjustment of these and other factors. The fourth chapter focuses on the application of canola meal in feed rations. Afterwards, these factors will be used mainly as a tool to discuss and evaluate the potential for canola as a U.S. crop. Lastly, the summary and conclusions chapter is presented which presents specific conclusions for each objective along with suggestions for further research.

CHAPTER II

NUTRITIONAL ASPECTS OF CANOLA OIL AND OTHER OILSEEDS

Fats and oils are recognized as essential nutrients in both human and animal diets. Fats and oils are present in varying amounts in many foods providing several functions. They render the most concentrated source of energy of any foodstuff, supply essential fatty acids, contribute greatly to the feeling of satiety after eating, are carriers for fat-soluble vitamins, and serve to make foods more palatable (ISEO 1988). The success of canola in the U.S. market will depend on the degree to which it satisfies these nutritional functions. Hence, a general knowledge of oil composition, health, and dietary trends is essential in understanding canola's domestic market position.

Composition

Fats and oils belong to a class of substances called lipids. The general term lipid refers to any substance which is soluble in an organic solvent. Lipids include triglycerides or fats, phospholipids, waxes, sterols, and others. However, the term fat or oil usually refers to what the biochemist calls a triglyceride.

Fatty Acids

Triglycerides are found in our bodies, in plant and animal foods, and seafoods. They are composed of one molecule of glycerol attached to three fatty acids (Figure 1). Triglycerides differ from one another by the kinds of fattyacids they contain. Those containing polyunsaturated fatty acids are liquid at room temperature and are called oils. Canola, corn, and safflower oil are familiar examples. Those containing a large proportion of saturated fatty acids are solid at room temperature. Examples of these are beef fat, lard, and butter (Nettleton 1985).

A saturated fatty acid is one that is saturated with hydrogen atoms. This is depicted in Figure 2.

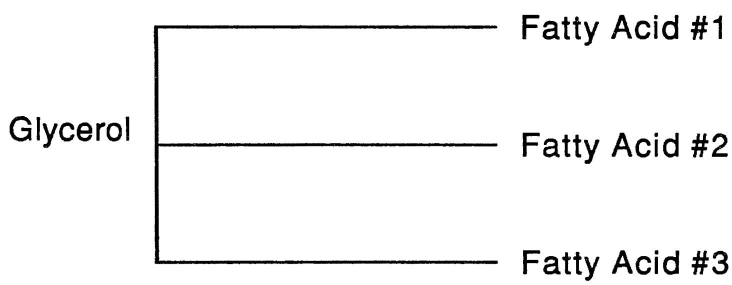


Figure 1. A Triglyceride

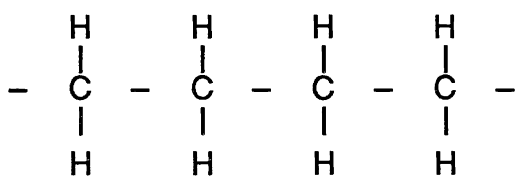


Figure 2. A Saturated Fatty Acid

An unsaturated fatty acid lacks a sufficient number of hydrogen atoms, so double bonds occur between the carbon atoms. Figure 3 illustrates this relationship.

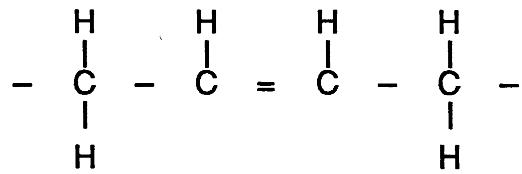


Figure 3. An Unsaturated Fatty Acid

Fatty acids with one double bond are called monounsaturated while those with two or more double bonds are called polyunsaturated. For instance, canola oil contains 6% saturated fatty acid, 32% polyunsaturated fatty acid, and 62% monounsaturated fatty acid (Stare 1986).

The degree of fat saturation in oils is important nutritionally. Of particular significance to researchers, retailers, and consumers is the amount of unsaturated fat in food products and its effect on serum cholesterol. Table 2 depicts a comparison of dietary fats from alternative oil and fat sources. Canola's 94% unsaturated fat level is the highest of all vegetable oils (Dziezak 1989, 68).

Health

Polyunsaturated fats are the source of essential fatty acids (EFA) such as linoleic and linolenic acid. Fats, especially vegetable oils, are good sources of

TABLE 2

COMPARISON OF DIETARY FATS

Oil Source	Saturated Fat	Monounsaturated Fat	Polyunsaturated Fat	Other Fats
	-------------------	percentage	-------------------	
Canola	6	62	31	1
Safflower	9	12	78	1
Sunflower	11	20	69	-
Corn	13	25	62	-
Peanut	13	49	33	5
Olive	14	77	9	-
Soybean	15	24	61	-
Cottonseed	27	19	54	-
Palm	51	39	10	-

Source: Procter & Gamble

such acids. These are fatty acids the body must have, but cannot make for itself. The amount of linoleic acid required is small and is easily obtained from the foods we commonly eat, especially vegetables and seafood. In addition, linolenic acid, an omega-3 fatty acid, appears to be essential in the human diet (Nettleton 1985, 28).

<u>Omega-3 Acids</u>

Omega-3 fatty acids are unique polyunsaturated fatty acids. The name reflects their chemical structure in which the first double bond is located three carbons from the terminal (omega) end of the molecule. In comparison, the omega-6 fatty acids have their first double bond on the sixth carbon from the omega end. The omega-6 fatty acids are the class of polyunsaturates, such as linoleic acid, which are found in most vegetable oils. The two most common omega-3 fatty acids are eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) which are found in fish oils. However, linolenic acid, found in leafy vegetables such as canola, is another member of the omega-3 family (Nettleton 1985, 29).

Linolenic acid can be converted into both EPA and DHA in the human body, but the conversion is quite slow. The presence of linoleic acid delays this conversion by competing for the same enzyme systems in the body. Omega-3 and omega-6 fatty acids are not interconvertible in the body's metabolic pathways. Thus, a supplementary diet source of each may be necessary (Harris 1985). Some nutrition authorities are beginning to recommend the inclusion of foods high in omega-3 fatty acids in the diet. These include most cold-water fish, canola, and soybean oils (USDA 1989).

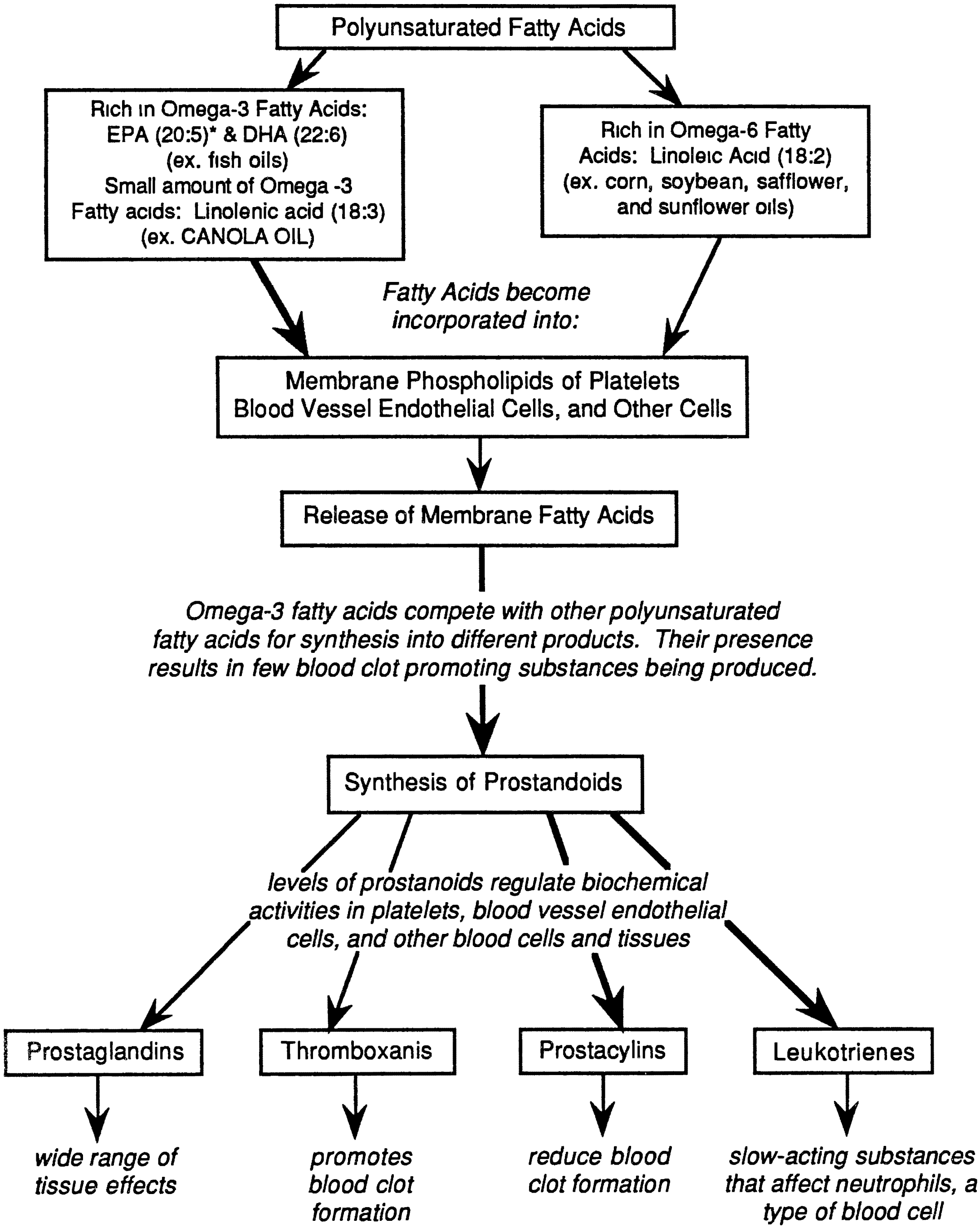
The extent to which dietary fat and cholesterol affect cardiovascular health is uncertain. Still, research is revealing the roles that monounsaturated and omega-3 fatty acids may play in reducing the risk of cardiovascular disease (Stare 1986). Much of this research resulted from a 1970's study by Bang et al. on Greenland Eskimos. These scientists were among the first to draw attention to the fact that Greenland Eskimos have a much lower incidence of heart disease and other medical condition than Americans. These findings were related to the Eskimos' diet which was rich in EPA and DHA, and that these omega-3 fatty acids came from eating marine animals and fish (Nettleton 1985, 34). EPA can also be synthesized from dietary alpha-linolenic acid found in vegetable oils such as canola (Stare 1986).

These omega-3 fatty acids affect platelet function in the blood stream. Platelets are the cells in blood responsible for blood clotting. Platelets not only clot blood, they interact with vessel walls where fatty plaques accumulate. In turn, they produce chemical products such as thromboxanes that affect blood clotting. One scheme to account for the ways in which omega-3 fatty acids might be exerting their effects through platelet and cell membrane metabolism is outlined in Figure 4. The diagram is greatly simplified, but serves to illustrate how dietary polyunsaturated fatty acids from fish and vegetable oils may be influencing both platelet and blood vessel wall function (Nettleton 1985, 39).

The diagram in Figure 4 is hypothetical but consistent with evidence accumulated to date. Generally, the omega-3 fatty acids follow the path depicted by the bolder arrows. That is, atherosclerosis may be retarded by the effects of these fatty acids on plasma lipid levels, platelet function, blood flow, and hypertension (Harris 1985). Atherosclerosis is the deposit or degenerative accumulation of pulpy, acellular, lipid containing materials in the arterial walls. Much more is known about the mechanisms of action of omega-3 fatty acids in atherosclerosis than has been demonstrated for the omega-6 polyunsaturated fatty acids (Simopoulos 1988, 16). Hence, the diagram depiction of omega-6 acid pattern allows for synthesis uncertainty of these fatty acids.

Whether it is of advantage to have the preformed EPA and DHA in our diet, or only their precursor, linolenic acid, has yet to be determined. Investigations with individual omega-3 fatty acids will define specifically the functions of linolenic acid, EPA, and DHA in health and disease. In the meantime, the increase of omega-3 fatty acids in our diet from fish and vegetable oils is recommended (Simopoulos 1988, 18).

In addition to nutritive applications of polyunsaturates, evidence is accumulating that diets high in monounsaturated fatty acids are effective in controlling blood lipid levels. Studies have shown monounsaturated fatty acids to be the equivalent of polyunsaturated fatty acids or low fat diets in lowering



* The number before the colon is the number of carbon atoms; the number after the colon is the number of double bonds.

Source: Nettleton

Figure 4. Influence of Fatty Acids on Blood Clotting

blood low-density-lipoprotein (LDL) cholesterol, but monounsaturates also maintain high-density-lipoprotein (HDL) cholesterol (Mattson 1989). Reduced LDL levels would be beneficial to most people, since a high LDL level is a risk factor for heart disease. Moreover, maintenance of HDL levels is desired because of its positive association with lower risk of heart disease (Nettleton 1985, 37).

Trends

Fat and oil consumption has increased significantly over the last twenty years. Specifically, there has been an increase of 18.5 pounds per person per year in total fat available for consumption between 1965 and 1985. During this period, the availability of fats from visible sources (i.e. vegetable oils) increased 16.7 pounds/person/year, whereas availability of fats from invisible sources (mainly meat, poultry, dairy, and fish) increased 1.8 pounds/person/year (ISEO 1988, 23).

Of particular significance is the trend toward the availability of products prepared from vegetable oils and away from those prepared from animal fats. In 1985, this trend continued, and vegetable oils now contribute about 90% of the visible fat available for consumption. Thus, over the past 45 years, animal fats have gone from a very predominant to a very subordinate position in the human diet while vegetable oils have become the dominant supplier of dietary fat.

This trend toward the more extensive use of edible vegetable oils has resulted in an increase in the ratio of polyunsaturated to saturated fatty acids (P/S) in the visible fat portion of the diet. From 1959 to 1972, it has been estimated that the P/S ratio in the visible fat portion of the U.S. diet increased from about 0.5 to 1.0. Since 1972, the availability of cooking and salad oils has continued to increase and the availability of butter and lard has continued to decrease.

It is likely that the P/S ratio of the visible fat in the average U.S. diet may now exceed 1.0. However, the total dietary P/S ratio of the American diet is currently around 0.4 to 0.5, largely due to the contribution of meat and dairy fats (ISEO 1988, 24). Controversy exists among the health advisory organizations about the appropriateness of such increases in the total dietary P/S ratio. Still, it is likely that the upward trend will continue while the overall health implications may allow for market opportunities.

Because of its nutritional profile and consumption trends, canola oil is becoming a very important vegetable oil in the American diet. Its composition is consistent with dietary recommendations based on the current understanding of the role of dietary fat in health and nutrition. Moreover, since canola is an all vegetable product, it contains no cholesterol. In addition, it contains a high monounsaturated fatty acid level which is associated with reduced mortality from coronary heart disease. Canola's polyunsaturated fat level contains a moderated amount of linoleic acid and a significant amount of alpha-linolenic acid, an omega-3 fatty acid (Stare 1986). This profile combined with the fact that canola oil is cholesterol free will ultimately determine additional import levels and policy-induced domestic production.

CHAPTER III

IMPORT AND DOMESTIC DEMAND FOR CANOLA OIL

Since 1985, canola oil imports have increased sharply. This is due, in a large part, to canola oil's superior nutritional characteristics along with changes in relative prices. Presently, soybean oil remains the dominant food oil in the U.S. market. Salad and cooking oils are by far the largest single volume usage of soybean oil. In contrast, canola oil is the newcomer to the U.S. market. Its unique fatty acid composition and 94% unsaturated fat level have peaked the interest of domestic refiners, food processors, and plant breeders.

In August, 1986, Procter & Gamble formally introduced canola oil to the U.S. consumer market as a reformulated Puritan brand oil (Dziezak 1989, 71). Today, Puritan is marketed as 100% canola oil. Additionally, canola oil is finding its way into salad dressings, margarines, and shortenings.

Canola Oil Market

Market Events

The growing demand for canola oil has been attributed to key events in the oilseed industry and retail market. In addition to its initial oil reformulation, Puritan cooking oil was recognized as the Food Product of the Year in 1987 by the American Health Foundation. This award was duplicated in 1989 by the American College of Nutrition (ACN). From the consumer perspective, the

Surgeon General's Report on the U.S. diet in 1988 recommended a reduction on the intake of dietary fat, particularly saturated fat (Agriculture (AG) Canada 1990, 18).

Labelling. Another major event in 1988 dealt with product labelling. During the fall, the FDA stopped requiring food companies to identify canola oil as "low erucic acid rapeseed oil" (LEAR) on food labels. According to Florence Kohn, this gave canola oil the first opportunity to compete on an equal footing with every other vegetable oil on the market. As a result, the American Soybean Association (ASA) hoped to bring U.S. canola growers under its umbrella. This came after unsuccessful ASA lobbying attempts to keep canola oil out of the country by restricting the FDA from granting canola oil its initial 1985 GRAS status.

Price Movements

Because of limited domestic production, the United States has been highly dependent upon canola oil imports to meet demand. Import levels are highly responsive to price differentials in the market. Specifically, the relative prices of canola oil and soybean oil often dictate the quantity of canola oil imports. As can be seen from Figures 5 and 6, when canola oil sells at a discount (premium) relative to soybean oil, imports increase (decrease).

Rising world vegetable oil production in 1985 set off a three year price decline. Canola oil became one of the cheapest traded oils during this period, while the competitive position of U.S. soybean oil deteriorated. Domestic canola oil consumption, although small, increased dramatically.

By mid 1985, only palm oil was cheaper than canola oil. In early 1987, canola oil became the cheapest of the major traded oils, a situation which

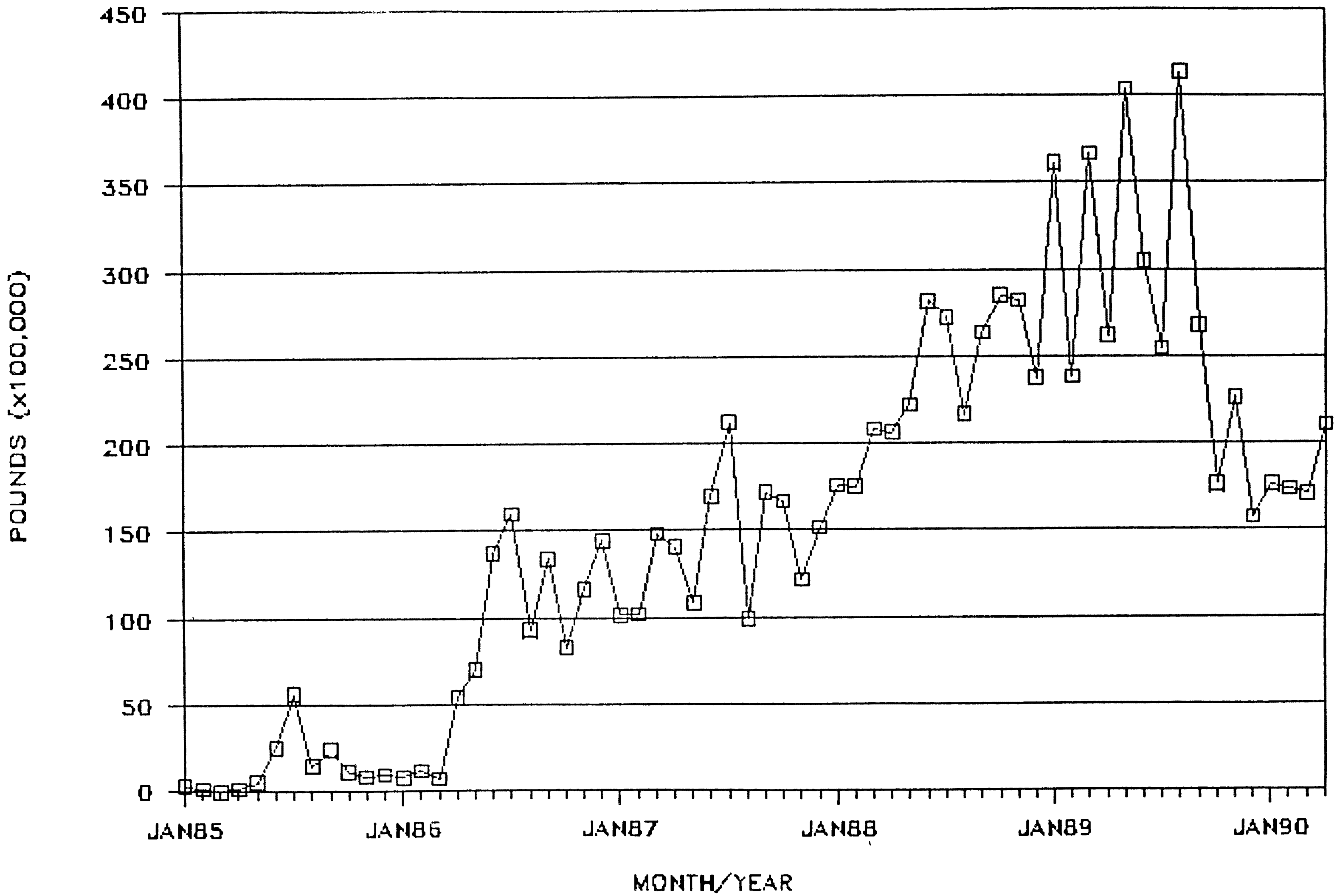


Figure 5. Canola Oil Import Quantity by Month

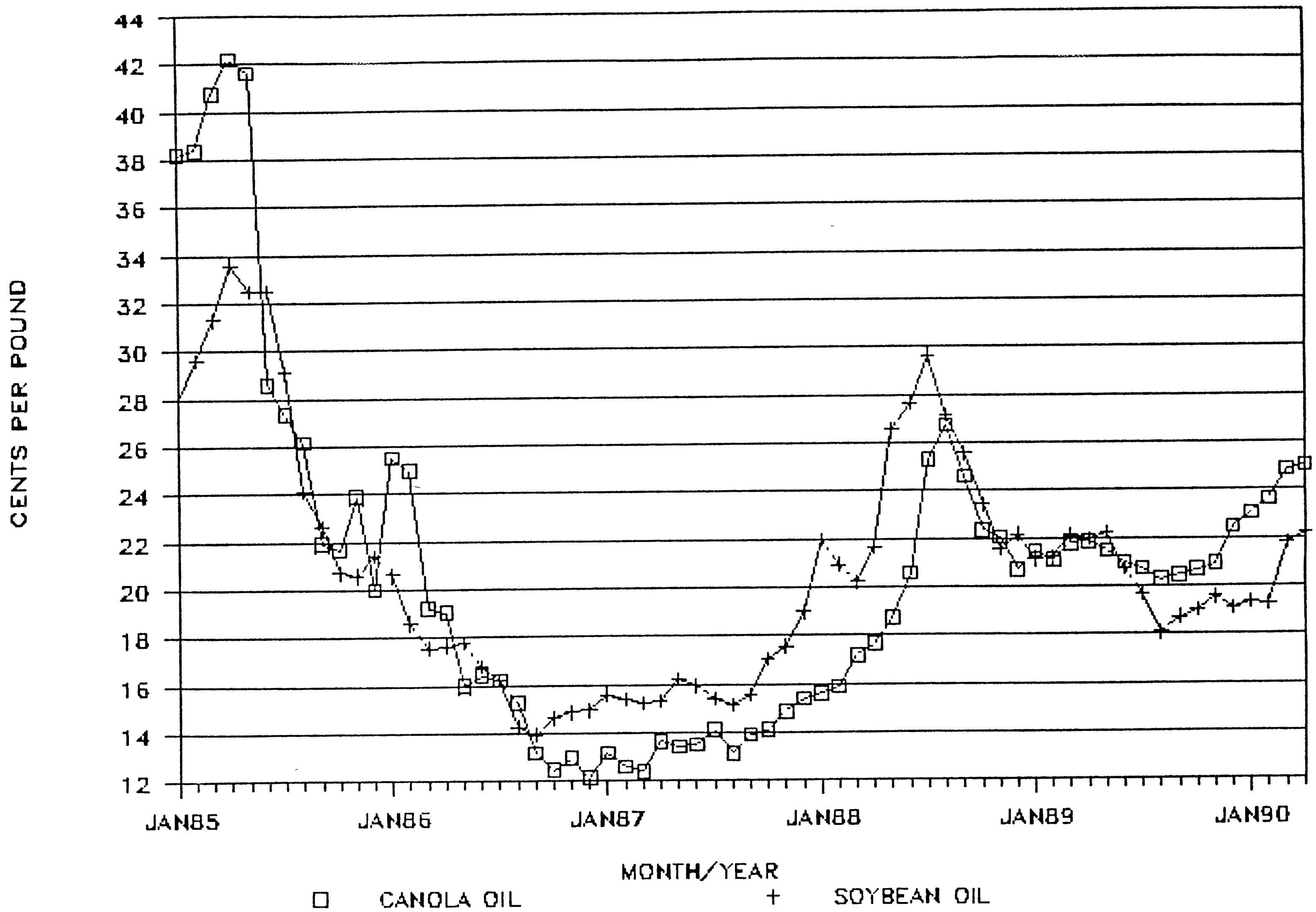


Figure 6. Canola Oil and Soybean Oil Monthly Price Differential

persisted for much of that year. By 1988, canola oil was trading at its largest discount to soybean oil. Since then, however, imported canola oil has traded equal to or at a premium to soybean oil. Declining soybean oil prices and projections for a short 1989 Canadian rapeseed crop were responsible (USDA 1989, 17). Still, recent canola oil imports have been significant.

Import Origins

U.S. canola oil imports have increased from 7,335 metric tons in 1985 to 180,357 metric tons in 1989. Of the total volume in 1988, 86% was imported from Canada (USDA 1985-1990). The remaining volume originated from the United Kingdom, Germany, France, Netherlands, Denmark, Italy, Sweden, and Belgium-Luxembourg. Comparison of the value of edible rapeseed oil (canola) imports with the Decatur soybean oil price shows growing competitiveness of the Canadian product (USDA 1989,17).

Import Demand Analysis

Given the favorable market events and growing demand for canola oil, imports will provide our domestic supply until canola moves beyond a specialty crop in the U.S. Therefore, the ability to estimate the demand for canola oil imports can become an important tool for market evaluation. It is hypothesized that canola oil imports are a function of relative prices and follows a partial adjustment process.

Conceptual Model

It is hypothesized that the quantity of domestic canola oil imported is a function of the price of canola oil, the price of the major oilseed competitor, soybean oil, and new product applications. Since canola oil imports from Canada make up such a large portion of total U.S. imports, the analysis focuses exclusively on imports with Canadian origin.

Canola oil price (COP) was expected to have a negative sign because the quantity of canola oil imports should decrease if its own price were to increase. Conversely, the cross price variable, soybean oil price (SOP), should have a positive value. This is because the quantity of canola oil imports should increase if the price of soybean oil increases. Initially, a trend (T) variable is included to measure adaptations in the market and increased health concerns. Its sign was expected to be positive indicating an increase in canola oil imports over time.

Equation 1 defines the equilibrium values of canola imports;

$$Q_t^* = b_0 + b_1T - b_2COP_t + b_3SOP_t \,. \qquad (1)$$

The star indicates the equilibrium or desired values of imports while the exogenous variables are represented on the right hand side of the equation. The current value of Q is hypothesized to partially adjust to its equilibrium value Q_t^* according to;

$$Q_t - Q_{t-1} = \phi(Q_t^* - Q_{t-1})\,,\ 0<\phi<1\,, \qquad (2)$$

where ϕ, called the adjustment coefficient, measures the proportion by which the difference between the equilibrium or desired value Q_t^* and the realized value Q_{t-1} is reduced during month t. The adjustment is partial because of friction in the market. Friction may be related to reluctance to change product formulations and time required to adjust to new economic conditions.

When ϕ=1, the current value of Q_t is equal to its equilibrium value ($Q_t = Q_t^*$). Then the adjustment is total and immediate, and we are back in the static case. The model implies that the value of ϕ lies between zero and one. Thus, the adjustment is smaller as ϕ approaches zero. Combining (1) and (2) through substitution we get;

$$Q_t - Q_{t-1} = \phi(b_0 + b_1T - b_2COP_t + b_3SOP_t - Q_{t-1}).$$

Solving for Q_t the estimated equation is:

$$Q_t = \phi b_0 + \phi b_1 T - \phi b_2 COP_t + \phi b_3 SOP_t + (1-\phi)Q_{t-1} + e_t. \quad (3)$$

A description of the variables in the above equation is in Table 3. Means and standard deviations for the respective variables are also given. The data used for estimation were obtained from the USDA Economic Research and Foreign Agricultural Services. The model incorporates a time series analysis on monthly quantity, own-price, and cross-price data from January 1985 to April 1990. Prices are cents per pound and quantity imported is given in terms of 100,000 pounds.

Estimation

Equation (3) was estimated for the variables as defined in Table 3. Because of the time series data, a potential serial correlation exists among the residuals. Therefore, it was assumed that e_t in equation (3) could follow a first order autoregressive process.

The equation was estimated using PROC NONLIN of SAS using the Gauss-Newton method. Starting values for the parameters were maximum likelihood estimates obtained from PROC AUTOREG in SAS. First degree

TABLE 3

DESCRIPTION OF VARIABLES, MEANS, AND VARIANCE

Variable	Description	Mean	Standard Deviation
Q_t	Quantity of canola oil imported from Canada in month t	154.2954[1]	108.2111
T	Trend variable to indicate increases in imports over time	32.5000	18.6190
COP_t	Price of imported canola oil from Canada including a 7.5% tariff in months	20.8820[2]	7.1978
SOP_t	Price of domestic soybean oil in month t	20.8156	5.0006
Q_{t-1}	Lagged dependent variable to account for adjustments in the market	153.4013	108.8418

[1] Quantities are in terms of 100,000 lbs.
[2] Prices are in cents per pound.

autocorrelation was tested using the asymptotic standard errors for the autoregressive coefficients from PROC NONLIN. The model coefficients are presented in Table 4. The R-squared value suggests that 82.41% of the total variation in canola oil imports is explained by the independent variables in the model.

TABLE 4

CANOLA OIL IMPORT DEMAND RELATIONSHIPS[1]

Variable	Coefficient	Std. Error
Intercept	-16.1452	20.6577
Trend	.9623	.5003
COP	-3.3688	1.3359
SOP	4.5026	1.8056
AR (first order)	-.5296	.1231
Q_{t-1}	.7634	.0898
R-squared	.8241	
Durbin-Watson	2.2633	
Durbin-h	1.5135	

1/ Coefficient values are in terms of 100,000.

When a lagged dependent variable is included in the model, a Durbin-h statistic must be used. This is because the Durbin-Watson depends on regressors being truly fixed. If a lagged value of the dependent variable is specified as a regressor, this assumption is tenable because the statistic is biased toward 2 (Mirer 1983, 274). The Durbin-h calculates a value which can be utilized in the standard *Z* distribution to determine a level of significance.

The Durbin-h can be calculated as;

$$h = (1 - d/2) * \sqrt{n/(1-nV)}, \qquad (4)$$

where d is the Durbin-Watson statistic, V is the variance of the lagged dependent variable coefficient, and n is the sample size. For our model, the Durbin-h equals 1.5135. This value indicates an insignificant level of autocorrelation in the model at an alpha level of .05.

Interpretation

Elasticities and Lagged Response

Own-price and cross-price coefficients are consistent with economic theory. Theoretically, if the own-price coefficient increases, import quantity should decrease. Alternatively, if the cross-price coefficient increases, import quantity should increase. For our analysis, the own-price slope coefficient is -3.3688, and the cross-price slope coefficient is 4.5026. Thus, empirically, we can formulate own-price and cross-price short and long run elasticities evaluated at the mean import price and quantity for the data period.

Recall that b_i represents the long-run equilibrium adjustment coefficient and ϕb_i measures the short-run effect. Thus, the elasticity equation for the short run is;

$$\text{Short Run Elasticity (SRE)} = ((\phi b_i)/\phi)*(P/Q) = b_i(P/Q). \qquad (5)$$

The elasticity equation for the long run is simply the short run elasticity divided by ϕ,

$$\text{Long Run Elasticity (LRE)} = \text{SRE}/\phi \,. \tag{6}$$

From Table 3, the mean own-price, cross-price, and quantity of canola imports for the 64 monthly observations are 20.8820 cents/lb., 20.8156 cents/lb., and 154.2954 (x100,000) lbs., respectively. The term ϕ is calculated from the Q_{t-1} coefficient, $(1-\phi)$. Given $(1-\phi)$ equals .7634, ϕ equals .2366. This datum is used in combination with the above equations, (5) and (6), to calculate the short run and long run price elasticities of demand.

Price elasticities express the percentage change in quantity associated with a given percentage change in price, other factors remaining constant. Here, own-price elasticity was calculated to be -.4559 in the short run and -1.9270 for the long run. Similarly, the cross-price elasticity was calculated to be .6074 for the short run and 2.5673 for the long run.

Therefore, a 1% increase from the mean import price of canola oil would result in a .4559% decrease from the mean quantity of canola oil imports in the short run. The import quantity decrease would reach 1.9270% in the long run. Additionally, a 1% increase from the mean price of domestic soybean oil would result in a .6074% increase in canola oil imports in the short run and a 2.5673% increase in the long run. These elasticities indicate that canola oil imports are much more responsive to soybean price changes over a longer period of time.

The length of short and long run concepts are related to the adjustment process. For instance, the adjustment period is the length of time it takes for 95 percent of the effect to occur. The long run coefficient is:

$$\lim_{J\to\infty} \sum_{j=0}^{J} (-\phi)^j \phi\beta = \beta \qquad (7)$$

Thus, the adjustment period is the minimum J* such that:

$$\sum_{j=0}^{J^*} (1-\phi)^j \Big/ \sum_{j=0}^{\infty} (1-\phi)^j \qquad (8)$$

is greater than .95 for habit dominance or less than 1.05 for inventory dominance effects (Tilley 1979, 44). The short run is the first period in the adjustment process and the long run refers to the entire adjustment period.

The lagged response coefficient indicates there is a tendency for canola oil import quantity to stay relatively stable. The adjustment coefficient, ϕ, was estimated to be .2366. This is the proportion by which the difference between the equilibrium value Q_t^* and the realized value Q_{t-1} is reduced during period *t*. The estimates of ϕ imply that it takes three periods, or months, for the basis to make 95 percent of the full adjustment. Thus, according to our estimate, this adjustment in the canola oil import market is significant, but not immediate, due to certain frictions in the market.

Implications

Due to the amount of substitutability inherent in the oilseed market, relative price changes of a particular commodity has had direct effects on the demand for competing oilseeds. Furthermore, with rapid growth in domestic canola oil consumption, interest has moved to domestic growing and processing. Research projects are underway in developing improved winter varieties for U.S. production. Future strains will result in higher levels of oil and protein.

Thus, canola is the oilseed with the largest projected growth, at least until the year 2000 (Daun 1984,296).

Fluctuations in canola oil import quantity have been highly responsive to canola oil price and the domestic price of the dominant competing food oil source, soybeans. The model reveals the importance of price and lagged effects on the quantity of imported canola oil.

CHAPTER IV

APPLICATION OF CANOLA MEAL IN FEED RATIONS

Canola Meal

In the U.S., markets for canola meal are beginning to develop. Canola meal has been used extensively in the Pacific Northwest and by feed mills in north and central California. Unlike industrial rapeseed meal, which has a high level of glucosinolates, canola meal can be fed to monogastric animals. For this reason, it has been used successfully for many years as a protein supplement in diets of growing and laying chickens and turkeys.

The canola seed typically yields 40 percent oil and 60 percent meal. In the meal market, soybean meal is the dominant protein supplement for both the poultry and livestock feed industry. So, all other meals, including canola, have to compete against it. Price and nutrient composition are the primary factors that will determine canola meal's ability to compete with soybean meal (AG Canada 1990, 15).

Feed Utilization

Canola meal can be used effectively to provide all the supplemental protein for finishing hogs without significantly reducing feed intake, growth rate, feed conversion efficiency, or carcass quality. In addition, canola meal is used extensively as a protein supplement in starter rations for calves, in the supplementation of growing and fattening rations for beef cattle, and most recently as a protein source in rations fed to lactating cows (Aherne et al. 1985, 402-3). With increasing feed applications for canola meal, imports will provide the supply needed until canola moves beyond a specialty-grown crop in the United States. Imports of cake and meal for both canola and industrial rapeseed more than doubled between 1984 and 1988 to about 228,000 metric tons (Dicks and Buckley 1989, 13).

The major area of concern in animal nutrition has been the level of glucosinolates in feedstuffs, which may interfere with thyroid function. Glucosinolates are the compounds that give mustard and radishes, which are of the same plant family as rapeseed, their distinctive taste and smell. A dramatic reduction of glucosinolates and erucic acid in rapeseed during the last 10-15 years led to a markedly superior product, canola. Canola meal is now used extensively in Canadian livestock feeds for pigs and poultry and is the main protein source of choice for dairy cattle diets in that market (McKinnon and Christensen 1989, 449).

Feed Rations

Nutritive Aspects

Depending on the type of feed ration, not all protein meals are perfect substitutes for one another. The degree to which the major meals can substitute for each other in a livestock/poultry ration depends upon their individual nutritional composition and relative prices. For example, canola meal is a high protein feed supplement containing a good balance of essential amino acids. The protein content of canola meal usually ranges from 36-38% on an as fed basis and purchased by feed manufacturers on a guaranteed protein content. A comparison of the nutrient composition of canola, soybean, and cottonseed meals is shown in Table 5. Soybean meal has a slightly higher level of lysine while canola meal has a higher percentage of methionine. As a result, when the supplements are used together in a diet, they tend to complement each other (Aherne et al.1985, 400).

TABLE 5

NUTRIENT COMPOSITION OF COMPETING HIGH PROTEIN MEALS[1]

	Canola Meal	Cottonseed Meal	Soybean Meal
Protein	37.15	41.00	44.60
Calcium	.61	.20	.30
Phosphorous	.95	1.09	.63
Potassium	1.24	1.26	1.97
Crude Fiber	12.00	11.90	6.20
Lysine	2.15	1.91	2.68
Tryptophan	.49	.66	.64
Threonine	1.70	1.57	1.66
Methionine	.77	.73	.52
Cystine	.90	.64	.75

1/ Values are percentages, as fed basis.
Source: National Research Council.

Level of Inclusion. The degree to which canola meal can be substituted or used with soybean meal depends on the particular ration. The levels at which canola meal can be used in alternative feed rations are derived mainly from Canadian experience and feeding trials. On the basis of research conducted, maximum levels of canola meal usage in diets for various classes of livestock and poultry are presented in Table 6. Application of canola meal at levels up to the maximums listed have been shown to give excellent results when replacing soybean meal in the diet.

TABLE 6

RECOMMENDED LEVELS OF CANOLA MEAL INCLUSION

Ration	% of Ration
Calves	20
Dairy Cattle	25
Beef Cattle	20
Starting Pigs	8
Growing Pigs	12
Finishing Pigs	(25-30%)[1]
Breeding Pigs	12
Starting Poultry	20
Laying & Breeding Chickens	10

1/ All Supplementary Protein.
Source: McKinnon and Christensen

There is some debate on what level of canola meal can be included in dairy rations without having a negative effect on productivity. There is concern among the industry that canola meal does not possess an adequate level of bypass protein (AG Canada 1990, 16). Still, canola meal can be used to provide the total supplemental protein requirements of the lactating dairy cow with no adverse effects on feed intake when compared to soybean meal. Experiments conducted with lactating cows at the University of Manitoba demonstrated that canola meal fed at 26% of the concentrate mixture resulted in the same level of performance as that of cows fed a concentrate mixture containing soybean meal (Aherne et al. 1985, 402).

Limited research has been conducted on fattening feedlot steers with canola meal versus soybean meal. However, it has been reported that no detectable levels of glucosinolates were found in the tissues of beef cattle fed canola meal. There is no nutritional reason to limit the amount of supplemental protein canola meal can provide in diets for various classes of cattle. Based on protein and energy requirements, canola meal is worth 80% as much as soybean meal on a unit weight basis (Aherne et al. 1985, 403). When the relative bulk delivery price reaches this level, it would be feasible to include it in feedlot and other rations.

For finishing pigs, there is a general consensus in the literature that canola meal can effectively provide all supplementary protein. Summaries of experiments with sows over several pregnancies have shown that canola meal can entirely replace soybean meal as a protein source in breeding pig and nursing sow diets. Recent field trial work in Alberta, Canada, by Alberta government staff has shown no meaningful differences in numbers of piglets born alive, birth weight, or weaning weight of piglets from sows of up to four pregnancies (McKinnon and Christensen 1989, 453).

In the poultry industry, animal nutritionists have determined that canola meal can be used safely up to 10% of the total ration for white-egg laying and breeding chickens. Usually, commercial use is closer to 7.5%. This is due to producer resistance resulting from the fear of liver hemorrhage brought on by higher glucosinolates in the meal prior to 1985. Memories of this problem continue to cause producer resistance to canola meal today. For starting and growing diets, results from research indicate that canola meal can make up to 20% of the diets. (AG Canada 1990, 16).

Ration Formulation

The studies previously mentioned evaluate the potential use of canola meal in livestock/ poultry feeds from a nutritional and dietary perspective. From an economic standpoint, canola meal must be priced competitively with other high protein feed meals. Given price competitiveness, according to the Agriculture Canada report, canola meal could potentially displace up to 50% of the protein supplements consumed in the feed industry with no adverse effects on livestock production.

To demonstrate the likelihood of using canola meal in rations, seven specific feed rations were specified. Through least-cost ration formulations, the incoming and outgoing (shadow) prices over a five year data period for canola and soybean meal in seven specific feed rations were evaluated. Specifically, using U.S. average prices for the last five years, the year(s) the price ranges for which canola meal would be included in a ration were determined.

The seven selected rations were chosen to represent a quasi-composite representation of the livestock/poultry industry. Following is a list of the rations used to evaluate the shadow prices of canola and soybean meal: feedlot finishing supplement; lactating dairy cattle concentrate; 32% protein cattle range cube; finishing swine ration; bred sow ration; 3 to 6 week broiler ration; and a white-egg laying hen ration.

Linear Programming Tableau. An example of the LP tableau used to develop a least cost feed ration is presented in Table 7. The objective of such a model is to determine the least cost combination of raw materials in a ration so as to attain required nutritional specifications. This portion of the program is a conventional linear programming model for ration formulation. Here, the matrix represents the data set used to formulate a finishing swine ration. Nutrients are listed in the first column of the table.

The next seven column headings in Table 7 are the possible ingredients in the ration. The numbers below the ingredients tell how much of each nutrient is contained in one unit of the ingredient. The far right column (right hand side) contains the specific nutrient requirement and imposes quantity limitations on some ingredients. For example, from the table, the specification of 18 in the crude protein row demands that a given combination of feed ingredients provide at least 18 pounds of protein in the 100 pound ration. Specifications for the other nutrients can be interpreted in a similar manner.

For some ingredients, quantity limitations are imposed to reflect maximum guidelines consistent with NRC recommendations. Because the met. energy row contains a specification of zero, it is termed an accounting row. Upon formulation, a reasonable amount of energy was accounted for. Otherwise, a non zero requirement would have been specified. In Table 7, rows with negative numbers and specifications are maximum restrictions. For instance, the salt max row means that the final ration will contain no more than .5 pounds of salt. Alternatively, rows with positive numbers are minimum restrictions.

TABLE 7

MATRIX MODEL FOR FINISHING SWINE RATION[1]

	Ingredients							
Nutrients	Corn(Q1)[2]	Canola Meal(Q2)	Soybean Meal(Q3)	Calcium Carb.(Q4)	Dicalcium Phos.(Q5)	Salt(Q6)	Vitamin TM-Mix(Q7)	Specs.
Protein	10.90	40.60	49.90	-	-	-	-	> 18.00
Potassium	.37	1.36	2.20	-	-	-	-	> 0.23
Calcium	.03	.67	.34	38.00	21.00	-	-	> 0.60
Phosph.	.29	1.04	.70	-	18.50	-	-	> 0.50
Met. Energy	1.69	1.33	1.43	-	-	-	-	> 0.00
Lysine	.28	2.33	2.99	-	-	-	-	> 0.75
Tryptophan	.09	.53	.71	-	-	-	-	> 0.12
Threonine	.40	1.85	1.85	-	-	-	-	> 0.48
Met. + Cyst.	.44	.84	1.41	-	-	-	-	> 0.41
Salt max	-	-	-	-	-	-100.00	-	> -0.50
Vitamin	-	-	-	-	-	-	100.00	> 0.50
Calcium max	-	-	-	-100.00	-	-	-	> -0.80
Corn min	100.00	-	-	-	-	-	-	> 70.00
Dical. min	-	-	-	-	100.00	-	-	> 1.25
Bulk max	1.00	1.00	1.00	1.00	1.00	1.00	1.00	> 1.00
Bulk Min	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	> -1.00
Price[3]	4.57	6.58	10.24	2.06	12.37	3.09	50.00	> 0.00

1 The data set is on a dry matter basis.
2 Items in parentheses represent equation variables.
3 Prices represent average monthly bulk wholesale prices/cwt. from Jan. 1985-Dec. 1989.

Mathematical Relationships. Data in the ingredient columns indicate the percentage composition of the ingredients. In other words, they denote the amount or percentage of each nutrient in one unit of the ingredient (Agrawal and Heady 1972, 52). To meet a required nutritional specification in a ration, the sum of each ingredient quantity multiplied by its corresponding nutrient composition must be greater than, less than, or equal to a predetermined requirement.

For example, let Q1-Q7 represent corresponding feed ingredients. Then, for the calcium row in Table 7, (Q1*.03) + (Q2*.67) + (Q3*.34) + (Q4*38) + (Q5*21) + (Q6*0) + (Q7*0) $\geq$ .60. This means that the sum of all the calcium provided by individual ingredients in the final 100 pound ration must be greater than or equal to .60 pounds. The other rows in the table can be interpreted in a comparable fashion.

The bulk max and bulk min rows force the ration to equal 100 pounds. Additionally, the price row gives the ingredient prices on a dry matter hundredweight basis. These two rows in Table 7 apply the restrictions in formulating the least-cost prices of a 100 pound finishing swine ration. Tableaus for the other six rations are similar in structure.

Nutritional Requirements

Initially, the nutrient requirements for the seven rations were obtained. These values are summarized in Table 8. In the least-cost formulation, these nutrient requirements are more commonly referred to as right-hand side (RHS) values. The nutrient specifications are consistent with National Research Council (NRC) requirements set forth for particular classes of cattle, swine, and poultry. Additional insight was provided by the following members of the OSU

Animal Science faculty: Donald R. Gill, Regents Professor; Charles A. Hibberd, Associate Professor; and Joe G. Berry, Professor.

TABLE 8

NUTRIENT SPECIFICATIONS FOR SELECTED RATIONS[1]

	Ration						
	Dairy	Feedlot	Range Cube	Swine	Sow	Broiler	Hen
NEg[2]	-	.63	-	-	-	-	-
NEl	.78	-	-	-	-	-	-
M.E.	-	-	-	1.50	1.60	1.43	1.42
Protein[3]	17.97	12.50	35.96	18.00	13.46	22.85	16.75
Fiber	3.00	3.00	14.00[4]	-	-	-	-
Calcium	.60	.50	.61	.60	.75	.80	3.40
Phosph.	.40	.34	.75	.50	.60	.40	.32
Potass.	.80	.60	-	.23	.20	.40	.15
Vitamins	.01	.01	.03	.50	.25	.60	.35
Lysine	-	-	-	.75	.43	.85	.64
Tryptophan	-	-	-	.12	.09	.17	.14
Threonine	-	-	-	.48	.30	.68	.45
Methionine + Cystine	-	-	-	.41	.23	.60	.55

1/ Data on a dry matter basis.
2/ Energy requirements are in mcal/lb.
3/ Other nutrient requirements are percentages.
4/ Denotes a maximum; all other values are minimum restrictions.

Requirements pertaining to palatability and feedstuff restrictions were omitted from Table 8 because they do not affect the solution value. Specific ration compositions are in the Appendix. Feedstuff prices in the appendix are monthly average prices from January 1985 to December 1989. To compete effectively in swine and poultry rations and command a larger share of the North American protein market, genetic improvements in canola will have to take place (Goodby 1989). The GRAS status for canola by the USDA reflected previous improvements such as lower erucic acid and glucosinolate content. Hence, the data period was begun in 1985.

Meal Prices

The prices used in the ration formulations were obtained primarily from the USDA Feed Situation & Outlook Report. Other prices were obtained from the Grain & Feed Market News published by the USDA Foreign Agricultural Service. The feedstuff prices are wholesale bulk prices and do not reflect commission and/or freight charges. These factors largely determine ration composition for a particular feed mill. However, the objective was to formulate rations based on composite feed prices for the United States and determine at what prices canola meal could possibly be included. Given this stipulation, these prices are sufficient for our purpose even though no individual feed mill faced this particular pricing scheme for the data period.

Vitamin and various mineral supplements, which do not affect the level of high-protein meal inclusion, are assumed to be constant throughout the data period. These bulk delivered prices were obtained from the Stillwater Feed Mill. Since domestic canola production is minute, import canola meal prices were used. Collective feed prices are presented in Table 9. The feed prices are in hundredweight (cwt) and on a dry matter basis.

As you can see from Table 9, canola meal has sold at a discount over the past five years relative to other high protein meals such as soybean and

TABLE 9

YEARLY FEEDSTUFF PRICES[1]

	1985	1986	1987	1988	1989	Avg.
Alfalfa Hay	4.05	3.55	3.62	4.53	5.31	4.21
Alfalfa Meal	5.07	5.02	5.22	6.49	7.30	5.82
Animal Fat	13.63	8.81	10.47	12.34	10.99	11.25
Beet Pulp	6.36	5.66	5.17	6.14	5.60	5.79
Cane Molasses	2.68	3.70	2.88	3.46	2.96	3.14
Corn #2	5.32	4.19	3.39	4.86	5.07	4.57
Wheat (Hard Red)	6.49	5.54	5.36	6.92	8.25	6.50
Wheat Midds	3.65	3.14	3.04	4.62	4.74	3.84
Milo	4.73	3.72	3.10	4.28	4.54	4.08
Urea	11.14	11.04	11.36	11.36	10.22	11.03
Meat Meal	7.89	9.24	11.08	14.12	12.97	11.06
Corn Gluten	11.14	11.89	13.55	17.01	15.53	13.91
Cottonseed Meal	5.64	7.72	8.54	10.24	9.93	8.41
Soybean Meal	7.11	8.84	9.88	13.16	12.19	10.24
Canola Meal	4.79	5.44	6.11	8.56	8.00	6.58
			Constant Prices			
Calcium Carbonate						2.06
Cottonseed Hulls						5.56
Corn Silage						2.68
Dicalcium Phosphate						12.37
Potassium Chloride						11.34
Rumensin 60						472.22
Tylan 40						593.33
Vitamin-TM Mix	80.00(Beef)		50.00(Swine)		46.00(Poultry)	
Vitamin A-30						88.89
Salt						3.09
Lime						5.00

1/ Prices are $/Cwt. and on a dry matter basis.

cottonseed meal. Figure 7 depicts these price relationships in the meal market. It shows how canola meal is highly correlated with the other two meals while selling at a discount. The discount is due to the lower protein content.

Certain events in the market led to the meal price variation shown in Figure 7. Sluggish domestic and world demand for high protein meal led to exceptionally low meal prices and abnormally large stocks in 1985. Lower beef and pork production offset an increase in poultry production which hindered meal demand during the year. In 1986, reductions in hog and fed cattle output were countered by increases in poultry production (USDA 1989). Higher prices for canola, cottonseed, and soybean meal reflected this increase in domestic use.

Soybean meal entered into a bull market during 1987 when prices increased and sustained levels above normal crush. This was caused by increases in pork production and increased Soviet imports of soybean meal. This, combined with a larger meal market, enabled canola meal to sell at a larger discount. Severe drought conditions in 1988 and growth in the livestock industry led to high soybean meal prices. As soybean and cottonseed meal prices rose, canola meal discounts reached their highest levels.

Because the mild winter minimized livestock stress, and thus, feeding rates, 1989 was characterized by weakness in the soybean meal market. The livestock industry experienced lower profits which forced producers to lighten rations allowing animals to remain in inventory. Lower canola and cottonseed meal prices also curbed soybean meal demand. The meal market has faced stronger demand in 1990 for soybean and canola meals because of lower prices. A 7 percent increase in poultry production and a rebuilding of hog herds could encourage additional feeding.

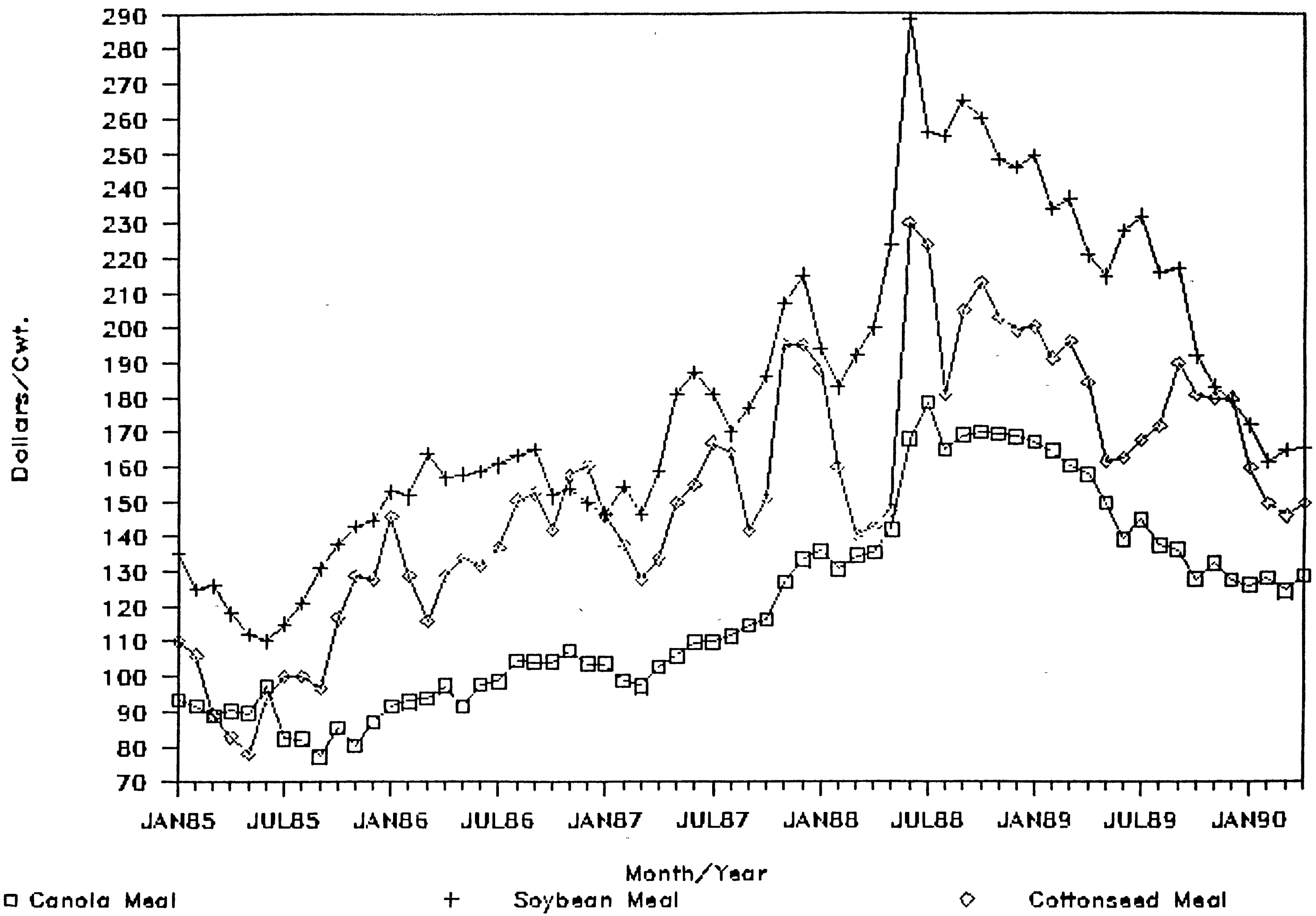


Figure 7. High Protein Meal Price Differential by Month

Shadow Prices

Using the Master Complete Ration Formulation Program maintained by the OSU Animal Science Department, least-cost rations for the seven livestock/ poultry feeds were calculated. From this analysis, canola and soybean meal price limits and levels of inclusion for the specified data period were concluded. Canola meal was restricted to its maximum recommended inclusion levels in all rations in accordance with Table 6. Additionally, the Appendix contains the actual ration compositions for the feed groups using 1985-1989 average prices.

Given the feedstuff prices in the previous section, price limits or shadow prices for high-protein feeds can be determined. After a particular ration is formulated, incoming and outgoing prices outline the shadow prices for individual ingredients. The incoming price gives the lower limit for the cost of each feed before reformulation will be required. The outgoing price is the highest price that the ingredient can reach and still have a valid solution without reformulation. These limits are important determinants when comparing the use of canola and soybean meal in specific rations. Tables 10 through 16 outline this shadow price information for the seven rations.

Tables 10, 11, and 12 present the limits and levels for the cattle feedlot, dairy, and range-cube rations, respectively. Because of its higher relative price throughout the data period, soybean meal was excluded from all cattle rations. Conversely, canola meal was included, to a certain extent, in each ration. Canola meal reached its maximum levels in the range-cube ration and was the major protein source of the dairy ration. For the feedlot, the lower canola meal inclusion was mainly due to low milo and wheat middling prices.

In the feedlot ration, a lower protein content is needed. Therefore, milo became a major portion of the supplement which left little room for canola meal.

For two of the years in which canola meal was excluded (1985 and 1988), its incoming price was just 24 cents/cwt below its actual price. Still, canola meal made up 5.86% of the ration using the average prices.

Canola meal was the major source of protein in the dairy cow concentrate. Because the final concentrate requires only 16 percent as fed protein, canola meal inclusion never reached its maximum after 1985. However, the higher protein range cube required a higher level of canola meal. Canola meal would have made up a higher percentage of the ration had it not been for the recommended restriction.

TABLE 10

CATTLE FEEDLOT FATTENING RATION USING CANOLA MEAL AND SOYBEAN MEAL[1]

	Year					
	1985	1986	1987	1988	1989	Avg.
CM Price	4.79	5.44	6.11	8.56	8.00	6.59
CM in Ration(%)	-	-	4.91	-	5.86	5.86
CM Incoming Price	4.55	4.58	5.59	8.32	7.95	6.39
CM Outgoing Price	-	-	6.49	-	8.27	6.88
SBM Price	7.11	8.84	9.88	13.16	12.19	10.24
SBM in Ration(%)	-	-	-	-	-	-
SBM Incoming Price	7.03	6.38	9.35	12.19	11.19	9.60
SBM Outgoing Price	-	-	-	-	-	-
Ration Price	5.21	4.26	3.96	5.14	5.23	4.79

1/ Prices are in $/Cwt., dry matter basis.

TABLE 11

LACTATING DAIRY COW CONCENTRATE USING CANOLA MEAL AND SOYBEAN MEAL[1]

	Year					
	1985	1986	1987	1988	1989	AVG.
CM Price	4.79	5.44	6.11	8.56	8.00	6.59
CM in Ration(%)	20.00	17.48	15.26	15.80	15.80	17.56
CM Incoming Price	-	5.29	5.92	5.09	5.29	4.81
CM Outgoing Price	5.32	7.00	7.51	8.71	8.14	6.65
SBM Price	7.11	8.84	9.88	13.16	12.19	10.24
SBM in Ration(%)	-	-	-	-	-	-
SBM Incoming Price	5.32	5.63	6.73	9.50	8.71	7.00
SBM Outgoing Price	-	-	-	-		-
Ration Price	4.51	4.02	3.64	5.25	5.27	4.59

1/ Prices are in $/Cwt., dry matter basis.

TABLE 12

32% PROTEIN RANGE CUBE FOR CATTLE USING CANOLA MEAL AND SOYBEAN MEAL[1]

	Year					
	1985	1986	1987	1988	1989	AVG.
CM Price	4.79	5.44	6.11	8.56	8.00	6.59
CM in Ration(%)	20.00	20.00	20.00	20.00	20.00	20.00
CM Incoming Price	-	-	-	-	-	-
CM Outgoing Price	5.31	6.72	7.32	8.86	8.77	7.22
SBM Price	7.11	8.84	9.88	13.16	12.19	10.24
SBM in Ration(%)	-	-	-	-	-	-
SBM Incoming Price	5.86	8.10	8.94	10.78	10.27	8.56
SBM Outgoing Price	-	-	-	-	-	-
Ration Price	4.85	5.75	6.25	7.87	7.78	6.47

1/ Prices are in Cwt., dry matter basis.

Similar information for the two swine rations is given in Tables 13 and 14. The higher relative price for soybean meal creates an opportunity for canola meal to provide supplementary protein for growing/finishing swine and bred sows. Recall from Table 6 that canola meal can provide all supplementary protein for finishing swine and a maximum of 12 percent for bred sows. The rations reflect these requirements, and demonstrate the effectiveness of canola meal in the swine and sow rations given its lower relative price.

TABLE 13

SWINE GROWING/FINISHING RATION USING CANOLA MEAL AND SOYBEAN MEAL[1]

	Year					
	1985	1986	1987	1988	1989	AVG.
CM Price	4.79	5.44	6.11	8.56	8.00	6.58
CM in Ration(%)	26.95	25.03	25.03	25.03	25.03	25.03
CM Incoming Price	3.09	4.19	4.20	4.86	5.07	4.57
CM Outgoing Price	5.32	7.18	7.01	9.68	10.46	8.60
SBM Price	7.11	8.84	9.88	13.16	12.19	10.24
SBM in Ration(%)	-	-	-	-	-	-
SBM Incoming Price	4.79	5.83	6.96	9.72	8.92	7.21
SBM Outgoing Price	-	-	-	-	-	-
Ration Price	5.45	4.81	4.40	6.07	6.09	5.37

1/ Prices are in $/Cwt., dry matter basis.

TABLE 14

BRED SOW RATION USING CANOLA MEAL AND SOYBEAN MEAL[1]

	Year					
	1985	1986	1987	1988	1989	AVG.
CM Price	4.79	5.44	6.11	8.56	8.00	6.58
CM in Ration(%)	10.79	9.81	9.81	9.81	9.81	9.81
CM Incoming Price	3.39	4.44	4.45	5.09	5.29	4.81
CM Outgoing Price	5.54	7.43	8.54	9.92	10.67	8.84
SBM Price	7.11	8.84	9.88	13.16	12.19	10.24
SBM in Ration	-	-	-	-	-	-
SBM Incoming Price	4.67	5.62	6.71	9.50	8.71	7.00
SBM Outgoing Price	-	-	-	-	-	-
Ration Price	5.45	4.54	3.91	5.43	5.56	4.98

1/ Prices are in $/Cwt., dry matter basis.

The lower relative price of canola meal enabled it to completely substitute for soybean meal in the swine and sow rations. The lower levels of canola meal in the sow ration are the result of a lower protein requirement. Furthermore, soybean meal faces approximately a $3/cwt. difference in its incoming and actual price. This differential provides canola meal with the opportunity needed to become a preferred protein supplement.

Tables 15 and 16 present the degree to which canola meal reaches and sustains its maximum recommended level of inclusion in the broiler and laying hen rations. A complementary relationship between canola and soybean meal develops to provide the necessary nutrient and protein levels for these poultry rations. The complementary relationship is made possible because of the recommended canola meal restriction. As a result, a certain level of soybean meal is needed to raise the protein content. Hence, the outgoing prices for soybean meal is especially high in the laying ration.

TABLE 15

BROILER RATION (3-6 WEEKS) USING CANOLA MEAL AND SOYBEAN MEAL[1]

	Year					
	1985	1986	1987	1988	1989	AVG.
CM Price	4.79	5.44	6.11	8.56	8.00	6.58
CM in Ration(%)	20.00	20.00	20.00	20.00	20.00	20.00
CM Incoming Price	-	-	-	-	-	-
CM Outgoing Price	6.49	7.68	8.47	10.92	10.21	7.68
SBM Price	7.11	8.84	9.89	13.16	12.19	10.24
SBM in Ration(%)	6.50	12.80	6.50	9.51	9.83	11.52
SBM Incoming Price	6.74	6.61	8.86	12.95	12.00	10.03
SBM Outgoing Price	8.84	9.29	10.41	13.21	12.26	10.66
Ration Price	5.88	5.47	5.33	7.15	7.04	6.13

1/ Prices are in $/Cwt., dry matter basis

The hen ration outgoing price for canola meal is lower than for the broiler ration outgoing price. This demonstrates a greater year to year likelihood for canola meal exclusion in the laying hen ration if canola meal prices were to increase relative to soybean meal. This is a result of lower recommended maximums for canola meal coupled with a greater dependence on soybean's protein content. Nevertheless, within the stated price limits, canola meal proves to be an important component in these two poultry rations.

TABLE 16

LAYING HEN RATION USING CANOLA MEAL AND SOYBEAN MEAL[1]

	Year					
	1985	1986	1987	1988	1989	AVG.
CM Price	4.79	5.44	6.11	8.56	8.00	6.58
CM in Ration	8.19	10.00	10.00	10.00	10.00	10.00
CM Incoming Price	4.30	-	-	-	-	-
CM Outgoing Price	5.51	6.18	6.32	8.79	8.43	7.00
SBM Price	7.11	8.84	9.89	13.16	12.19	10.24
SBM in Ration(%)	12.28	5.62	5.63	5.62	5.62	5.62
SBM Incoming Price	5.90	8.77	9.63	12.89	11.68	10.12
SBM Outgoing Price	7.70	29.04	36.12	44.07	38.83	34.72
Ration Price	5.70	5.16	4.78	6.37	6.36	5.69

1/ Prices are in $/Cwt., dry matter basis.

The use of canola meal in various feed rations is feasible given price competitiveness. Its nutrient and protein composition make it a viable supplementary feed ingredient. However, the price relationships explained earlier are crucial when formulating feed rations. While soybean meal and canola meal have similar characteristics, their individual prices and availability will be the key factors that ultimately determine their rate of inclusion in feed rations at specific mills.

Relative prices and discounts are indirectly reflected as price limits in the previous tables. Regardless of its lower protein content, canola meal displaced soybean meal to some extent in each ration and data period. The meal and other feedstuff prices used are not indicative of the price structure faced by individual feed mills and manufacturers. However, the prices do represent composite wholesale feed prices in the U.S. market. Therefore, they are realistic yearly approximations of feed prices excluding costs such as freight, commission, and storage.

The feed model presented gives a range of feedstuff prices and effectively demonstrates the use of canola meal in practical livestock/poultry rations. If canola is domestically produced in regions where soybeans are currently being produced, freight and commission charges are likely to be similar for the two crops. Storage costs may be slightly higher for canola depending on moisture content at harvest.

CHAPTER V

TRADE AND AGRICULTURAL POLICY ISSUES

Recent legislation on agriculture and trade policy could provide producers with necessary incentives to grow alternative crops such as canola. The future establishment and success of canola as a domestically grown crop can be influenced by agricultural policy and trade negotiations. Major applicable points of recent legislation are addressed including a brief overview of the new farm bill and changes in trade relationships.

Policy

The growing season for canola in the southern plains is similar to that of winter wheat. Hence, future canola plantings will likely come at the expense of wheat acreage. Therefore, policies affecting wheat acreage will have direct effects on base wheat acreage and could create opportunities for domestic production of canola.

1990 Farm Legislation

The 1990 legislation generally continues the market oriented approach to farm policy of the 1985 Food Security Act. A key provision affecting potential canola acreage deals with planting flexibility and payment acres. Producers have more planting flexibility under the 1990 legislation, but deficiency payments will be paid on fewer acres than in the past.

An illustration of the planting and payment options for the 1991 standard wheat program is given in Table 17. For 1991, the Acreage Reduction Program (ARP) for wheat cannot be less than 15 percent. For the 1992-1995 crop years, the range of ARP percentages will be determined by the ending stocks-to-use ratio for the previous year.

As shown in the table, up to 25 percent of a participating producer's crop base may be planted to other crops under the flexibility provisions. This planting diversion is divided among the following provisions, Normal Flexible Acres (NFA) and the Optional Flexible Acres (OFA) or flex acres. NFA removes 15 percent of total base acreage from eligibility for deficiency payments. These acres can be planted to any crop except fruits and vegetables (USDA 1990). Year-round haying and grazing is also permitted on the Normal Flexible Acres. NFA is referred to as semi-flexible because it is mandatory for the five year (1991-1995) farm bill. However, an exception is made for winter wheat in 1991. In this year, base acreage is protected and these acres are eligible for price support loans (Sanders 1990).

The best opportunity for producers willing to grow canola will likely come under the Optional Flexible Acres (OFA) provision. As the title suggests, OFA allows producers to remove an additional 10 percent of total base acreage from eligibility for deficiency payments. In return, the producer is given permission to plant anything. However, soybeans are excluded if the soybean average price is estimated to fall below 105 percent of the loan rate.

The producer's base acreage is protected, and these acres are eligible for price support loans for program crops (Sanders 1990, 2). However, planting

TABLE 17

OVERVIEW OF THE STANDARD
1991 WHEAT PROGRAM

No Deficiency Payments	ARP: 15 percent	Idle
	NFA: 15 percent	Flexibility Provisions: Plant to any crop except vegetables or fruit
Deficiency Payment Acreage If planted to wheat	OFA: 0-10 percent	
	Wheat for Pay 60-70 percent	Plant to Wheat

Source: USDA(ERS).

another crop on this 10 percent of crop base will result in the loss of wheat deficiency payments on these acres.

If a producer were to opt for the OFA provision in the standard wheat program scenario depicted in Table 17, he would then have four categories of acres. Included would be: 1) Acreage Reduction Program acres; 2) Normal Flexible Acres (NFA); 3) Optional Flexible Acres (OFA) and 4) deficiency payment acres. As support prices become excluded on a proportion of acres under the flexibility provision, more producers will turn to crops with higher net returns. This suggests that if canola competes with other alternative crops on a net return basis, it will displace wheat on the flexible permitted acreage (AG Canada 1990, 32).

Free Trade Agreement

The General Agreement on Tariffs and Trade (GATT) provides an international forum to promote reduced government interference in all international trade. Negotiations to eliminate, or significantly reduce trade distorting policies, world patterns of oilseed production and trade would likely change.

In the future, imports from Canada will face progressively lower U.S. import tariffs under the U.S. - Canada free trade agreement. Under this agreement, import duties for canola oil will be eliminated over a ten year period which began on January 1, 1989. The present tariff of 7.5 percent is scheduled to decrease 10 percent annually. Still, there is strong interest among some canola processors to accelerate the tariff reduction.

Since canola oil and meal are reflective of soybean oil and meal prices in the United States, there is no flexibility to adjust the final delivery price to reflect marketing costs including tariffs. Hence, U.S. tariffs result in lower returns to Canadian processors. Therefore, there is strong interest among some canola processors to expedite the tariff reduction process (AG Canada 1990, 51).

Duty Laws. In promoting the development of exports of canola and canola products to the U.S. market, Canada must keep in mind that the United States will retain its counter-vailing duty laws. Thus, Canadian agricultural policies, which are deemed to be subsidies by the U.S., will come under close scrutiny of the countervailing duty law of the U.S. That is, obvious subsidies used by Canada to promote the production and exportation of canola and canola products in the U.S. will most likely be subject to duty action. After the free trade agreement was signed, countervailing duty-type actions were implemented suggesting that the duty threat will not go away (Schmitz 1989).

The goal of liberalizing agricultural trade is difficult to achieve. The success depends, in part, on how well mechanisms can be worked out to ensure the welfare of producers and consumers upon the elimination of trade distorting policies. To reach this goal, the U.S. submitted the following comprehensive negotiating proposals in November 1990 during the current round of the GATT;

- reduce export subsidies by 90 percent,
- reduce unfair trade barriers by 75 percent,
- replace non-tariff barriers with a tariff rate quota system, to be phased down to zero or low levels over a ten year period (tariffication),
- set a final tariff rate maximum of 50 percent,
- reduce internal support by 75 percent if trade distorting,
- permit non-trade distorting support,
- permit an income safety net.

The extent to which each of these proposals will be accepted by other countries will be decided at a later time. Still, negotiations continue toward achieving freer trade for agricultural goods. By the end of the current GATT round, agreements could be reached that would alter global oilseed and oilseed product markets, just as past negotia- tions helped shape regional oilseed and oilseed product trade.

CHAPTER VI

CANOLA PROCESSING AND PRODUCTION COSTS

Given that agricultural policy provides necessary canola production support, the ability of processors to crush canola becomes the next step in providing a market for canola. Several U.S. processing plants currently can process canola. Subsequently, producers will require reasonable price estimates of the raw product on which to base budget projections. These factors are of importance if the United States is to lessen it dependence upon canola imports.

Projected processing costs are given in order to indicate canola crushing profitability and feasibility of conversion. Estimates of implied seed prices based on product value and transportation costs are presented. Cost and return projections for individual crushing facilities are then given.

Costs of Processing

As indicated in the Agriculture Canada report, the U.S. International Trade Commission, at the request of the U.S. Senate under section 332(5) of the tariff act, initiated an investigation entitled U.S. Global Competitiveness - Oilseed and Oilseed Products on December 1, 1986. The commission held public hearings and collected data and information from questionnaires sent to the nine largest soybean processors in the U.S. The respondents represented a total of 65 U.S. mills engaged in soybean processing.

An analysis of the cost of processing soybeans was performed by size of mills. Table 18 summarizes the data. The average total cost was $21.17 per ton of seed in 1986. This total cost represents the break-even point required to recover costs. In other words, it is the minimum crush margin which equals the joint weighted products revenue less the cost of seed.

Conversion Costs

Costs for processing canola and soybeans are not directly comparable because of differences in technology. Some cottonseed mills and all sunflower and peanut mills are equipped with an expeller, which physically extracts additional oil from the seed. Conversion to crush canola for these mills would not require significant investment. However, soybean mills and other cottonseed mills have no expellers. In this case, conversion would require a significant expenditure.

The supplementary prepress extracting phase is the foremost difference in the processing of canola versus soybeans (AG Canada 1990, 38). Prepress equipment adds substantially to the cost of canola processing. In addition to increased capital expenditures, operating cost will also increase. This cost typically represents between 30 and 40 percent of total processing cost. Much of this increase is due to maintenance and overhaul expenses.

A gross assessment of the incremental cost is presented in Table 19. A 937 ton per day plant is used as a model. This is the typical size of a western Canadian crusher and is assumed to be the size of an average U.S. soybean mill. The calculations are on the basis of 100 percent utilization of capacity.

TABLE 18

1987 PROCESSING COSTS FOR
U.S. SOYBEAN MILLS

	All	Daily Processing Capacities - Tons: Less Than 937	938-1312	1313-1781	1782-2249	2250-2718	2719-3186	Over 3186
Manufacturing Costs								
Labor	3.02[1]	5.04	3.37	3.37	2.69	2.69	3.37	2.69
Energy	5.72	6.39	6.05	4.71	4.71	6.39	5.72	6.05
Repairs	2.02	2.02	2.35	2.35	1.68	2.02	2.69	2.02
Solvent	0.34	0.67	0.67	0.34	0.34	0.67	0.34	0.34
Depreciation	3.02	2.69	3.37	3.70	2.35	3.02	3.37	3.37
Other	3.37	3.37	3.02	4.04	3.02	3.70	2.69	3.70
SUBTOTAL	17.48	20.17	18.83	18.50	14.78	18.49	18.16	18.16
General, Selling and Administrative Costs	2.02	1.68	2.35	1.68	2.02	2.35	0.67	1.01
Financial Expenses and Corporate Overhead	1.68	2.35	1.34	2.02	2.02	1.01	0.67	1.68
TOTAL COST PER TON OF SEED	21.17	24.20	22.52	22.19	18.81	21.84	19.50	20.84

[1] Values are in dollars per ton of seed.
Source: AG Canada.

TABLE 19

INCREMENTAL COST OF
CRUSHING CANOLA

	Expense	Cost	Cost/Ton
1)	Prepress Extractor		
	i) Capital & Interest		
	- Building	500,000	
	- Five Presses	1,250,000	
	- Equip. & Inst.	750,000	
	Payment Per Year	328,684	1.13
	ii) Labor	120,000	.42
	iii) Maintenance	150,000	.52
	iv) Energy		.90
2)	Hexane Loss		.23
3)	Super-degumming operation		2.04
4)	Total Incremental Expense		5.24

Source: AG Canada.

The five presses are assumed to cost $250,000 each and will require $30,000 of maintenance per press. The payment per year is the yearly liability for the capital assuming a fifteen year life with no salvage value at a 10 percent interest rate. The labor cost reflects a need for four shifts requiring 1 person year/shift at an expense of $120,000.

Because of the higher hull percentage in canola which binds the oil, the capacity of the hexane extractor has to be reduced by 5 to 10 percent. The loss of hexane solvent per ton of seed is about 50 percent higher for canola than for soybeans. Specifically, the loss is .54 gallons per ton loss in canola and .36 gallons per ton loss for soybeans. The hexane net loss of .18 gallons/ton multiplied by the price per gallon of hexane ($1.30) equals the .23 figure in the table.

Most canola oil output is super-degummed before refining, whereas soybean oil is not. Hence, this treatment results in more significant oil loss with canola oil. Typically this loss is 2 percent more on a crude oil basis. This translates into 17 more pounds of oil loss when crushing canola. This loss is partially offset by a greater meal yield (AG Canada 1990, 38). Specifically, if the oil loss is multiplied by the canola oil and meal price differential, the cost per ton of the product losses during the super-degumming operation can be determined. Doing so, assuming the oil and meal price is 20 and 8 cents per pound, respectively, the $2.04/ton is derived.

Given these specifications, the total incremental cost of crushing canola is estimated to be $5.24 per ton of seed. If this total is added to the U.S. soybean mill cost of processing depicted in Table 18, a general idea of the total cost of crushing one ton of canola is obtained. Thus, assuming the data are representative of typical market conditions, it would cost approximately $29.44 per ton to crush canola from a converted soybean mill with a 937/ton/day capacity. This figure is an important component of the equation for seed price determination.

Production

Seed Price Estimation

Prices for raw seeds are closely linked to the value of processed products less associated costs. Specifically, they are equal to the weighted average value of oil and meal less processing and transportation costs. Thus, the implied price of raw seeds follows the ensuing price relationship:

$$P_{SD} = [(1/A)*P_{ML}] + [(1/B)*P_{OIL}] - P_P - P_T \qquad (9)$$

where, P_{SD} = Price per ton of the oilseed.

A	=	Amount of seed necessary to produce one ton of meal.
P_{ML}	=	Price per ton of the meal.
B	=	Amount of seed necessary to produce one ton of oil.
P_{OIL}	=	Price per ton of the oil.
P_P	=	Cost of crushing one ton of the oilseed.
P_T	=	Cost of transporting one ton of the oilseed.

(Gardener 1988, 120).

To derive the implied price per ton of the oilseed, using the above equation, yearly averages for canola oil and meal prices from 1985 to 1990 were used. The seed prices are derived from oil and meal prices with Canadian origin. Only January through April prices were used in 1990. Additionally, a north-south freight rate of $19.05/ton and an east-west rate of $13.61/ton was used (Dickey). These are the current rates of transporting canola by rail. Also, the equation assumes that the canola seed is fully used and produces 40 percent oil and 60 percent meal.

The derived prices for canola seed are depicted in Table 20. The prices were lowest in 1986 and 1987 because of low oil and meal prices during these years. Recently, however, implied prices have climbed above the ten cent per pound level. This suggests that for 1988, 1989, and 1990 processors could have contracted with producers guaranteeing them a price close to 10 cents per pound and been profitable.

Of course, processors must realize that potential volatility exists. The value of the processed canola products are highly reflective of the value of soybean oil and meal. If stocks of soybeans become plentiful, the value of soybean oil and meal will likely decline, and thus, profitability of crushing canola will decrease.

TABLE 20

DERIVED PRICES OF CANOLA SEED[1]

Year	$/Ton	$/Lb.[2]	$/Ton	$/Lb.[3]
1985	251.00	.126	256.44	.128
1986	146.53	.073	151.97	.076
1987	127.69	.064	133.13	.067
1988	210.09	.105	215.53	.108
1989	208.46	.104	213.90	.107
1990	220.86	.110	226.30	.113
Average	190.76	.095	196.20	.098

1/ Assumptions include; fully utilized seed comprised of 40 percent oil & 60 percent meal, yearly oil & meal prices are reflective of market conditions, and transportation costs remain directionally constant.
2/ $19.05/ton freight.
3/ $13.61/ton freight.

Production Costs

Cost-return projections become important for producers deciding on whether or not to plant canola. If legislation allows flexible planting acreage and processing conversion lessens price risks, a farmer can focus on the prospective costs and returns associated with growing canola. Canola budgets are based on wheat expenses except where data are available. This is because only minor adjustments are needed to change equipment from wheat to canola. Similarities of cropping practices will allow for this type of analysis because of a lack of data from individual farm records (Brotemarkle 1989, 13).

Using a canola production budget from Kansas State University, costs of production of canola versus wheat are compared. The wheat budget was obtained from the USDA Economic Research Service publication of the 1988 Cost of Production for major field crops. A comparison of wheat and canola cost and return projections is shown in Table 21. The canola budget is representative of the canola production year in a canola-sorghum-fallow rotation in western Kansas. The wheat budget is for acreage in the southern plains.

Interest on variable costs were calculated for one half year at 12 percent interest. Similarly, interest on machinery was calculated at 12 percent interest for half the cost of machinery. All fixed costs were computed and then multiplied by a factor of 1.5 to account for fallow land (two crops every three years). Other factors used for the estimation are as follows: 75 pounds of fertilizer at 11 cents per pound; $325/acre on land; $82 for machinery investment which has a life of 7 years; machinery insurance rate of .25 percent; and 1.25 hours of labor for canola at a rate of $6 per hour.

The comparison demonstrates the competitiveness of canola given these cost and return projections. Though the cost section should remain fairly stable, profitability of canola can vary substantially depending on yields and prices of the raw seed. Therefore, breakeven prices and yield to cover those costs becomes an interesting aspect of the analysis.

TABLE 21

COST-RETURN PROJECTIONS FOR
CANOLA AND WHEAT

Costs and Returns Per Acre	Canola[1]	Wheat[2]
Variable Costs:		
Labor	$ 7.50	$ 2.61
Seed	7.00	4.94
Pesticides	8.80	5.48
Fertilizer	8.25	11.95
Fuel & Oil	9.00	11.36
Maintenance	9.00	6.28
Misc.	4.00	4.00
Interest on variable costs	3.21	2.80
Total Variable Costs	$ 56.76	$ 49.42
Fixed Costs:[3]		
Real Estate taxes	4.88	4.88
Interest on land	29.25	29.25
Depreciation	17.57	17.57
Interest on machinery	7.38	7.38
Insurance on machinery	.31	.31
Total Fixed Costs	$ 59.39	$ 59.39
Total Costs	$116.15	$108.81
Yield Per Acre[4]	1300.00(lbs)	35.00(bu.)
	26.00(bu.)	2100.00(lbs)
Price	.10(lb.)	3.00(bu.)
Returns Per Acre	$ 130.00	$ 108.50
Returns Above Variable Costs	$ 73.24	$ 59.08
Returns Above Total Costs	$ 13.85	$ (0.31)

1/ Source: Brotemarkle, Jack K.
2/ Source: USDA (ERS)
3/ Fixed costs are assumed to be the same for each crop.
4/ Canola was assumed to weigh 50 pounds per bushel and Wheat was assumed to weigh 60 pounds per bushel.

The breakeven prices and yields needed to cover the $116.15 total costs in the budget are shown in Table 22. As yield increases, lower prices are required to cover the total costs. The analysis provides producers with a range of possible conditions when the crop is harvested. These prices are well within the range of the implied prices derived from the value of processed products.

TABLE 22

BREAKEVEN CANOLA YIELDS AND PRICES

Yield: pounds/acre	Cents/pound[1]
800	14.5
900	12.9
1000	11.6
1100	10.6
1200	9.7
1300	8.9
1400	8.3
1500	7.7

Assumption: production costs are representative of a typical canola-sorghum-fallow rotation in western Kansas.
1/ Price required to cover the $116.15 total costs.

The ability of domestic producers to grow canola profitably on a large scale remains to be seen. Policy and price determinants will dictate the levels of production. From an agronomic standpoint, canola can be grown. However, infrastructure and marketing of the crop will determine its success as a domestic crop. Producers will want to study availability of market outlets and applicable government programs on which to base their planting decisions.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Due to the amount of substitutability inherent in the oilseed market, characteristics and price of canola will regulate its use. Factors such as crush margins, market acceptance, and legislation will determine whether canola will move beyond a specialty or contract crop in the United States (USDA 1989, 18).

Pricing and public perception are among the conditions which will dictate the success of canola in the U.S. Canola oil and meal must be priced competitively with other food oils that are derived from soybeans, cottonseeds, and palm kernels. This would allow canola to compete more efficiently in the domestic and world markets. If the public perceives canola oil as nutritionally superior to other oilseeds and is convinced of the health attributes of canola oil, then canola could command a price premium relative to other vegetable oils.

Meanwhile, as domestic consumption and demand for canola increases, interest has moved toward domestic growing and processing. The emergence of crushing/refining facilities will play a pivotal role in expansion of the canola market and grower acceptance. Until these facilities become fully developed, a key challenge for Canada in the coming years is to insure that production grows rapidly enough to enable them to be a consistent supplier of canola to the United States.

The primary purpose of this study is to identify and explain various factors dictating the demand and competitiveness of canola in the domestic oilseed market. The nutritional characteristics of canola and other oilseeds is examined which provides a basis for market and consumption growth.

In addition to following a partial adjustment process, an empirical model of canola oil imports is hypothesized to be highly dependent on the price of the principal competitor, soybean oil. The joint product nature of canola is examined to determine nutrient and price feasibility of canola meal inclusion in livestock feed rations. Other factors which will determine the success of canola as a U.S. crop include legislation, processing, and costs of production.

Conclusions and Implications

Objective One

Objective one is to present nutritional characteristics of canola that are likely to determine its acceptance in the U.S. market. Superior nutritional traits of canola have driven the increases in canola oil consumption over the last few years. The success of food processors in meeting and sustaining this demand will depend on their ability to differentiate the quality of canola oil versus other vegetable oils. This can be accomplished through advertising and other means of public perception which focus on the health and fat profile of canola oil. This profile, in part, determines the level of canola oil imports.

Objective Two

Objective two is to estimate the import demand for canola oil. The estimated import demand model suggests that the quantity of canola oil imported from Canada is highly dependent upon its own price as well as the price of soybean oil. Additional trend and partial adjustment variables indicate and increase in imports over time and a significant, but delayed, adjustment to new information in the market. The results show that a substantial amount of the variation in canola oil imports is explained by the model.

Objective Three

The third objective is to determine the degree to which canola meal could be included in certain feed rations. The analysis included a cattle feedlot fattening ration, lactating dairy cow concentrate, 32% protein range cube for cattle, swine growing/finishing ration, bred sow ration, broiler ration, and a laying hen ration. The results indicate that the level of inclusion of canola meal in feed rations depends on the particular livestock group and ingredient prices. The nutritional profile of canola meal competes effectively with other high protein feedstuffs in various cattle, swine, and poultry rations. Incoming and outgoing prices for canola and soybean meal are given for seven selected rations. At the given prices for 1985 to 1990, canola meal can be used as the primary source of protein for all of the indicated livestock rations excluding the feedlot ration.

Objective Four

The final objective is to outline policy, processing, and economic factors and their likely effect on U.S. production. Changes in farm policy will give producers the opportunity to grow canola on optional acreage under the 1990 farm bill. If so, the United States could lessen its dependence on imports. In addition to legislation, estimates from crushing facilities and budget projections could also provide producers with profitable prices. Producer response to such information remains to be seen. However, the results suggest that if production risk can be reduced, a growth in domestic production will occur over the next several years.

Suggestions For Further Research

The possibility of utilizing canola meal in high protein feed rations provides an opportunity for further analysis. A problem remains regarding feed ingredient costs in a least cost ration format. Transportation and costs of supply often necessitate the mix of ingredients in certain rations. Feed mills minimize their costs according to availability of inputs. Our analysis shows that canola meal can successfully be used in certain rations. However, further regional analysis of feed mill costs and feeding trials will determine if canola meal will be used.

Limited public information on crushing facilities exists within the oilseed market. The results of this analysis suggest that additional knowledge of conversion costs and effects on crushing margins are needed. Further research in this area could have ramifications for food retailers as well as individual producers.

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APPENDIX

RATION COMPOSITIONS USING 1985-89 AVERAGE PRICES

I. FEEDLOT FATTENING RATION W/ SUPPLEMENT

Supplement	
Canola Meal	5.86
Cane Molasses	6.00
Milo	72.24
Salt	.30
Urea	.40
Rumensin-60	.02
Tylan-40	.01
Vitamin A-30	.01
	84.84 lbs.
Ration	
Supplement	84.84
Alfalfa Hay	4.50
Calcium Carbonate	.59
Corn Silage	4.50
Animal Fat	5.07
Meat Meal	.50
Total	100.00 lbs.

II. LACTATING DAIRY COW CONCENTRATE

Ration	
Calcium Carbonate	1.00
Canola Meal	17.56
Cane Molasses	4.00
Corn #2	43.08
Dicalcium Phos.	.02
Salt	1.00
Vitamin A-30	.01
Wheat Midds	33.33
Total	100.00 lbs.

III. 32% PROTEIN RANGE CUBE

Ration	
Calcium Carbonate	.84
Cane Molasses	4.00
Canola Meal	20.00
Cottonseed Meal	46.30
Salt	1.00
Trace Mineral	.01
Wheat Midds	27.83
Vitamin A-30	.02
Total	100.00 lbs.

IV. SWINE GROWING/FINISHING RATION

Ration	
Corn #2	71.92
Canola Meal	25.03
Calcium Carbonate	.80
Dicalcium Phos.	1.25
Salt	.50
Vitamin-TM Mix	.50
Total	100.00 lbs.

V. BRED SOW RATION

Ration	
Corn #2	86.96
Canola Meal	9.81
Calcium Carbonate	.80
Dicalcium Phos.	1.69
Salt	.50
Vitamin-TM Mix	.25
Total	100.00 lbs.

VI. BROILER RATION (3-6 WEEKS)

Ration	
Corn #2	61.00
Soybean Meal	11.52
Canola Meal	20.00
Meat Meal	3.31
Alfalfa Meal	2.50
Corn Gluten Meal	.06
Dicalcium Phos.	.06
Salt	.30
Limestone	.65
Vitamin-TM Mix	.60
Total	100.00 lbs.

VII. LAYING HEN RATION

Ration	
Corn #2	71.33
Soybean Meal	5.62
Canola Meal	10.00
Corn Gluten Meal	3.51
Dicalcium Phos.	1.20
Limestone	7.99
Vitamin-TM Mix	.35
Total	100.00 lbs.

VITA

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