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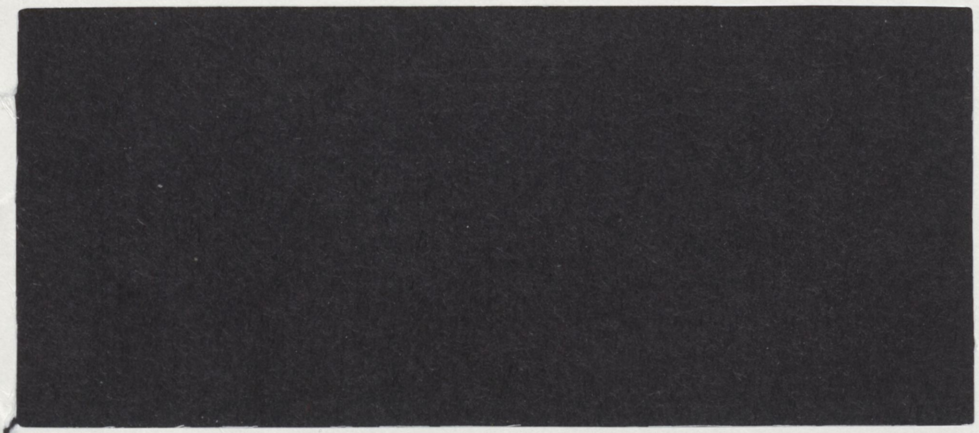

AN ECONOMETRIC MODEL OF THE CANADIAN OILSEED SECTOR

(Working Paper 2/93)

by

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1. INTRODUCTION

1.1 Problem Statement

One of the main goals of Canadian agricultural policy is to increase the value-added content of Canadian agricultural exports. This is part of an overall goal to make Canadian agriculture more market responsive. In order to reach these goals it will be necessary for the value-added sectors of Canadian industries to be competitive. It will also be necessary for international markets to be open and free of distortions. Trade must take place in an environment where comparative advantage and thus efficiency determines production and consumption and thus trade patterns. Success of the general Agreement on Tariffs and Trade (GATT) Round and the North American Free Trade Agreement (NAFTA) are important components of the future for Canadian agriculture.

Canadian agriculture is largely comprised of primary production. This is particularly true of Canadian exports. The oilseed sector is one in which exports have been mostly in the form of primary products. Between 1987 and 1991 Canada accounted for 42 percent of world canola seed exports. However, it accounted for only 20 percent of canola meal exports and 12 percent of canola oil trade. The situation for flaxseed is worse. Canada comprised over 80 percent of world trade in flaxseed but exports virtually no linoil and no linseed meal.

There are many factors that hinder the development of export markets for processed Canadian oilseed product and hence the growth of the processing industry. These can be summarized as follows:

1. Policies in competitor markets and importing countries inflate seed prices to producers and increase oilseed production. And at the same time many of these same countries have policies that protect domestic crushers and processors, such as the Japanese import tariff on vegetable oils, and offer crushing subsidies, (the European Community or EC*) and export subsidies (EC export restitution and US Export Enhancement Program or EEP).

2. Domestic policies target primary agriculture such as transportation subsidies in Canada granted under the Western Grain Transportation Act (WGTA) to grain and oilseed producers in Western Canada. The consensus is that the current method of paying the WGTA subsidy to the railways increases the cost of seed to processors and other users of primary grains and oilseeds. This raises the cost of seed to Western canola crushers and thus reduces their competitiveness. This has resulted in the need for the introduction of offsetting subsidies in the forms of Minimum Compensatory Freight Rates (MCRs) to the crushers on the transportation of processed oilseed products.

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* The European Community which comprises 12 countries is often called EC-12 or EC. EC will be used in this report.

3. Low utilization rates of existing capacity in the Canadian oilseed processing sector resulted in the closure of plants in Canada. By simultaneously raising the cost of seed and lowering the market price of vegetable oils, domestic and international policies are hindering the growth of the oilseed processing sector and causing low capacity utilization in Canada. This leads to inefficiency and reduces the industries competitiveness in export markets.

4. Canadian canola processors have not been successful in capturing a significant portion of the US vegetable oil market. Part of this is due to the lack of marketing that establishes a "brand name" recognized by consumers. Canadian processors need to find ways to better penetrate the US market.

1.2 Need for the Project

The Food and Agriculture Regional Model (FARM) as it now stands does not include the oilseed processing sector therefore it cannot forecast and analyse the impacts of the above issues affecting the oilseed processing sector. Medium-term forecasts also require the estimation of oilseed demands which are derived demands. The FARM model without an oilseed processing component fails to accurately project crucial variables, such as demand, farm marketing and ending stocks. Therefore, it is necessary that the analytical tool be developed which would link primary agriculture and the processing sector.

1.3 Objectives

The primary objective of the project is to develop an econometric model of the Canadian oilseed sector. A second objective is to forecast the effects of changes in national agricultural policies (both domestic and foreign) on Canada's oilseed sector.

1.4 Background

There are six major oilseeds produced in the world. In terms of world production, the most important is soybeans which averaged over 100 million tonnes produced over the past six years (see Table 1.1). This is followed, at a considerable distance, by cottonseed (32 million tonnes), canola/rapeseed (23 million tonnes), peanuts (22 million tonnes) and sunflowerseed (21 million tonnes). Further back is flaxseed (2 million tonnes).

The largest oilseed crop in Canada is canola, followed by soybeans and flaxseed (see Table 1.2). Canola and flaxseed are grown almost exclusively on the prairies, although there is some canola grown in British Columbia and (in recent years) in Ontario. Soybeans are grown almost exclusively in Ontario and Quebec.

The oilseeds are crushed for their products, oil and meal. Canola oil and soyoil are edible oils used in the production of cooking oil, salad dressing and margarine. The oil of flaxseed (called linseed oil or, in this report, linoil) is an inedible oil and is used primarily in the production of oil-based paints. The meal is used as livestock feed. Almost all of the products from the domestic crush are consumed within Canada. Canada is a major exporter of canola seed and flaxseed and a modest exporter of canola oil and meal. The capacity for crushing oilseeds and refining oils in Canada is outlined in Table 1.3. It shows that based on a 24-hour day, there are 6,545 tonnes of capacity to crush canola, 2,520 tonnes for soybeans and 2,525 tonnes for flaxseed. There is also some crush capacity for sunflowerseed (a minor oilseed in Canada) amounting to 1,440 tonnes. Total annual refining capacity is 977 thousand tonnes.

The dominance of the US soybean industry in the world oilseed market and in the soymeal/protein market means production in the US has a strong influence on US and world prices for all oilseeds. In the seed market, the dominant position of soybeans has eroded somewhat over the past two decades due to increase in production of other oilseeds. At the same time, the dominant position of the US in this market has also declined, predominantly due to the growth in soybean production and export from Brazil and Argentina. One of the important recent changes in the oilseed market, particularly canola, is the growth of the EC as a producer of oilseeds. During the 1980s, EC production of oilseeds has increased three-fold. Rapeseed and sunflowerseed are the major oilseeds but soybeans has also been increasing in output rapidly in the past few years. This was part of a deliberate policy by the EC to reduce its dependence on the rest of the world for oilseeds and in particular protein feeds. The oilseed industry in the EC has target prices which are often significantly above the prevailing rapeseed price in Rotterdam.

In the world edible oils market, production shares show a similar trend with the importance of soyoil being eroded by the growth in the output of other oils. The soybean oil trade has followed the growth of the soybean industry in Brazil and Argentina. For example, in 1989/90 the soyoil exports of Argentina and Brazil combined were about three times as large as US soyoil exports. The influence of palm oil is also significant in the world edible oils market because the production has been growing rapidly in the last few years. Additionally, the long-term nature of palm oil production suggests that an acreage response due to low or high prices is very slow.

The world soybean meal trade has become dominated by the exports of Brazil and Argentina. In 1989/90 Brazil and Argentina provided almost 57 percent of the world soybean meal trade with the US declining to a relatively minor 16 percent share. The annual trade in soymeal is over 25 million tonnes, or over one-third of output.

The remaining sections of this background report deal respectively with the canola market, the soybean market, and the flaxseed market. These sections are separated into sub-sections dealing with domestic production, domestic crushing, domestic demand for oil and meal, domestic stocks demand, the export market and price determination.

TABLE 1.1: WORLD PRODUCTION OF THE MAJOR OILSEEDS (1000 TONNES)

Year	Cottonseed	Flaxseed	Peanuts	Rapeseed	Soybeans	Sunseed
1986	27 739	2 658	20 383	19 550	98 104	19 252
1987	32 073	2 270	20 978	23 457	103 806	20 918
1988	33 180	1 674	23 281	22 728	95 635	20 363
1989	30 948	1 853	22 052	21 851	107 274	21 872
1990	33 550	2 295	22 883	25 371	103 025	22 289
1991	34 901	2 016	23 511	27 221	105 283	21 357
Average:	32 065	2 127	22 181	23 363	102 188	21 008

Source: United States Department of Agriculture, Foreign Agriculture Service, Production, Supply and Distribution Data Base.

TABLE 1.2: CANADA: OILSEED PRODUCTION (THOUSANDS OF METRIC TONNES)

Production	1987/88	1988/89	1989/90	1990/91
Canola	3 847	4 288	3 096	3 281
Soybeans	1 270	1 153	1 219	1 292
Flaxseed	729	372	497	935
Total	5 846	5 813	4 812	5 508

Source: Canada Grains Council, *Statistical Handbook* (various issues), Winnipeg, Manitoba.

TABLE 1.3: CRUSHING PLANTS AND CAPACITIES, 1992

	Canola	Soybean	Sunflower	Flaxseed
	tonnes/24 hour day			
ADM Agri-Industries Ltd. (owned by Archer Daniels Midland Co.				
- Windsor, Ontario	1200	1250	1200	1200
- United Oilseed Products Inc. at Lloydminster Alberta	720	-	-	-
Total	1920	1250	1200	1200
CanAmera Foods Ltd. (owned by Manitoba Pool Elevators, Sask. Wheat Pool & Central Soya of Canada Ltd.				
- Hamilton, Ontario	600	1270	-	-
- Altona, Manitoba	725	-	-	-
- Harrowby, Manitoba	600	0	240	725
- Nipawin, Sask.	600	-	-	600
- Fort Sask., Alberta	700	-	-	-
Total	3225	1270	240	1325
Canbra Foods Ltd. (owned by Pocklinton Financial Corp.)				
- Lethbridge, Alberta	700	-	-	-
Northern Lite Canola Inc. (owned by Alberta Development Corp.)				
- Sexsmith, Alberta	700	-	-	-
TOTAL	6545	2520	1440	2525

	Annual Capacity '000 tonnes
ADM Agri-Industries Ltd. - Windsor, Ontario	159
Canada Starch Company Inc. - Cardinal, Ont.	50
CanAmera Foods Ltd.	
- Montreal, Quebec	102
- Toronto, Ontario	147
- Dundas, Ontario	20
- Altona, Manitoba	103
- Nipawin, Saskatchewan	104
- Wainwright, Alberta	73
- Total	549
Canbra Foods Ltd. - Lethbridge, Alberta	68
Gainers Inc. - Edmonton, Alberta	9
Monarch Find Foods - Rexdale, Ontario	82
Proctor and Gamble Inc. - Hamilton, Ontario	50
J.M. Schneider Inc. - Kitchener, Ontario	5
Other Refineries	5
TOTAL	977

Source: Canola Crushers of Western Canada, correspondence with R. Broeska, 1992.

1.5 Scope and Methodology of the Project

The project consisted of the specification, estimation and simulation of an econometric model of the Canadian oilseed complex. The model essentially consisted of three separate sub-models for canola, flaxseed and soybeans with certain price linkages between them. The models comprised structural equations for the various categories of demand for the primary commodities and the joint products. Identities were established where appropriate to include price linkage equations, technical relationships between seed crushed and the joint oil and meal quantities and the market clearing equations.

One of the main difficulties in the project was to determine at the beginning the required complexity of the model to satisfy the forecast and policy expectations. Instructions were to keep the model as simple as possible without compromising the integrity of the model. The problem is that what may be sufficient for forecasting purposes may not be adequate for policy analysis. In order to adequately examine the implications for regional policies such as the WGTA in Canada, a Canadian regional model would have been required. To examine trade and commodity policies in the EC, the US and Japan, a regional model would have been preferred. This would have led to a very large model well beyond the established framework of the project.

The empirical model included data for the period 1970/71 to 1990/91. The model was specified on an annual crop year basis.

1.6 Outline of the Report

The report is organized around each of the three oilseed sectors, canola, flaxseed and soybeans, in that order. In each section there is a description of the domestic Canadian industry including production, domestic crush, domestic demand for the oil and meal and international trade of the products. For each oilseed there is section on price determination and a description of the conceptual model. For each oilseed this is followed by a description of the estimated model complete with the relevant statistical parameters. The model simulation results are contained at the end of each section.

The impact multipliers are contained in section 5. The list of data sources, statistical procedures of the study and data are contained in Appendix A. Appendix B contains additional institutional information on canola.

2. CANOLA

2.1 Canola Market

2.1.1 Domestic Production

Canola has become an increasingly important crop in Canada during the past three decades. The quality of both the oil and the meal have been improved through the efforts of plant breeders. Canola is the second most important component of farm cash receipts from crop on the prairies.

Ontario has recently begun producing canola and in 1989 and 1990 accounted for almost 1 percent of the total canola seeded acreage in Canada. The annual seeded acreage of canola for Ontario and the four western provinces is indicated in Table 2.1 for the period 1985 to 1992. Canola yields for each province are shown in bushels per acre for the period 1985-1992 in Table 2.2. This Table indicates that there has been a substantial increase in yield over the period and that Ontario currently has the highest annual average canola yield in Canada.

TABLE 2.1: ANNUAL CANOLA SEEDED AREA FOR SELECTED PROVINCES (000 HECTARES)

Crop Year	Ont.	Man.	Sask.	Alberta	B.C.	Canada
1985/86	22.3	405.0	1174.0	1133.0	49.0	3071.3
1986/87	37.6	396.6	1019.8	1133.1	42.5	2629.6
1987/88	16.2	392.5	1396.2	1173.6	40.5	3019.0
1988/89	22.3	647.5	1558.0	1456.9	30.4	3715.1
1989/90	16.2	445.2	1335.5	1092.7	28.3	2917.9
1990/91	20.2	352.1	1133.1	991.5	32.4	2529.3
1991/92^{P}	26.0	507.8	1359.4	1206.8	40.5	3140.5

P = preliminary.
Source: Field Crop Reporting Series, Catalogue 22-002, Statistics Canada, various issues.

TABLE 2.2: CANOLA YIELDS FOR SELECTED PROVINCES (BUSHELS/ACRE)

Crop Year	Ont.	Man.	Sask.	Alberta	B. C.	Canada
1985/86	2010	1570	1310	1100	590	1260
1986/87	1950	1430	1410	1400	1070	1410
1987/88	1820	1440	1010	1420	1230	1230
1988/89	1220	980	990	1350	1340	1140
1989/90	1540	870	1020	1290	1120	1100
1990/91	2130	1310	1280	1290	910	1290
1991/92^{P}	1740	1570	1270	1340	920	1350

P = preliminary
Source: Field Crop Reporting Series, Catalogue 22-002, Statistics Canada, various issues.

2.1.2 Domestic Crush

The demand for canola is derived from the demand for the products of canola crushing: oil and meal. Canola is most valued for its oil because oil is higher valued per pound than meal. Crushing canola results in about 40 percent oil and 58 percent meal by weight.

The location of the canola crushing plants and refineries and their respective capacities as well as their ability to crush multiple oilseeds is indicated in Table 1.3. This indicates that canola crushing capacity exists both in the prairie region and Central Canada. However, some canola crushing plants operating on the prairies during the 1980s have ceased to operate because of unfavorable crushing margins. Some plants also received partial funding or assistance from governments during this period. Additional concessions were made to the canola crushing industry in the form of favourable rail freight rates for moving canola products under Minimum Compensatory Rates (MCRs). (For details, see 2.1.3.)

The annual domestic canola crush plus seed, feed, waste and dockage, will use approximately one half of the seed utilized annually during the past decade. Canola exports account for the other half of the seed utilization. Supply and disposition for Canadian canola seed since 1970 is indicated in Table 2.3. Exports have averaged slightly higher than domestic consumption over the period. The level of domestic crush in Canada each year is determined by the crushing margin. The crushing margin for canola is determined by the value of the products less the cost of the seed. Canola produces (almost) fixed proportions of products and these fixed proportions provide the relative weightings for canola oil and meal prices in calculating a crushing margin. The prices for canola oil, meal and seed are therefore the key variables in determining the crushing margin. The price in Canada for canola seed is strongly influenced by the demand for seed in Japan and from Canadian crushing plants. Japan purchases seed from behind a protective tariff wall which penalizes the entry of canola oil but allows seed to enter free. Canola seed exports to Japan are relatively stable as they have a preference for canola oil relative to other oils.

The lack of an ability to hedge canola oil and meal in Canada make it impossible for crushing firms to buy canola seed futures and sell canola oil and meal futures to lock in a favourable crushing margin. The result has been a canola crushing industry in Canada that has a history of volatile margins and periods when a number of the firms are shut down for a period. A look at the annual reports of some of the companies such as CSP Foods indicates the volatility of the industry. (See Appendix B, Table B.1.)

TABLE 2.3: SUPPLY-DISPOSITION OF CANOLA SEED, CANADA (1000 TONNES)

Year	Area	Yield	Prodn.	Im-ports	Ex-ports	Ending Consn.	Feed Stock	Use	Crush
1970	1639	1	1638	0	1062	410	250	216	194
1971	2147	1	2155	0	966	461	978	188	273
1972	1343	0.98	1318	0	1226	601	469	248	353
1973	1297	0.94	1224	0	889	512	292	178	334
1974	1279	0.91	1164	0	593	463	400	187	276
1975	1829	1.01	1839	0	683	508	1048	161	347
1976	720	1.16	837	0	1019	667	199	117	550
1977	1453	1.36	1973	0	1014	833	325	203	630
1978	2825	1.24	3497	0	1721	1033	1068	308	725
1979	3406	1	3411	0	1743	1259	1477	362	897
1980	2080	1.19	2484	0	1372	1261	1328	258	1003
1981	1402	1.32	1849	0	1359	1126	692	181	945
1982	1777	1.25	2225	0	1271	1160	486	256	904
1983	2334	1.12	2609	6	1498	1483	120	324	1159
1984	3071	1.11	3412	6	1456	1612	470	322	1290
1985	2783	1.26	3498	11	1456	1573	950	362	1211
1986	2641	1.43	3787	11	2126	2003	619	461	1542
1987	2671	1.14	3847	10	1750	2075	651	473	1602
1988	3672	1.17	4311	12	1949	1876	1149	514	1362
1989	2904	1.07	3096	7	1971	1512	769	282	1230
1990	2582	1.27	3281	7	1881	1756	420	416	1340
1991	3270	1.28	4200	75	2000	1953	742	393	1560

Source: United States Department of Agriculture, Foreign Agriculture Service, Production, Supply and Distribution Data Base.

Canadian canola crush should increase as the crushing margin increases, but it cannot exceed the annual crushing capacity of the crushing plants in the industry (an upper bound as a constraint). Crushing becomes more profitable as the price of canola seed on the prairies declines relative to product prices or relative to the price of canola in Vancouver. Implicitly, this provides a larger crush margin than usually calculated if canola seed can be purchased more cheaply on the prairies (where much of the crushing capacity exists). The prairie canola industry appears to be a residual crusher where if the volume of seed is large and crushing margins profitable the industry will operate at a profit, but when seed supplies are tight, the margins in Canada decline, these firms are the first to shut down. (For more details, see 2.16 and 2.17.)

2.1.3 Domestic Demand for Canola Oil and Meal

The domestic canola crush produces oil and meal and the disposition of these products is indicated in Tables 2.4 and 2.5 respectively. About 60 percent of Canadian canola oil has been used domestically with the remainder exported over the past decade. Approximately half of the canola meal has been used domestically and about half has been exported over the past decade.

Canola oil is used as cooking oil, as salad dressing and for margarine as well as some industrial uses. Canola oil has recently earned the reputation as a health-food oil and it won the health-food-of-the-year award in the US. Canola oil will trade at a premium to soybean oil at times and at a discount at other times.

Canola oil is the major vegetable oil utilized in Canada. The recent concerns over health and cholesterol have made canola oil a premium product for some health-conscious consumers. Some of the major fast-food chains are considering using canola as their only form of cooking oil to benefit from the health-food status canola oil has achieved (Leibfried, 1990). The technological trend to produce a higher quality canola oil in Canada contributed to an increased level of Canadian consumption.

The domestic demand for canola oil is expected to increase as population increases and to be influenced by the level of Canadian disposable income. The price of soybean oil and palm oil relative to canola oil are also expected to influence canola oil consumption.

Canola meal is used as a protein feed in livestock production. The protein content of canola meal is below soybean meal and canola meal has a higher fiber content. Canola meal is used mainly in the rations of hogs but some is also used for dairy cattle and poultry.

TABLE 2.4: DISPOSITION OF CANOLA OIL, CANADA, 1970-1991 (1000 TONNES)

Year	Crush	Extract Rate	Prodn.	Im-ports	Ex-ports	Consn.	Ending Stock	Food Use
1970	194	0.4	77	0	0	76	2	76
1971	273	0.39	106	0	0	103	5	103
1972	353	0.38	134	0	25	109	5	109
1973	334	0.38	126	0	33	91	7	91
1974	276	0.39	108	0	20	91	4	91
1975	347	0.41	141	0	33	106	6	106
1976	550	0.41	226	0	92	131	9	131
1977	630	0.41	259	0	74	184	10	184
1978	725	0.41	296	0	111	177	18	177
1979	897	0.41	365	0	152	199	32	199
1980	1003	0.42	418	0	198	233	19	233
1981	945	0.4	382	0	163	225	13	225
1982	904	0.4	366	0	111	247	21	247
1983	1159	0.39	456	0	177	289	11	289
1984	1290	0.4	514	0	237	270	18	270
1985	1211	0.41	498	0	165	309	42	309
1986	1542	0.41	627	0	306	313	50	313
1987	1602	0.41	652	0	336	334	32	334
1988	1362	0.4	543	0	208	338	29	338
1989	1230	0.39	483	0	150	330	32	330
1990	1340	0.39	523	0	160	365	30	365
1991	1560	0.39	610	0	220	380	40	380

Source: United States Department of Agriculture, Foreign Agriculture Service, Production, Supply and Distribution Data Base.

TABLE 2.5: DISPOSITION OF CANOLA MEAL, CANADA, 1970-1991 (1000 TONNES)

Year	Crush	Extract Rate	Prodn.	Im-ports	Ex-ports	Consn.	Ending Stock	Feed Use
1970	194	0.58	113	0	0	111	5	111
1971	273	0.6	163	0	0	165	3	165
1972	353	0.58	204	0	19	183	5	183
1973	334	0.58	194	0	47	149	3	149
1974	276	0.57	158	0	11	150	0	150
1975	347	0.57	197	0	28	162	7	162
1976	550	0.57	315	0	107	204	11	204
1977	630	0.57	357	0	156	202	10	202
1978	725	0.58	417	0	170	239	18	239
1979	897	0.58	521	0	176	353	10	353
1980	1003	0.57	574	0	204	359	21	359
1981	945	0.58	551	0	162	398	12	398
1982	904	0.58	522	0	120	388	26	388
1983	1159	0.59	688	0	304	403	7	403
1984	1290	0.6	768	0	319	436	20	436
1985	1211	0.57	691	0	291	393	27	393
1986	1542	0.57	879	0	444	442	20	442
1987	1602	0.57	917	0	510	382	45	382
1988	1362	0.57	777	0	495	287	40	287
1989	1230	0.57	702	0	355	354	33	354
1990	1340	0.57	764	0	390	367	40	367
1991	1560	0.57	890	0	400	490	40	490

Source: United States Department of Agriculture, Foreign Agriculture Service, Production, Supply and Distribution Data Base.

The quality of the meal has improved over the past decades as the levels of glucosinolates in the meal have been reduced through the plant breeding program. Canola meal continues to trade at a discount to soybean meal due to lower energy and protein levels. The domestic demand for canola meal is dependent upon the numbers of livestock in Canada. The demand for canola meal is expected to increase as the output of livestock increases. The relative price of soymeal to canola meal is also important as these products are substitutes. Several decades ago, there was a stigma attached to feeding rapeseed meal to livestock but this has largely been overcome through the breeding program for canola and through the education of livestock producers and feed manufacturers.

The production region for canola meal is predominantly the prairie region but the major livestock populations of dairy, poultry and hogs are in Ontario and Quebec. This has created a considerable movement of both canola and canola products across Canada. This movement has sometimes been influenced by policies such as the former Crow Rate on canola seed. Prior to 1976, canola seed moved at the statutory freight rate and the products moved at full commercial rates. Beginning in 1976, MCRs were applied to canola oil and meal. The MCRs are regulated rail rates which cover the direct costs of moving the products but are below the full commercial rates. In 1983, the Western Grain Transportation Act (WGTA) was introduced. Since then, the WGTA (federal payment is made based on distance and actual shipments) rates have applied to both canola and its products moving to Thunder Bay and to export shipments through Vancouver.

2.1.4 Domestic Stocks Demand

The domestic demand for stocks consists of demands for the canola seed stocks and for the canola product stocks. The demand for seed stocks arise at both the farm level and the commercial level (exporter, handler and crusher level). Farmers' demand for canola consists of a small amount for seed purposes which is almost negligible since canola seeding rates are between 3 and 10 pounds per acre. The major demand by farmers is holding stocks in expectation of higher prices which may occur due to a short-term squeeze on the availability of supplies. There is a cost to storing canola in terms of foregone revenue and in terms of risk of loss during storage. Canola is more difficult to store than wheat as it is more likely to heat during warm temperatures and it also will flow out of the bin easily if there are any holes or if the bin is infested with rodents. Farmers hope to achieve a premium price by holding physical commodities. Farm stocks may also be held in response to the lack of a Canadian Wheat Board (CWB) delivery quota. This can occur when there is limited capacity in the grain handling and transportation system to physically move the product and each of the grains must bear some share of the capacity constraint.

There is also a commercial demand for canola stocks. Crushing plants and exporters will maintain some stocks to minimize the potential for disruptions in throughput. A long commercial pipeline in Canada results in stockholding as elevators will maintain some stocks as the canola is assembled into carload lots. Higher expected prices is another factor in holding commercial inventory.

The demand for canola oil and meal stocks are expected to be mainly for pipeline purposes. Canola oil does not store as well as the seed so it would be prudent to maintain the necessary stocks for refining but not excessive stocks. Oil storage also requires specialized storage facilities. The stocks demand for canola meal is also expected to be mainly for pipeline purposes. Most livestock feeders or feed manufacturers purchase the meal only as needed and do not carry large inventories. If inventories are large at the crushing site, prices tend to soften.

2.1.5 International Market

The major producers of rapeseed are the EC-12, China, India and Canada. Rankings change according to annual seeded acreage and growing conditions. The production comparisons for 1986-1991 are shown in Table 2.6. Canada has been surpassed by India in the past four years and now ranks fourth.

TABLE 2.6: PRODUCTION OF RAPESEED/CANOLA IN THE WORLD'S FOUR MAJOR PRODUCING REGIONS, 1986-1991 (1000 TONNES)

Year	EC-12	China	India	Canada
1986	4066	5881	2605	3787
1987	6352	6605	3455	3847
1988	5594	5044	4377	4311
1989	5342	5435	4123	3096
1990	6143	6958	5400	3281
1991	7288	7100	5000	4200

Source: United States Department of Agriculture, Foreign Agriculture Service, Production, Supply and Distribution Data Base.

The major export demand for canola seed is from Japan where canola oil is a preferred product. Canada is an important producer of canola but is the dominant seed exporter in the world. Approximately half of the seed produced in Canada is exported as seed. Japan is the dominant importer and accounts for about 80 percent or more of Canadian canola seed exports in most years. The other seed purchasers are Mexico and the Netherlands. Despite several decades of production of canola, the effort to diversify the market to other customers in either the canola seed or the canola oil have been disappointing.

The Japanese import canola from behind a protective tariff wall where the imports of canola oil face a high tariff. The current tariff is 17 yen/kg or 17000 yen/tonne. This encourages seed imports rather than oil imports. Canadian canola crushers can face extremely thin crushing margins and yet the Japanese will continue to import seed due to the protective oil tariff.

The quantity of export demand for Canadian canola oil has historically been dominated by sales of oil via the Canadian International Development Agency (CIDA). Recently, commercial sales of canola oil have been to the US after canola received Generally Regarded as Safe (GRAS) status. Previously this had served as a non-tariff barrier to keep edible canola oil out of the US market. The US market is more lucrative than most markets for canola oil since it is a commercial market which recognizes canola oil as a premium health food product. Many of the other markets are low-priced markets where EEP soybean oil or aid sales are the norm. The tariffs on canola and its products into the US have been reduced under the Canada-US Trade Arrangement. In 1992, they are tariff-free if Canada is certified as the point of origin (personal communication, US Customs, May 1992).

The export demand for canola meal is determined by price, trading rules and availability of alternative protein sources. Some canola meal is exported to Japan. The canola meal is more difficult to move than the canola seed as it is dusty and sometimes must be pelletted or sprayed with canola oil to reduce the dust. Canola meal is a low-value product relative to either the canola oil or the canola seed and consequently it is expected to be the least likely to find a distant market for consumption.

2.1.6 Price Determination

The Winnipeg Commodity Exchange is the only market in the world where canola futures are traded. It is therefore an important center for canola/rapeseed price discovery. On this market, only futures in the seed are traded and not futures in the products. This is in contrast to the situation in the United States where both soybeans and its products (soyoil and soymeal) are traded on the Chicago Board of Trade.

The inability of a Canadian crusher to sell canola oil and canola meal on the futures market and purchase the seed to lock in a crushing margin may be one of the reasons for the volatility which has historically characterized the Canadian canola industry. Canadian crushers will sometimes achieve healthy profits during one period and then face significant losses or be forced to shut down crushing for several months due to an unprofitable crushing margin.

Canola contracts trade basis Vancouver with delivery months of January, March, June, September and November. Canada is the most important canola-seed exporter in the world so seeded acres and the condition of the canola crop in Canada can influence the relative value of canola seed to soybeans and other oilseeds. Canadian production does not set world prices but it can influence whether canola oil is at a premium or a discount price to soybean oil and palm oil.

The canola futures market is also influenced by the capacity of the Canadian grain handling and transportation system as there are delivery quotas on canola during most periods. The CWB quotas are announced during the crop year and this, in addition to the price signals, will attract the canola supplies off the farm and into the market.

Canola prices are obviously influenced by the prices of soybean oil and meal as well as the other major oils such as palm oil. The market place at Winnipeg serves as the center for price discovery where the country elevators, producers and exporters come together and discover prices.

It appears that the Canadian market for canola meal is kept at a price where it is competitive with soymeal to be used in part of the ration but not priced so low as to result in largely displacing soymeal, even within the prairies. The pricing practice from several spot pricing checks over the past several years[1] is that the price quoted for canola meal in a prairie position is often higher than price quoted at a port position such as Vancouver less the costs of freight, interest, etc. in moving the canola meal from a prairie position to Vancouver. One could hypothesize that oligopolistic pricing exists in the pricing of canola meal on the prairies or that higher distribution costs from small volumes are factors which contribute to these differences.

2.1.7 Institutional Arrangements Influencing the Canola Industry

The Canadian canola industry is influenced by many subsidies, regulatory and institutional factors that have shaped its performance and evolution over the past decades. The Canadian canola industry is also influenced by the marketing practices and institutions of the Canadian grain marketing system.

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1 Personal observations of Ken Rosaasen every few years since the mid-1970 period. No published product price series for the prairie region is available.

Some of these include the CWB delivery quota system, the WGTA, MCRs and the provision for waiving the right to recall grain which is delivered to a primary elevator in exchange for free storage.

The CWB delivery quota has already been alluded to in the previous section but it requires further elaboration. The CWB delivery quota system also applies to non-Board crops such as flax, rye and canola. A quota is opened in response to requests from the elevator companies to the CWB. The result is that producer deliveries are encouraged or discouraged by both a price signal and quota availability. Conceptually, during some earlier time periods, the canola market was often inverted. Cash prices could be at a premium to futures and near-month futures at a premium to deferred months futures, even within the same crop year. Farmers are unable to sell canola on the local cash market (elevator street price) and purchase futures which would be a logical strategy in response to an inverted market. This could be used in a country like the US but cannot be used in Canada due to the CWB delivery quota constraint which restricts the volume of current sales of the physical product.

During some periods there have been special quotas for producers if the delivery is made to a crushing plant rather than to a country elevator. In times when cash flow is restricted and the quota to a crushing plant is 20 bushels per acre and the quota to a country elevator is 5 bushels per acre, there is a strong incentive to deliver to a crusher. Quota acres which are not used in delivering canola can be utilized to deliver wheat or barley or any of the other crops to which the producer chooses to assign the quota acres. There is also the provision that this higher level of quota can be applied to the movement of canola to a crushing plant outside the region (e.g., to Ontario). Then the limited rail car supply is utilized to move the seed to an alternate crusher to keep the access to seed from across Canada on an "equitable" basis despite the reality that a domestic car shipped uses up a carload of capacity for export.

Waiving the right to recall grain is another anomaly of the Canadian open market system. This allows a farmer to haul in canola when the delivery quota is available and place it in storage in a country elevator. The elevator company would rather move it so the practice that developed in the 1970s was that the elevator would grant free storage if the producer agreed not to ask to recall his canola. The result was that the producer saved storage costs and achieved the convenience of being able to sell via a phone call when field work was underway rather than having to shut down to deliver the canola. The elevator companies saved the interest costs which are normally part of the basis used in calculating the street price. The unpriced seed then moved through the commercial system. When it reached Vancouver, the canola was sold to prevent congestion and the elevator company took a long position in the futures to enable it to be protected in the event that prices increased and the farmer opted to sell. This buying pressure on the futures months during the early 1980s resulted in a set of future prices where the value of the deferred months futures exceeded the value of the nearby (cash) month by more than the cost of financing and terminal storage. Under a freely-operating market, one would have expected arbitrageurs to correct this situation. That is, speculators would buy the undervalued cash canola or the near-month futures and accept delivery. At the same time they would sell the relatively high-priced deferred futures and then deliver on the deferred futures at a profit. This however was not allowed in Canada due to a rule that anyone purchasing cash canola at Vancouver must have made an export sale. The result was a regulatory wedge between the cash and futures price.

A further anomaly existed in that an individual who shipped a producer car was exempt and could deliver on the futures market rather than accept the cash canola price. This artificial premium greatly encouraged the use of producer cars. The existing elevator companies were told that a proportion of each carload shipped must come from producer car stocks. The result was that elevator companies would pay premium prices to the producer car shippers and purchase seed off the futures market and then incur a loss by selling it to exporters at the discounted cash price. Subsequently a cash call market at Vancouver was established. This cash canola is not deliverable against a futures contract due to the regulatory provisions that only provide rail cars to firms which indicate an export sale has been made.

Now, the total canola industry is unable to effectively utilize the Vancouver futures delivery point as a hedge because of the added basis risk between cash and futures prices at Vancouver. The discounts on the cash price relative to the printed futures price accrue to the Japanese buyers who dominate the market and can make actual purchases (i.e. as export sales).

There is also direct intervention in the transportation rates for canola through the historic Crow rate, and through the more recent version, the Western Grain Transportation Act (WGTA). The former Crow rate which became the Statutory Rates in the mid-1920s did not include rapeseed in the list of products which were covered by the fixed maximum freight rate. In the early years when rapeseed was grown on the prairies, it did not receive preferential freight rates. In 1961, the legislation was changed and rapeseed was added to the list of eligible crops.

The prairie crushers complained during the 1970s about the volatile crushing margins and about the freight subsidy on seed and not on products. Hedging a crush margin in Canada for canola was not possible as no futures market was available for canola oil and meal. Soyoil and soymeal could have been hedged but this added basis risk due to different products and countries, i.e., exchange rate risk. The "freight inequities" were addressed in 1976 when minimum compensatory rates were applied to canola oil and canola meal moving by rail from Thunder Bay to eastern Canada. The rates are regulated at levels "which cover only the railways' direct cost of moving canola products. No direct subsidy is paid by the federal or provincial government related to this program." (Transportation Talks, 1991, p. 10.) Reduced transportation rates were provided in order to make rapeseed crushing more attractive in Canada (particularly western Canada) and to increase the use of oils and meal produced in Canada.

These policy interventions influenced the relative prices for prairie commodities in the West Coast and Thunder Bay positions. The price premiums at Vancouver (on ocean water), relative to the lower prices at Thunder Bay (an inland water route), have been evident for decades. In the early 1970s there were two canola contracts traded on the Winnipeg Grain Exchange. One contract used Thunder Bay as the delivery point and the other used Vancouver as the delivery point. It is noteworthy that at that time there were considerable premiums for canola delivered to Vancouver. Designated freight stations were paid premium prices with the designated stations being west of a line between about Saskatoon and Biggar. Some have questioned the preferential treatment afforded canola in terms of shipping it out of the port where values are the highest and not having canola shippers share the port capacity constraints which are identified as causing the price premiums at the west coast. (See Groenewegen (1986) and Olesen and Brooks (1987).

Perhaps the largest influence that Canada has on the canola market is its seeded acreage and the production outcome (which is subject to some weather uncertainty). Once Canadian output is achieved, the Japanese market has the first claim on it because of their ability to pay premium prices as they can bid for canola seed from behind a protective tariff wall for canola oil. The crush margin in Canada can be very good if stocks are ample but very small and unprofitable if stocks of canola become tight. This, plus the absence of a canola product futures market which would allow crushers to lock in a crushing margin, makes for a very volatile and vulnerable industry. Recently, a crusher chose to locate a new plant in Windsor, Ontario, since this would provide access to canola as well as access to Ontario and US soybeans if canola crushing margins moved to low and unprofitable levels.

2.2 Canola Model

The main directive given to this study was to establish a simple econometric model of the Canadian oilseeds sector for policy analysis and medium-term forecasting. The meaning of 'simple' is that the number of variables to be included in a formal econometric model be few in number and readily accessible since time series of these data will need to be maintained and updated. With this in mind, the following section describes the modeling framework for canola and canola products. Although a systems approach to estimate the domestic demands for canola and soy oils and meals is preferable and was attempted (see May Interim Report, Section 5) estimation problems because of data constraints required that a single equation approach be adopted.

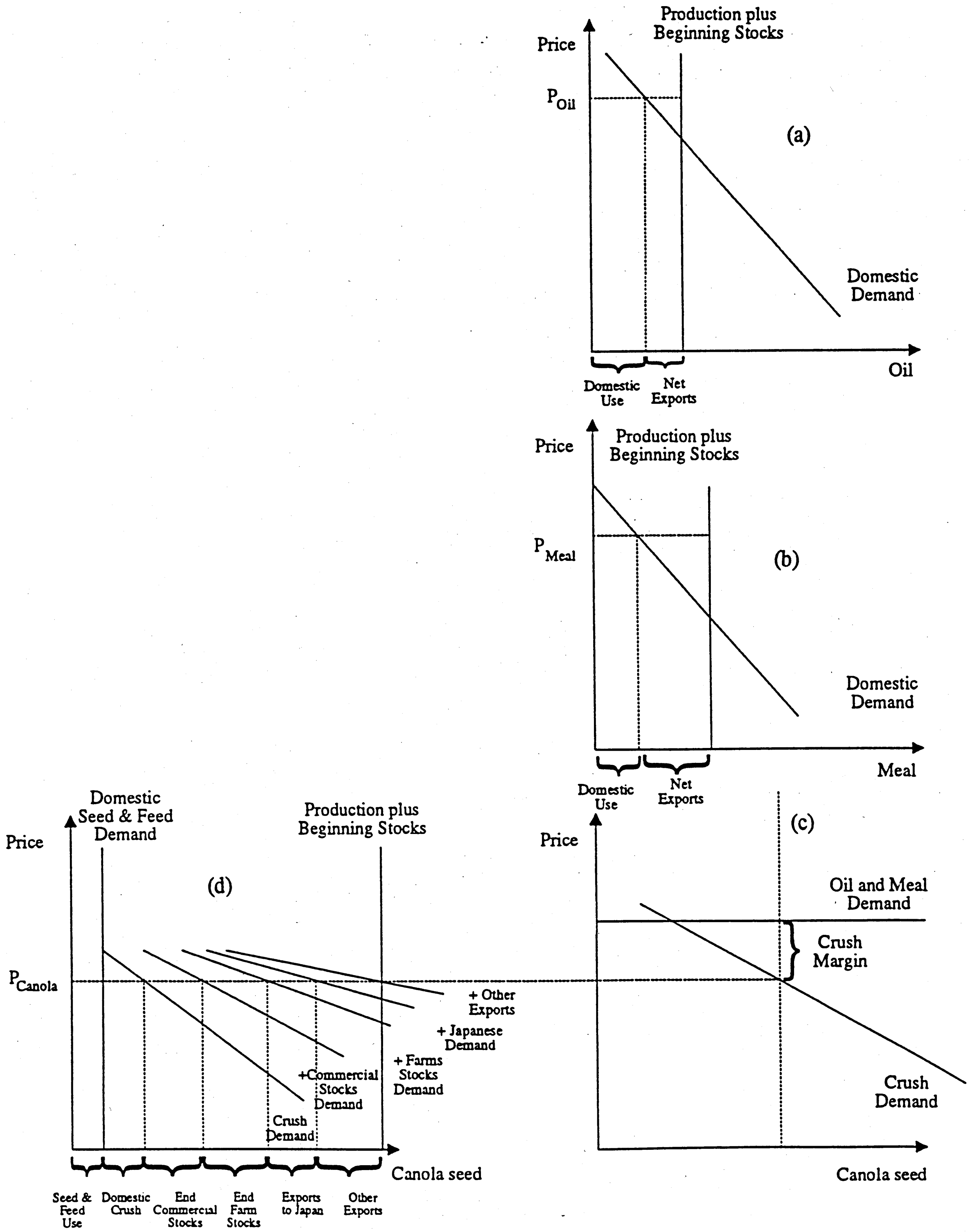
2.2.1 Conceptual Model

The Canadian canola market consists of three components: canola oil, canola meal and canola seed. The oil and meal markets are small relative to the seed market, with slightly less seed crushed domestically than is exported. Canada is the world's largest exporter of canola/rapeseed accounting for about 50 percent of all seed exports. Canada exports some canola oil and meal, with canola oil increasing in importance in recent years.

The model is essentially described as three markets vertically linked through domestic crush. A conceptual model of the canola market is given in Figure 2.1. In this model, the Canadian price of canola is determined by the price of US soybeans and the price of canola oil in Canada. These are deemed to be the major factors considered by Japan in their bids for Canadian canola seed [P_{canola} in panel (d)]. In panel (d) production plus beginning stocks are treated as given. World (US) prices determine the values for canola oil and canola meal due to substitutability in panels (a) and (b). The demands for domestic crush and stocks and exports are assumed to be price-responsive. Exports are divided into demand from Japan and demand from the rest of the world (other exports). Hence equilibrium values for these demand categories are determined simultaneously. Demand for feed, seed, waste and dockage is assumed to be directly related to the canola production level.

The domestic crush demand is represented in both panels (d) and (c). In panel (c), crush demand is seen to be derived from the demand for the oil and meal less the gross crush margin. In panel (d), the crush demand is one of the competing uses for canola seed with exports (Japan and other), stocks and seed, feed and waste. In panel (c), oil and meal demand is represented as a horizontal line. This is derived from the representations of the oil and meal markets in panels (a) and (b) respectively. In each of these panels, the product price is assumed to be exogenous and is driven by the US price of soymeal and soyoil, adjusted for exchange rate and with expected differences due to quality factors. This is reasonable since Canada is an insignificant player in the world markets for these products. In these panels, the quantity of oil and meal supplied is predetermined by the quantity of seed crushed. As already mentioned, this latter variable is determined in the Canadian seed market in panel (d). There are assumed to be price-responsive domestic demands for the oil and the meal. Exports of the oil and meal are specified as residuals (domestic production less domestic consumption adjusted for inventory changes) in the model. Small pipeline stocks are needed for oil and meal.

FIGURE 2.1 CONCEPTUAL MODEL OF CANADIAN CANOLA MARKET



The quantity exported to Japan plus the domestic demand for canola seed plus stocks plus other exports must combine to clear the available supply in panel (d). The crush margin absorbs the variability in prices. A fixed physical conversion of seed to oil and meal at prevailing prices less seed costs determines the crush margin [panel (c)].

The model is represented in equations form in Table 2.7 below. Equations 2.1 and 2.2 are price linkage equations that relate the Canadian prices of canola oil and canola meal to the prices of soyoil and soymeal as determined in the soybean model. Equation 2.3 links Canadian canola prices to the price of canola oil (a substitute for soyoil) and the price of soybeans. Equation 2.4 is an identity to deflate the price of canola seed, (PRA), using the Consumer Price Index, (CPI). Equation 2.5 is an identity in which the gross crush margin is related to the Canadian prices of oil and meal, physical conversion rates and the Canadian price of canola seed. Equation 2.6 is similar to equation 2.4, deflating the crush margin, CMRA by the CPI. Equation 2.7 represents the relationship between the gross crush margin, the crushing capacity for canola seed in Canada and the total quantity of canola seed crushed. Equation 2.8 explains commercial inventories as a function of the deflated price of seed, canola production, lagged commercial stocks and a dummy variable to account for a 90-day limit on farmers holding unpriced seed in the system after 1982. Feed, seed and waste (equation 2.9) is specified as a function of canola production. Exports to Japan (equation 2.10) are specified as a function of the deflated price of canola seed in Japanese yen and the deflated per capita income in Japan. The deflater used for these exogenous variables is the Consumer Price Index in Japan (CPIJ). Equation 2.11 relates farm inventories, (FIRA), to production, the inverse of the deflated price of canola seed and a dummy variable for years in which the delivery quota was restrictive. Farm marketings, (FMRA), is calculated as a residual (equation 2.12) as are exports to countries other than Japan (EXRAO, equation 2.13). Equations 2.14 and 2.15 are identities which use technical relationships to determine the production of oil and meal from the level of total crush. The per capita domestic demand of canola oil is a function of the deflated canola oil price and a time trend (equation 2.16). Total domestic demand for oil is obtained by multiplying per capita demand for oil by the population in Canada (equation 2.17) and the domestic demand of canola meal (equation 2.18) is specified as a function of the deflated price of canola meal and the number of hogs in Canada. Exports of canola oil and canola meal are residuals in equations 2.19 and 2.20, given by production minus domestic demand minus the change in inventories.

The model can be simulated recursively, solving equations 2.1 to 2.5 first. Once prices are simulated, the crush equation (2.7) and inventory equations (2.8 and 2.11) can be simulated.

Equations 2.9 and 2.10 can be simulated directly as they involve only exogenous right-hand side variables. The identities 2.12 and 2.13 are used to simulate farm marketings and exports to countries other than Japan, sequentially. Equations 2.14 to 2.20 are also simulated in sequence. The statistical procedures used in the study and data sources are contained in Appendix A.

TABLE 2.7: CANOLA MODEL IN EQUATIONS FORM

$PRL = f_1(PSL)$ . . . . . (2.1)

$PRM = f_2(PSM)$ . . . . . (2.2)

$PRA = f_3(PRL, PSO4C)$ . . . . . (2.3)

$PRAD = f_4(PRA/CPI)$ . . . . . (2.4)

$CMRA = .40 * PRL + .58 * PRM - PRA$ . . . . . (2.5)

$CMRAD = f_5(CMRA/CPI)$ . . . . . (2.6)

$CSRA = f_6(CAP, CMRAD)$ . . . . . (2.7)

$CIRA = f_7(PRAD, QRA, CIR_{t-1}, DI2)$ . . . . . (2.8)

$DFRA = f_8(QRA)$ . . . . . (2.9)

$EXRAJ = f_9(PRAJYD, PCDIJD)$ . . . . . (2.10)

$FIRA = f_{10}(QRA, PRAD^{-1}, QDUM)$ . . . . . (2.11)

$FMRA = FIRA_{t-1} + QRA - DFRA - FIRA$ . . . . . (2.12)

$CIRA_{t-1} + FMRA = EXRAJ + EXRAO + CSRA + CIRA$ . . . . . (2.13)

$QRL = .40 * CSRA$ . . . . . (2.14)

$QRM = .58 * CSRA$ . . . . . (2.15)

$PCDDRL = f_{11}(PRLD, T)$ . . . . . (2.16)

$DDRL = POPCAN * PCDDRL$ . . . . . (2.17)

$DDRM = f_{12}(PRMD, HOG)$ . . . . . (2.18)

$EXRL = QRL - DDRL - IRL + IRL_{t-1}$ . . . . . (2.19)

$EXRM = QRM - DDRM - IRM + IRM_{t-1}$ . . . . . (2.20)

Endogenous Variables:

PRA	= Price canola seed
PRL	= Price canola oil
PRM	= Price canola meal

(continued)

TABLE 2.7 (Continued)

Endogenous Variables: (Continued)

EXRAJ	= Exports canola seed to Japan
EXRAO	= Exports canola seed to countries other than Japan
DFRA	= Canola feed waste and dockage
CIRA	= Commercial inventories canola seed
FIRA	= Farm inventories canola seed
FMRA	= Farm marketings canola seed
CMRA	= Crush margin
CSRA	= Total canola crush
QRL	= Production canola oil
QRM	= Production canola meal
DDRL	= Domestic demand canola oil
DDRM	= Domestic demand canola meal
EXRL	= Net exports canola oil
EXRM	= Net exports canola meal
PCDDRL	= Per capita demand for canola oil

Exogenous Variables:

PSM	= Price soymeal, Canada
PSL	= Price soyoil, Canada
PSO4C	= Price soybeans, Decatur ($CDN)
PCDIJ	= Per capita disposable income, Japan
QRA	= Production canola seed, Canada
QDUM	= Dummy for quota constraint
HOG	= Number of hogs, Canada
CAP	= Crush capacity for canola, Canada
CPI	= Consumer Price Index (Canada) (deflator for PRAD, PRLD, PRMD and CMRAD)
DI2	= Dummy for unpriced seed (1 from 1982-83 forward)
JY	= Japanese yen to Canadian dollar exchange rate (used to form PRAJY)

(continued)

TABLE 2.7 (Concluded)

Exogenous Variables: (Concluded)

CPIJ	= Consumer Price Index, Japan (deflator for PRAJYD and PCDIJD)
T	= Time trend
IRL	= Inventories canola oil
IRM	= Inventories canola meal
POPCAN	= Population of Canada

2.2.2 Estimated Equations

The price of canola in Canada is determined by the supply and demand balance of the world oilseed sector and the price of soyoil and soymeal which are important substitutes for canola products. These market forces influence the Canadian canola market through a price linkage equation between the Canadian prices of soyoil and soymeal and their impact on canola oil and meal prices

The demand for both canola oil and canola meal in Canada were estimated as single equations. Early attempts at estimating these equations with soyoil and soymeal equations in a systems model were rejected since acceptable estimates using the systems approach could not be achieved.

Canola oil price was specified as a function of Canadian soyoil prices. Canadian soyoil prices were driven off the price of US soyoil and the Canada-US exchange rate. A complete price series for canola oil during the period is not available in published sources so some data was estimated using soyoil prices to replace the missing series. Prices in the canola model are deflated prices. The exception is the case of canola products prices as a function of soyoil prices since deflating the series on both sides of the equation for CPI results in no change.

$$PRL = \underset{(0.735)^{*}}{34.324} + \underset{\substack{(11.304) \\ (0.937)^{**}}}{0.84018} \ PSL \qquad (2.1)$$

$$R^{2***} = 0.8719 \qquad RHO = 0.15844 \qquad D.W. = 1.8847$$

* The first row of brackets are the t- statistics.

**The second row of brackets are elasticities calculated at the mean.

***The R^2s in the study are corrected R^2s.

The price of canola oil in Canada is positively and significantly related to the price of Canadian soyoil expressed in Canadian dollars. The elasticity with respect to the price of soybean prices approaches 1 (0.937).

Equation 2.1 was corrected for autocorrelation using the standard Cochrane-Orcutt type procedure. The procedure converged after 5 iterations to a log L.F = -113.065 at RHO = 0.15844.

The price of canola meal in Canada was specified to be linked directly to the Canadian price of soymeal which is driven off the US soymeal market. Canola meal is a relatively close substitute for soymeal in livestock feeds.

$$PRM = \underset{(0.929)}{19.018} + \underset{\substack{(7.479)\\(0.870)}}{0.57291}\ PSM \qquad (2.2)$$

$$R^2 = 0.8566 \qquad RHO = 0.63363 \qquad D.W. = 1.9843$$

Equation 2.2 was corrected for autocorrelation using the standard Cochrane-Orcutt type procedure. The procedure converged after 5 iterations to a log L.F = -89.6278 at RHO = 0.63363.

The price of canola meal in Canada is positively and significantly related to the price of Canadian soymeal. Canola meal has a price ceiling and floor imposed on its movement due to the potential for protein meal to be moved between the two countries. The elasticity of canola meal prices with respect to soymeal prices is 0.870.

The price of canola seed is determined by the price of canola oil and the US soybean price expressed in Canadian currency. Canola is valued for its oil, but the soybean component also enables both the oil and the meal value to influence canola seed prices.

$$PRA = \underset{(-1.031)}{-24.317} + \underset{\substack{(7.557)\\(0.562)}}{0.30112}\ PRL + \underset{\substack{(5.670)\\(0.522)}}{0.58537}\ PSO4C \qquad (2.3)$$

$$R^2 = 0.9284 \qquad RHO = 0.35599 \qquad D.W. = 1.8031$$

The canola seed price was positively and significantly related to both the variables. The elasticity at the mean for each of the prices was just over 0.5. This seed price then implicitly sets the crushing margin in Canada. Japan purchases canola relative to the value of soyoil and soybeans and has a preference for canola oil.

Equation 2.3 was corrected for autocorrelation using the standard Cochrane-Orcutt type procedure. The procedure converged after 4 iterations to a log L.F = -92.5030 at RHO = 0.35599.

The crushing margin for canola was specified as an identity. The physical yield of canola of 40 percent oil and 58 percent meal were used and multiplied by oil and meal prices respectively. The value of canola seed was then deducted to determine the crushing margin. The variability of the oil content in canola as well as the volatility of the crushing margin within a year were discussed earlier. There has been no deflation of these price variables to this point.

$$CMRA = .40\ PRL + 0.58\ PRM - PRA \qquad \text{[identity]} \qquad (2.5)$$

The total domestic canola crush was specified as being determined by the total rated canola crushing capacity in Canada and the crush margin deflated by CPI. Although some plants can crush more than one oilseed, the total plant capacity cannot be exceeded. It was expected that the crushing volume would be positively related to the crush margin.

$$\begin{array}{llll} CSRA = & -177.52 & + 0.2515\ CAP & + 129.36\ CMRAD \\ & (-1.6241) & (11.788) & (1.5126) \\ & & (1.1495) & (0.0557) \\ & R^2 = 0.892 & & D.W. = 1.7232 \end{array} \qquad (2.7)$$

The volume of canola crushed was positively related to canola crush capacity. It was highly significant with a t-value of 11.788.

One would expect that the elasticity on capacity would be close to one. It was 1.15 which is acceptable. Canola crush was relatively unresponsive to the deflated crushing margin in the canola industry as the elasticity at the mean was only 0.0557. The low coefficient for crush capacity suggests underutilization of the Canadian capacity and that other seeds such as soybeans may be crushed in some of the plants.

Commercial inventory values are taken at the end of the crop year and are quite variable as levels of 105,000 tonnes to 1,137,000 tonnes were recorded during the period. The commercial inventory of canola was specified to be largely determined by the level of canola production, the deflated price of canola seed, and the level of beginning commercial inventories. A dummy variable was added beginning in 1982/83 to reflect the regulation imposed that seed could only remain in the system for 90 days unpriced. Previously, there had been no limit to the length of time that seed could remain unpriced. Equation 2.8 explains the relationships.

$$CIRA = 102.08 + 0.2403QRA - 28.201\ PRAD + 0.2675\ CIRA_{t-1} - 495.78\ DI2 \qquad (2.8)$$

$$\begin{array}{ccccc} (0.3421) & (4.7011) & (-0.7491) & (1.8735) & (-4.7075) \\ & (1.2054) & (-0.2383) & (0.2673) & (-0.4320) \end{array}$$

$$R^2 = 0.667 \qquad D.W. = 2.235$$

The equation shows that ending commercial inventories are highly dependent upon the level of canola seed production. The coefficient is significant and the elasticity of 1.205 states that if production increases by one percent, ending inventories will increase by 1.2 percent. Commercial inventory demand was somewhat responsive to the deflated price of canola seed with an elasticity of -0.23. The price variable, however, was not significant. Ending commercial inventory also had a positive and significant relationship with the beginning level of commercial inventory. After considerable difficulty in developing a reasonable estimate for commercial inventories, a dummy variable, DI2, was incorporated to report the change in how long unpriced canola seed could remain in the commercial system. In 1982/83 a 90 day limit was imposed. Previously it was not uncommon for farmers to hold canola on storage ticket for one year or more as they waited for price to increase. This variable showed the expected negative sign as the commercial inventory was expected to decline after the 90 day limit was imposed.

Feed, waste and dockage was estimated as a function of production, shown in equation 2.9.

$$DFRA = 33.496 + 0.0994\ QRA \qquad (2.9)$$

$$\begin{array}{cc} (1.1784) & (9.5636) \\ & (0.8831) \end{array}$$

$$R^2 = 0.819 \qquad D.W. = 2.097$$

Production is highly significant with a t-value of 9.564 and an elasticity of 0.88 percent. The D.W. is close to two indicating no autocorrelation.

Exports were split to create two variables, exports to Japan and exports to other countries. The highest percentage of Canadian exports go to Japan. The specialized demand for canola (rapeseed) oil in

Japan coupled with Japan's tariff on imported vegetable oils, makes it a unique market. Studies have shown [Swallow (1983) and Furtan, Nagy and Storey (1979)] that Japan has a competitive advantage over Canadian crushers in buying "Canadian" seed. The separate equation for Japanese exports was an attempt to capture these effects. It is shown in equation 2.10.

$$\begin{array}{llll} EXRAJ = 521.8 & - 0.2152\ PRAJYD & + 6.1458\ PCDIJD & (2.10) \\ (2.983) & (-1.938) & (7.7193) & \\ & (-0.1592) & (0.6776) & \\ R^2 = 0.945 & RHO = 0.376 & D.W. = 1.633 & \end{array}$$

Japanese exports were expressed as a function of the deflated price of Canadian canola seed in Japanese yen and Japanese disposable income. The deflater used was CPI in Japan. Both variables were significant and had the expected signs. Exports were negatively related to the deflated price of canola seed expressed in Japanese yen. The elasticity of -0.159 reflects the expected inelastic relationship. Deflated per capita disposable income had the expected positive relationship.

As equation 2.10 displayed autocorrelation the standard Cochrane-Orcutt procedure was used. The procedure converged after 5 iterations to an L.L.F = -126.784 at RHO = 0.376.

Farm inventories were specified to be a function of production, the inverse of the price of canola deflated by CPI and a dummy variable for delivery quota constraints. It is shown in equation 2.11.

$$\begin{array}{lllll} FIRA = -90.124 & + 0.0439\ QRA & + 378.25\ PRAD^{-1} & + 231.93\ QDUM & (2.11) \\ (-1.3670) & (1.5982) & (1.1840) & (4.7841) & \\ & (0.6353) & (-0.5100)^{1} & (0.3238) & \\ R^2 = 0.639 & D.W. = 1.857 & & & \end{array}$$

The elasticity of 0.635 on the production variable indicates that farm inventories are responsive to changes in canola production. The price of canola was specified as the reciprocal of price in order to prevent inventories from going negative. Also, a low price generally is expected to be reflective of high

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[1] The elasticity is derived as follows from the estimated coefficient of 378.25 as E = -378.25 (170.76 * 4.3428).

inventories and conversely low inventories with high prices. The price variable had an estimated elasticity of -0.51 indicating that there is a reasonable responsiveness of farm inventories to price. There were several years, 1971, 1975, 1978, 1979 and 1980 when delivery quotas were quite low (15 bushels per assigned quota acre or less) and this restricted farm deliveries. The variable was highly significant with an elasticity of 0.323.

A balancing identity at the farm level was used to determine farm marketings, FMRA. This is shown in equation 2.12.

$$FMRA = FIRA_{t-1} + QRA - DFRA - FIRA \qquad (2.12)$$

Lagged farm stocks and production are exogenous and feed, seed, waste and farm stocks are estimated.

A balancing identity at the commercial level was used to determine exports to other countries, EXRAO. This is shown in equation 2.13.

$$CIRA_{t-1} + FMRA = EXRAJ + EXRAO + CSRA + CIRA \qquad (2.13)$$

Identities were used to reflect the physical relationships between canola seed and the output of oil and meal when it is crushed. The percentage of oil and meal were 40 percent and 58 percent respectively. This is expressed in the identities of equations 2.11 and 2.12.

$$QRL = .40 * CSRA \quad \text{[identity]} \qquad (2.14)$$

$$QRM = .58 * CSRA \quad \text{[identity]} \qquad (2.15)$$

The per capita domestic demand for canola oil was expressed as a function of the price of canola oil (deflated) and time to capture the increasing substitution of canola oil for other vegetable oils in the Canadian market. It is shown in equation 2.16.

$$PCDDRL = 3.8536 - 0.08737\ PRLD + 0.5123T \qquad (2.16)$$

(3.9092) (-1.2483) (11.435)

(-0.0842) (0.6430)

$R^2 = 0.957$ RHO = 0.338 D.W. = 1.962

The deflated price of canola displayed the expected negative sign but was not significant. It was very inelastic. Time was very significant.

Equation 2.16 was corrected for autocorrelation. The procedure converged after 5 iterations to an L.L.F = -21.431 at an RHO = .338.

In order to obtain a total domestic demand for canola oil, per capita demand is multiplied by the population in Canada (POPCAN).

$$DDRL = POPCAN * PCDDRL \qquad (2.17)$$

Domestic demand for canola meal was expressed as a function of the price of canola meal (deflated) and hog numbers. The estimation was started in 1975 because there were structural changes taking place in the meal market partly resulting from the glucosinolate problems of the early rapeseed meal which were corrected by the introduction of double-zero varieties. It is shown in equation 2.18.

$$DDRM = -28.809 - 17.041\ PRMD + 42.518HOG \qquad (2.18)$$

(-0.2467) (-0.7639) (4.6329)

(-0.1177) (1.1976)

$R^2 = 0.824$ RHO = 0.481 D.W. = 1.864

The price of canola meal (deflated) had the correct sign but was not significant. It was also very elastic at -0.12. Hog numbers (in millions) was significant and had the expected positive sign. One would expect an elasticity close to one; it was 1.20. This may be reflecting a trend toward increasing use of canola meal as hog numbers have increased. The equation explained a large percentage of the variability in meal usage.

The equation was corrected for autocorrelation. The procedure converged after 7 iterations to an L.L.F = -78.979 at RHO = 0.481.

Two further identities were used to balance the quantities of products produced. Canola oil and canola meal were required to be disposed of when crushing occurred. The exports were treated as the residual with the export volume equal to the volume of output from crushing less the domestic level of consumption adjusted for changes in canola meal inventory during the year.

$$EXRL = QRL - DDRL - IRL + IRL_{t-1} \qquad \text{[identity]} \qquad (2.19)$$

$$EXRM = QRM - DDRM - IRM + IRM_{t-1} \qquad \text{[identity]} \qquad (2.20)$$

The results of the estimates are acceptable. The initial attempt to model the crush margin as a major factor in the canola market emphasized the importance of the domestic industry in the world oilseed complex. The respecification of the model to be driven by the soybean complex resulted in the canola crushing margin being determined as an identity based on seed, meal and oil values which were driven by the large US soy complex. Plants in Japan can bid the canola seed away from Canadian crushers and therefore cause the industry to shut down as seed costs increase and as volumes of crush begin to decline and the cost of crushing rises due to the under-utilization of the plants.

The next test for the model is to evaluate it by using simulation.

2.2.3 Model Simulation

Simulation is a common method of evaluating an estimated model. The dependent variable is simulated by using the estimated coefficients on the independent variables and the actual independent variable values in this evaluation process.

Statistics are available to measure the ability of the estimated model to simulate the dependent variables. Two of the more common statistics are the predicted mean squared error, PMSE and Theil U. Each of the simulated variables are also charted for a quick overview of their performance.

The price variables of PRL and PRM are shown in Figures 2.2 and 2.3. Both of these variables were simulated quite accurately in the model although the oil price equation performed better than the meal price equation. The PMSE and Theil U for each of the variables in the model is shown in Table 2.8. PRA simulated values are shown in Figure 2.4 The canola seed price simulation performed well.

The crush margin did not simulate well as shown in equation 2.5. The volume of canola crushings performed moderately well as indicated in Figure 2.6 although Theil U was greater than 1.0.

The commercial inventory of canola performed reasonably well in the simulations. The addition of the dummy variable to depict the change to a 90 day limit on unpriced seed in the system strengthened the performance of the forecast from previous runs. Commercial inventory is volatile which makes forecasting difficult and turning points difficult to predict. It is shown in Figure 2.7.

The feed, seed waste and dockage for canola performed well. It was a function of production alone. Figure 2.8 plots the results of the simulation.

Exports of canola to Japan provided reasonable results. The results are displayed in Figure 2.9. Exports to countries other than Japan were estimated as a residual. As shown in Figure 2.10 it performed reasonably well with a Theil U of 1.0295 but the PMSE was high. Total exports shown in Figure 2.11 also performed quite well.

Farm inventories which were estimated had a PMSE greater than 1.0 but a Theil U of .40. From Figure 2.12 it performed well up to about 1980 then showed a wider discrepancy of simulated to actual values. This may have been due to quota changes or the need to hold inventories on farm if price expectations were positive since if placed in the commercial system the canola must be sold within 90 days.

Farm marketings were derived as residual of the farm level identity. The simulation statistics were very good. Domestic production of canola oil and canola meal both provided reasonable results which are shown in Figures 2.14 and 2.15. Domestic demand for canola oil and canola meal both provided satisfactory results which are shown in Figures 2.16 and 2.17. Figures 2.16 and 2.17 show the results for exports of Canadian canola oil and meal respectively. These were balancing identities which reflect some of the physical relationships in the sector and the reality that the quantity supplied must equate with the quantity demanded over the period. These identities are forced in the simulation model.

TABLE 2.8: CANOLA MODEL FORECAST STATISTICS

Variable	PMSE	Theil U
PRL	0.1264	0.3823
PRM	0.1365	0.6468
PRA	0.1037	0.3840
CMRA	30.2180	1.0058
CSRA	0.2708	1.0723
CIRA	0.4376	0.4495
DFRA	0.1768	0.5420
EXRAJ	0.1518	0.6802
EXRAO	5.7856	1.0295
EXRA	0.1638	0.8025
FIRA	1.5512	0.3792
FMRA	0.0606	0.3404
QRL	0.4028	1.5868
QRM	0.4013	1.4586
DDRL	0.1130	0.7000
DDRM	0.1172	0.7293
EXRL	1.0195	1.0139
EXRM	1.0541	1.0455

FIGURE 2.2: PRICE OF CANOLA OIL, 1970/71-1990/91

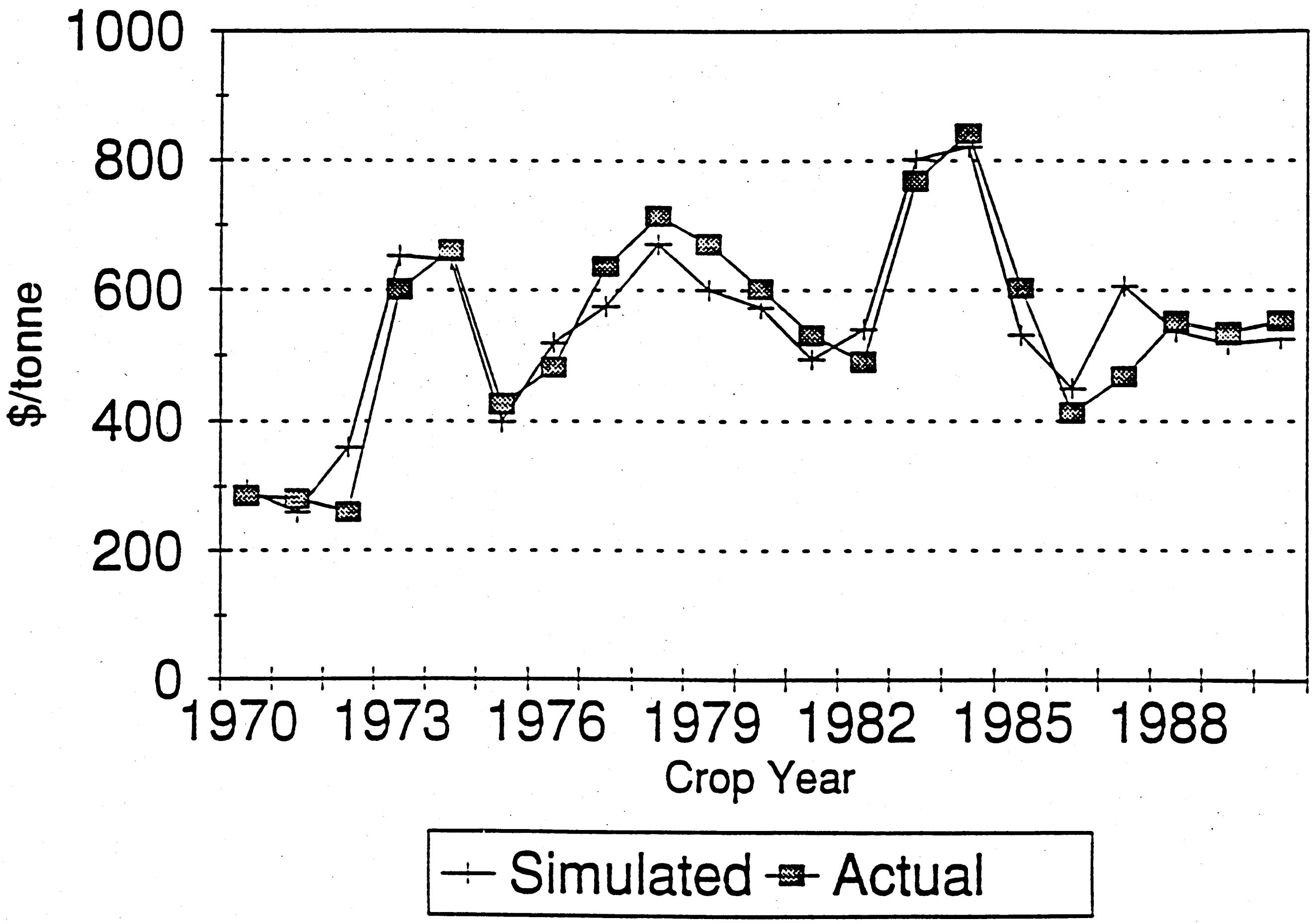


FIGURE 2.3: PRICE OF CANOLA MEAL, 1970/71-1990/91

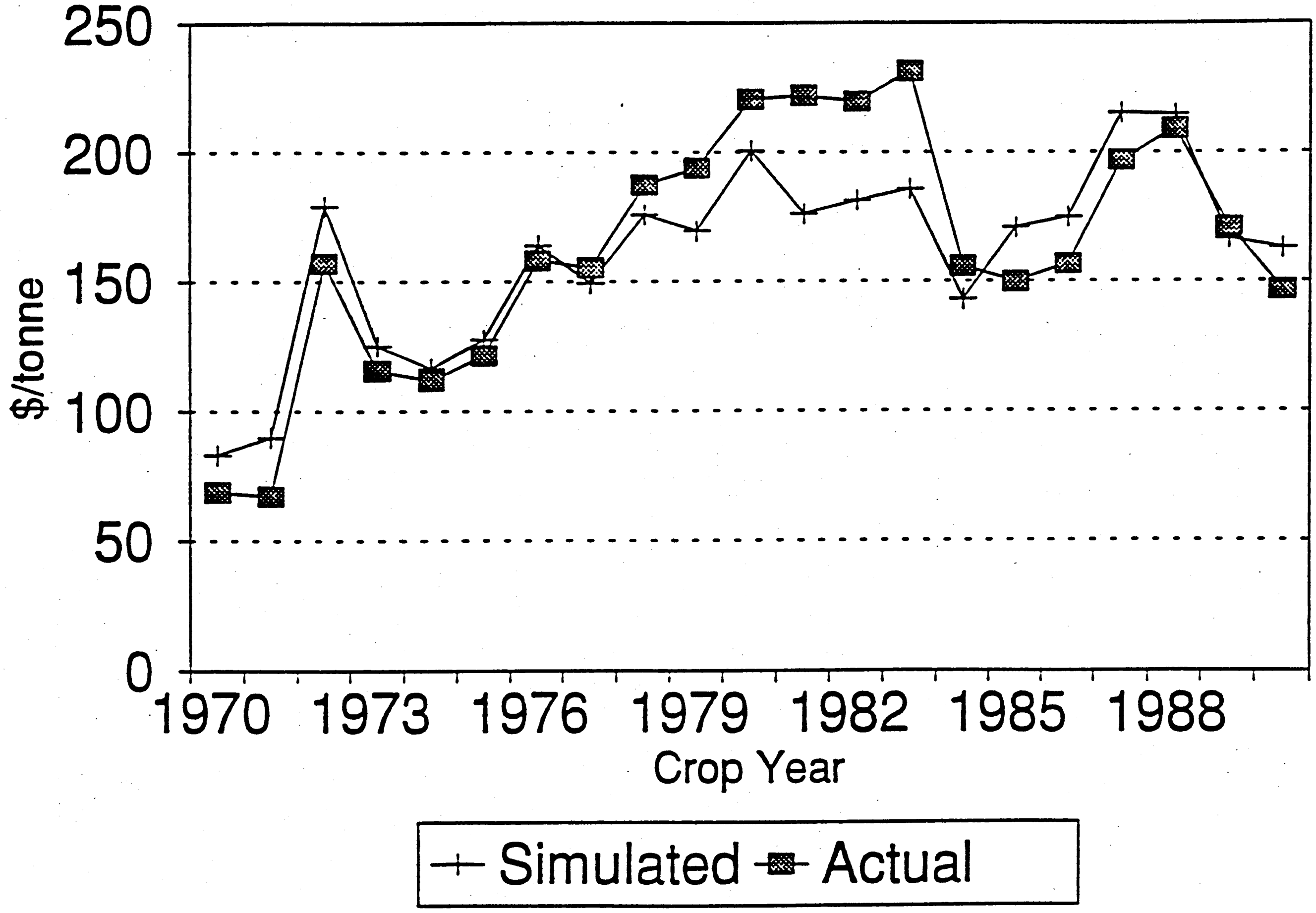


FIGURE 2.4: PRICE OF CANOLA SEED, 1970/71-1990/91

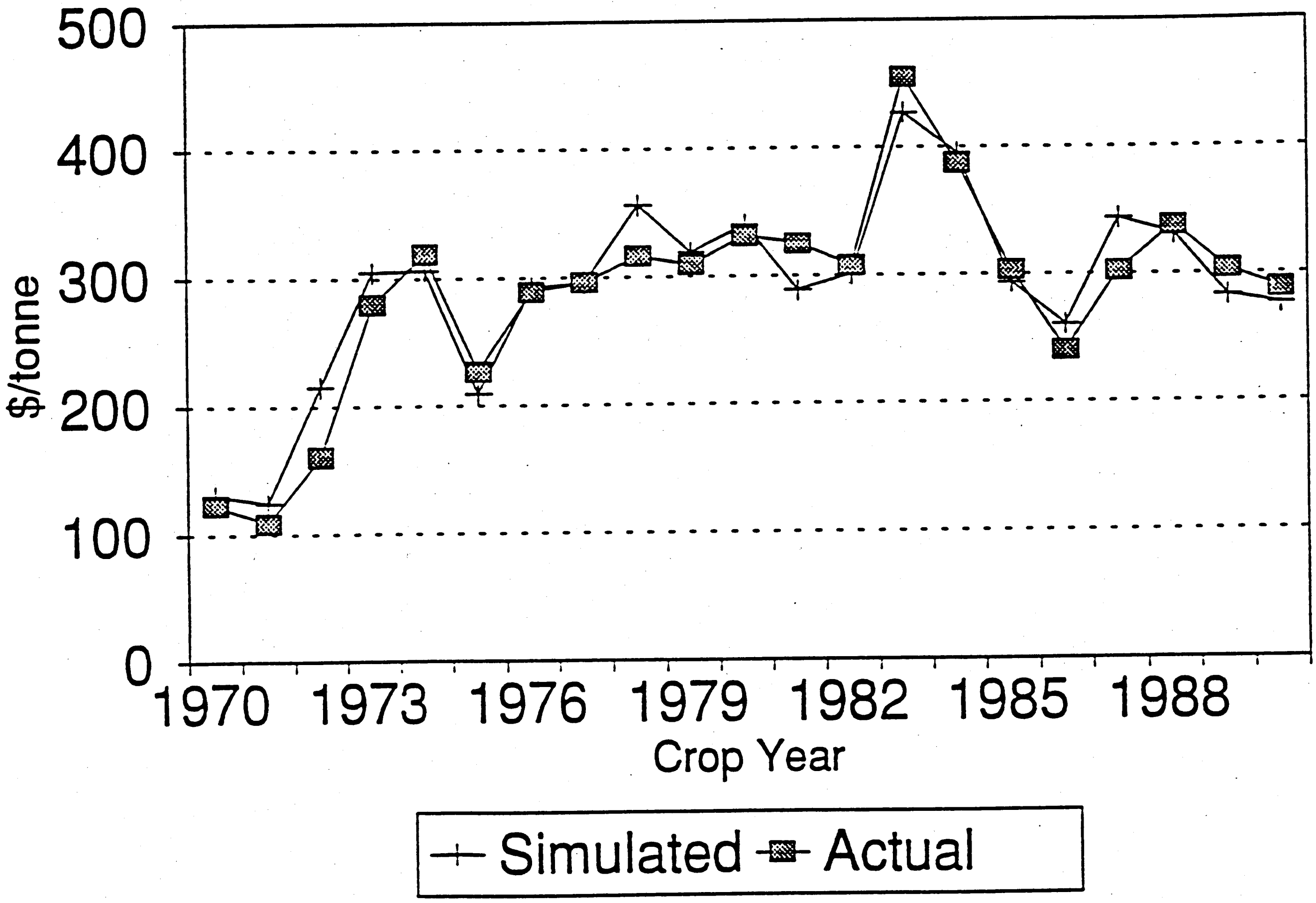


FIGURE 2.5: CRUSH MARGIN OF CANADIAN CANOLA SEED, 1970/71-1990/91

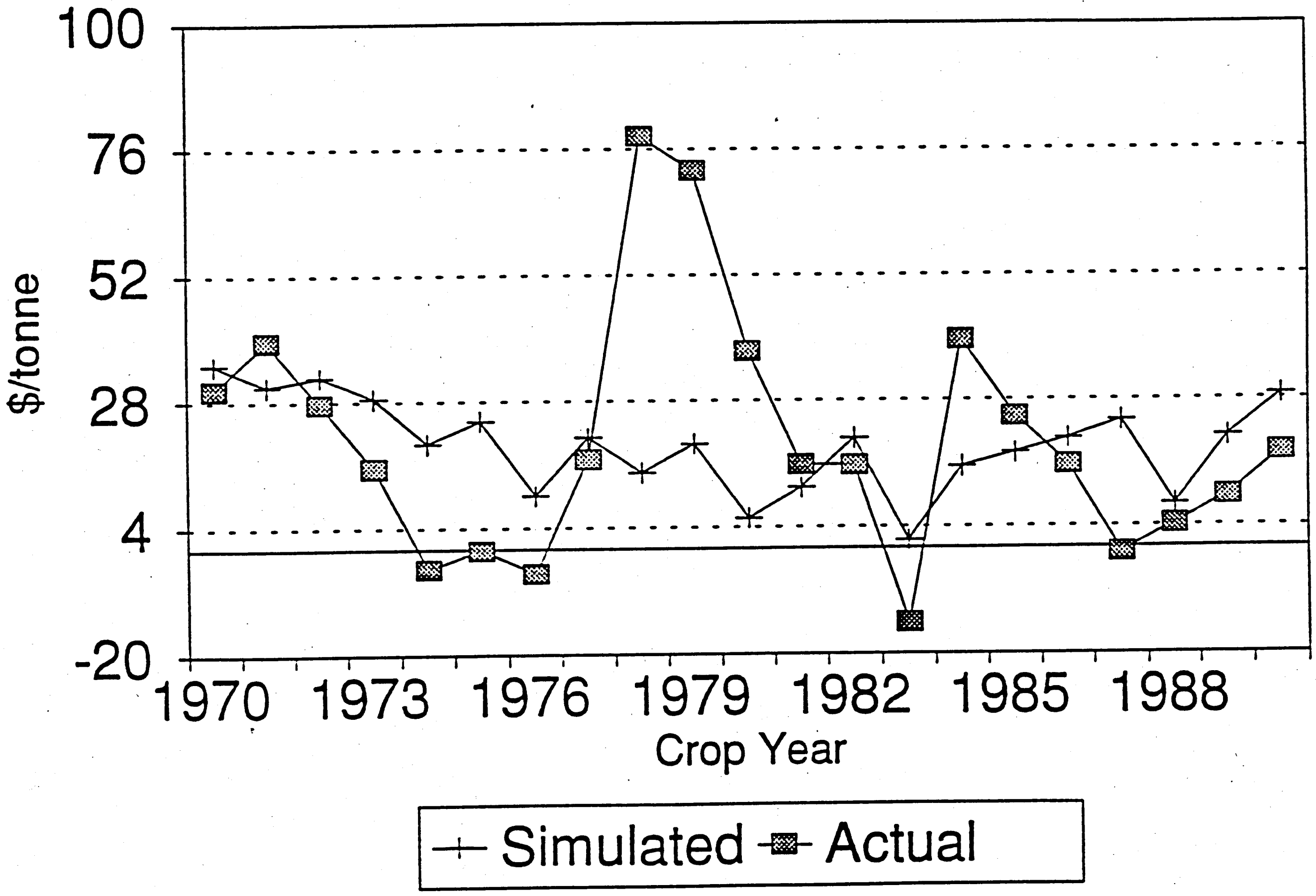


FIGURE 2.6: TOTAL CRUSH OF CANADIAN CANOLA SEED, 1970/71-1990/91

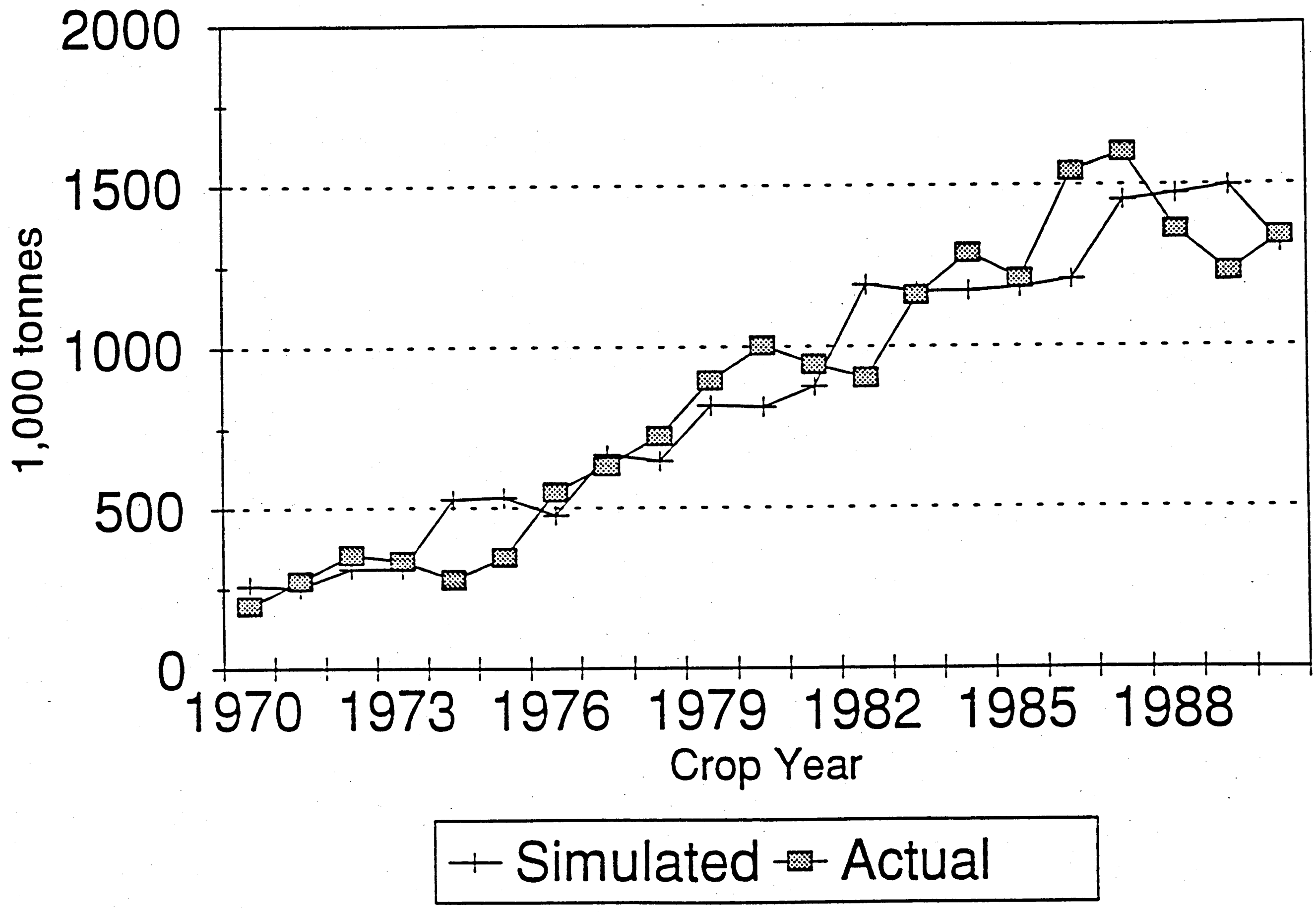


FIGURE 2.7: COMMERCIAL INVENTORIES OF CANADIAN CANOLA SEED, 1970/71-1990/91

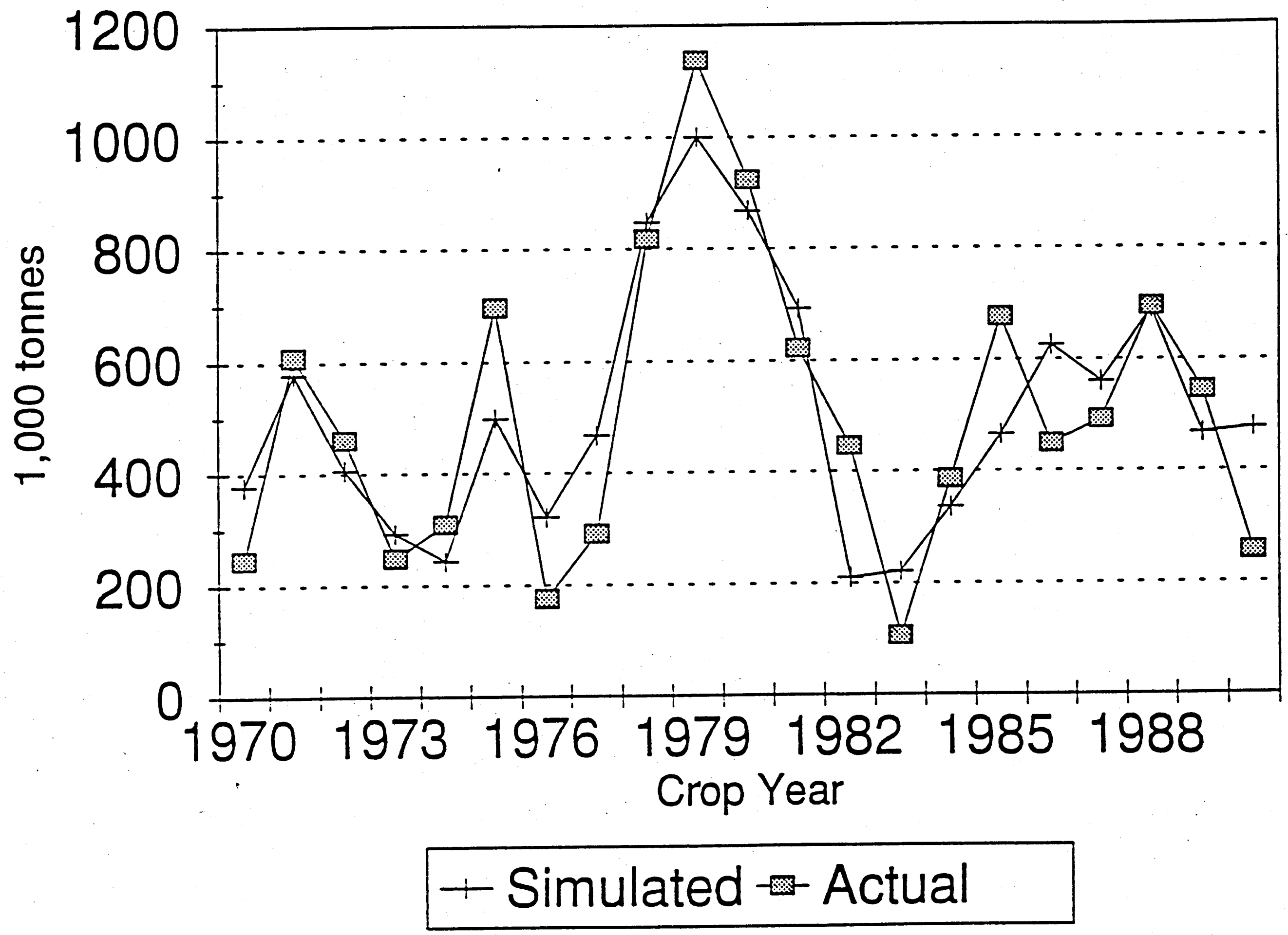


FIGURE 2.8: FEED, SEED, WASTE OF CANOLA SEED, 1970/71-1990/91

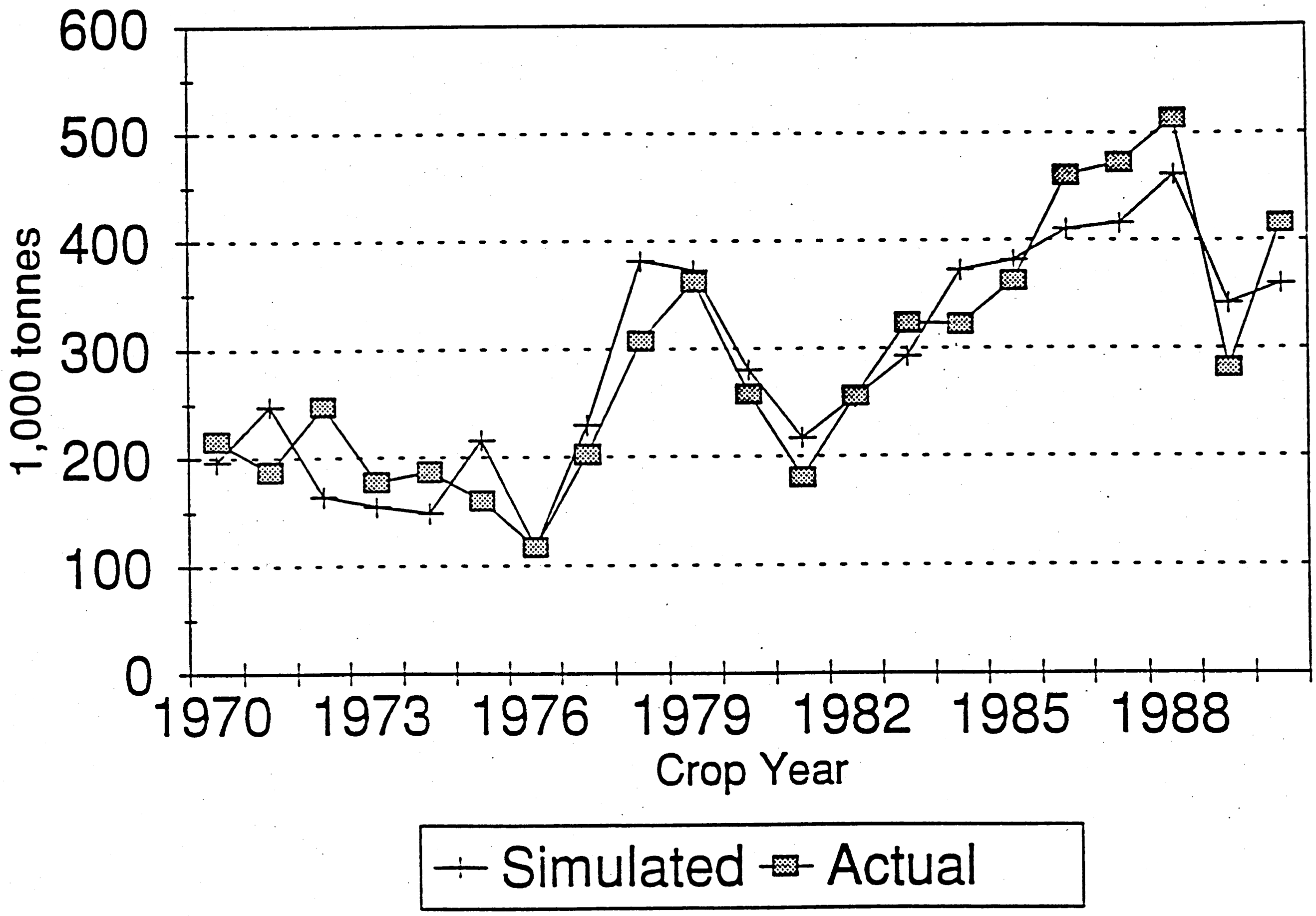


FIGURE 2.9: EXPORTS OF CANADIAN CANOLA SEED TO JAPAN, 1970/71-1990/91

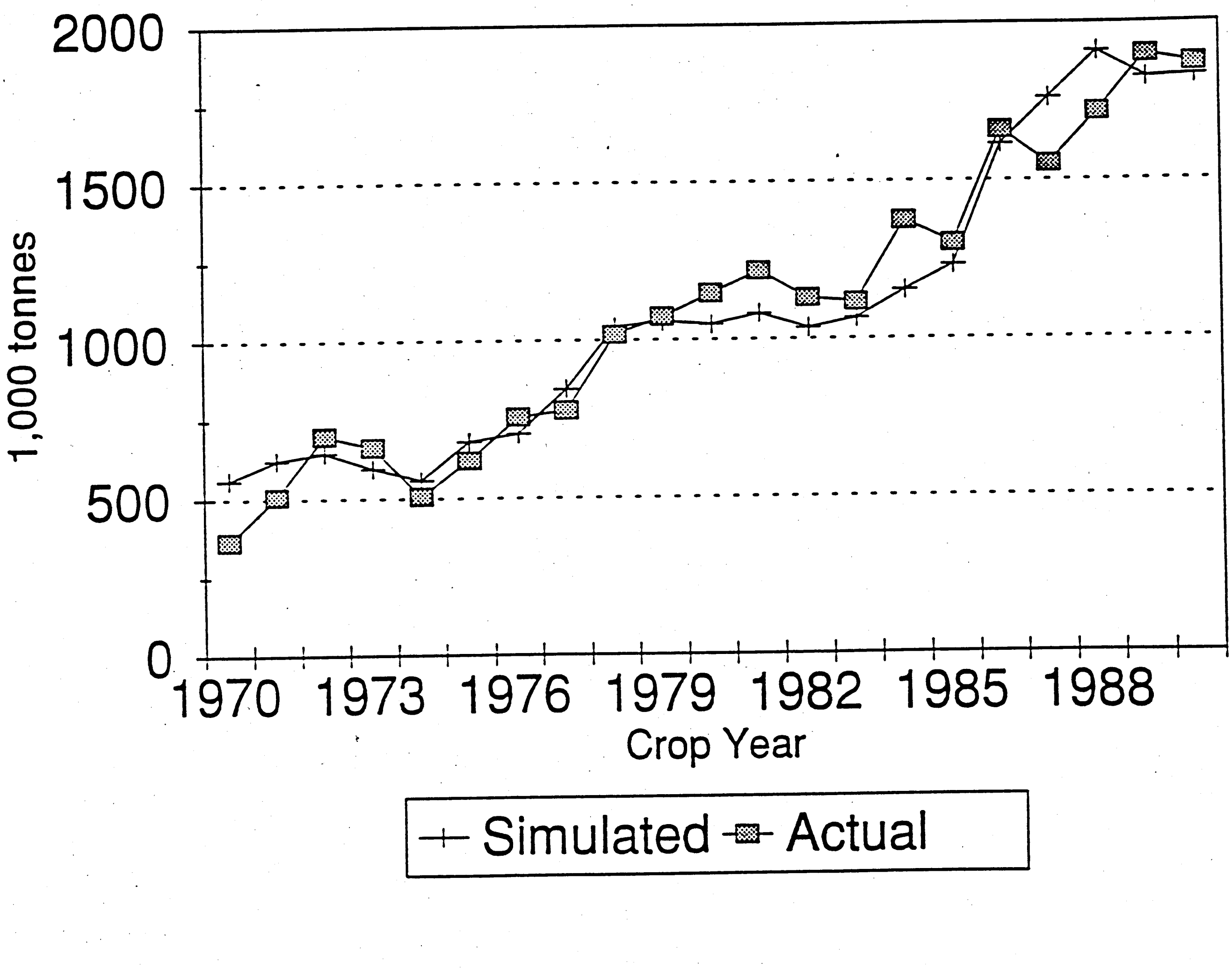


FIGURE 2.10: EXPORTS OF CANADIAN CANOLA SEED TO OTHER COUNTRIES, 1970/71-1990/91

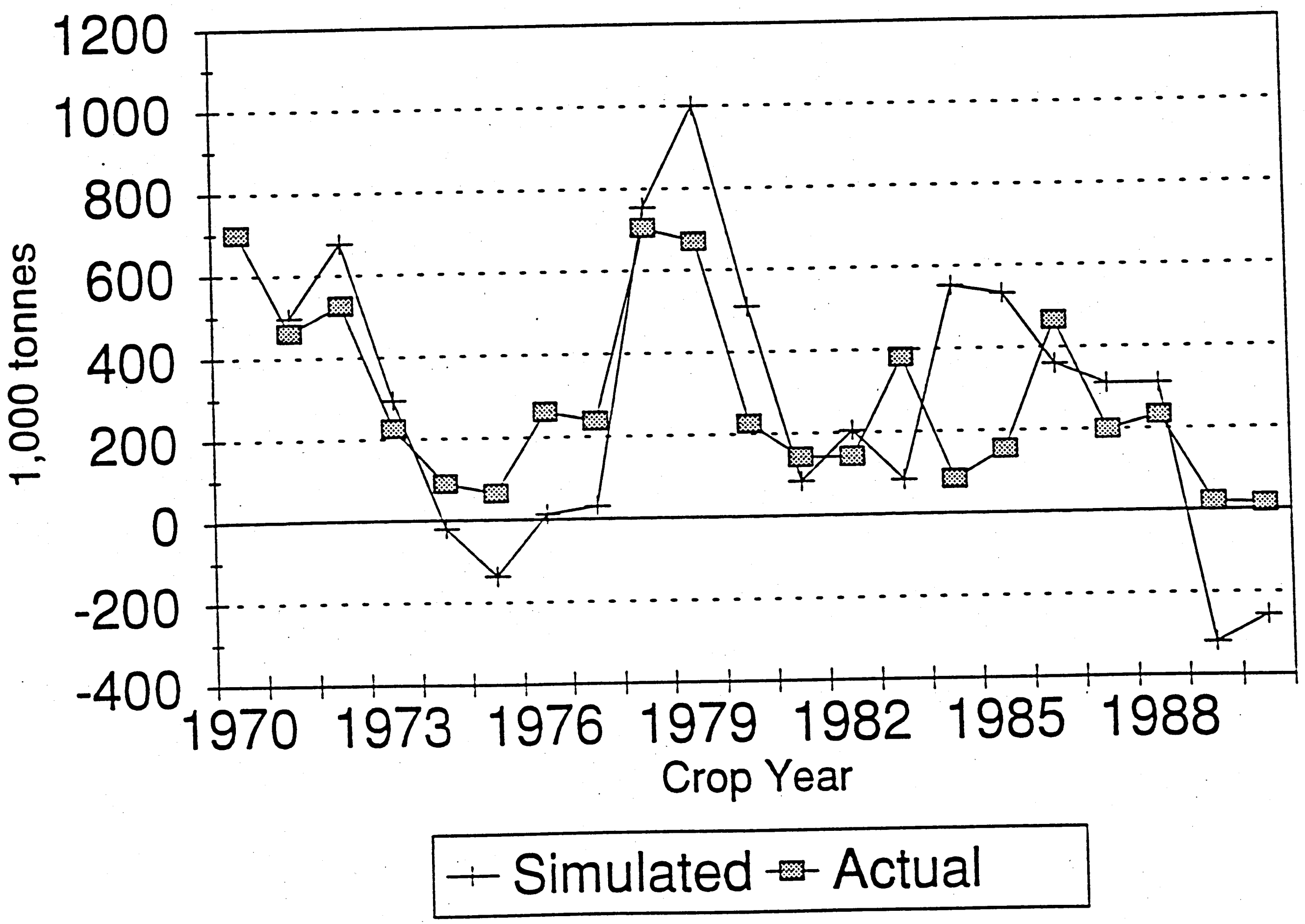


FIGURE 2.11: TOTAL EXPORTS OF CANADIAN CANOLA SEED, 1970/71-1990/91

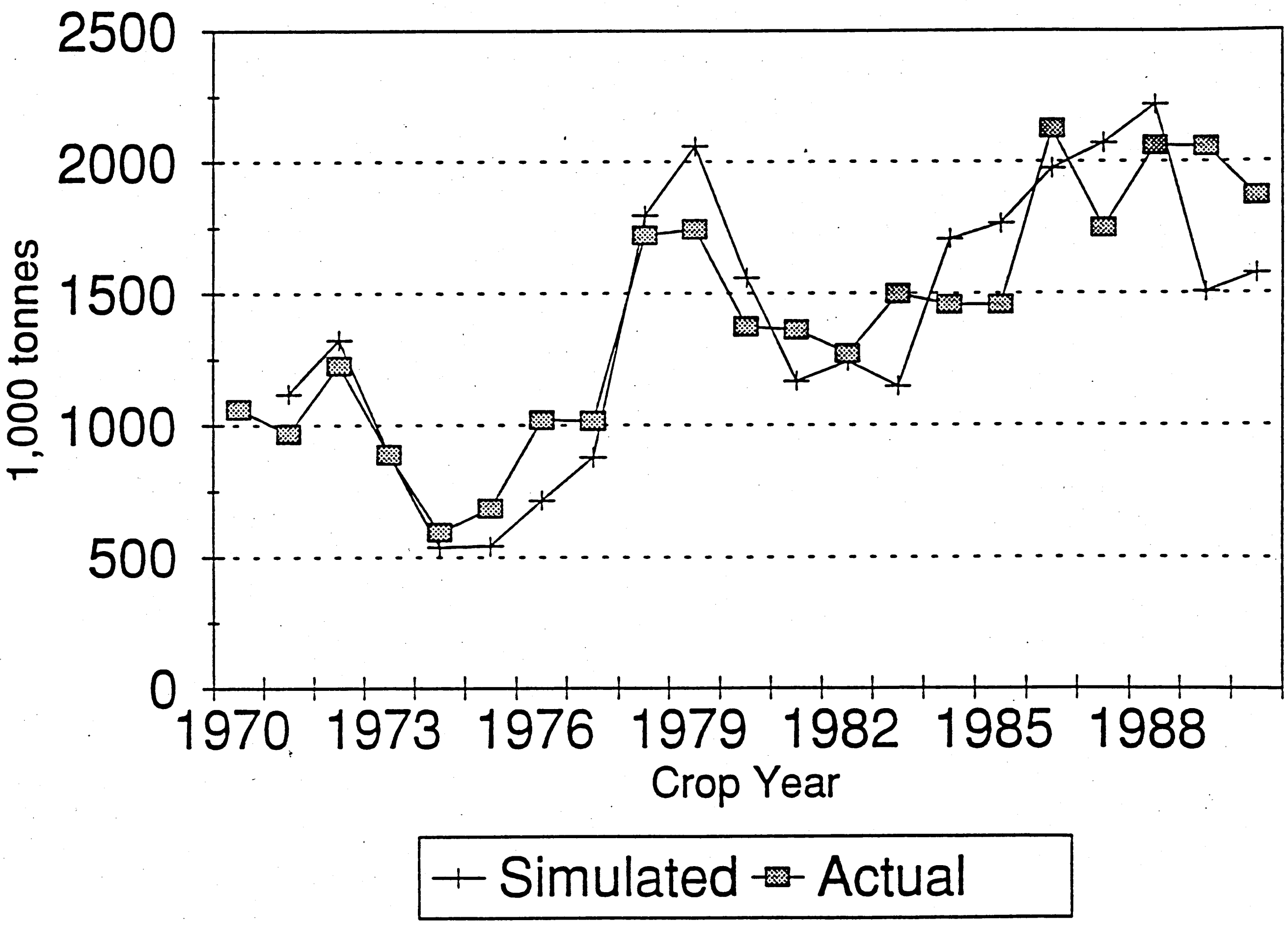


FIGURE 2.12: FARM INVENTORIES, CANADIAN CANOLA SEED, 1970/71-1990/91

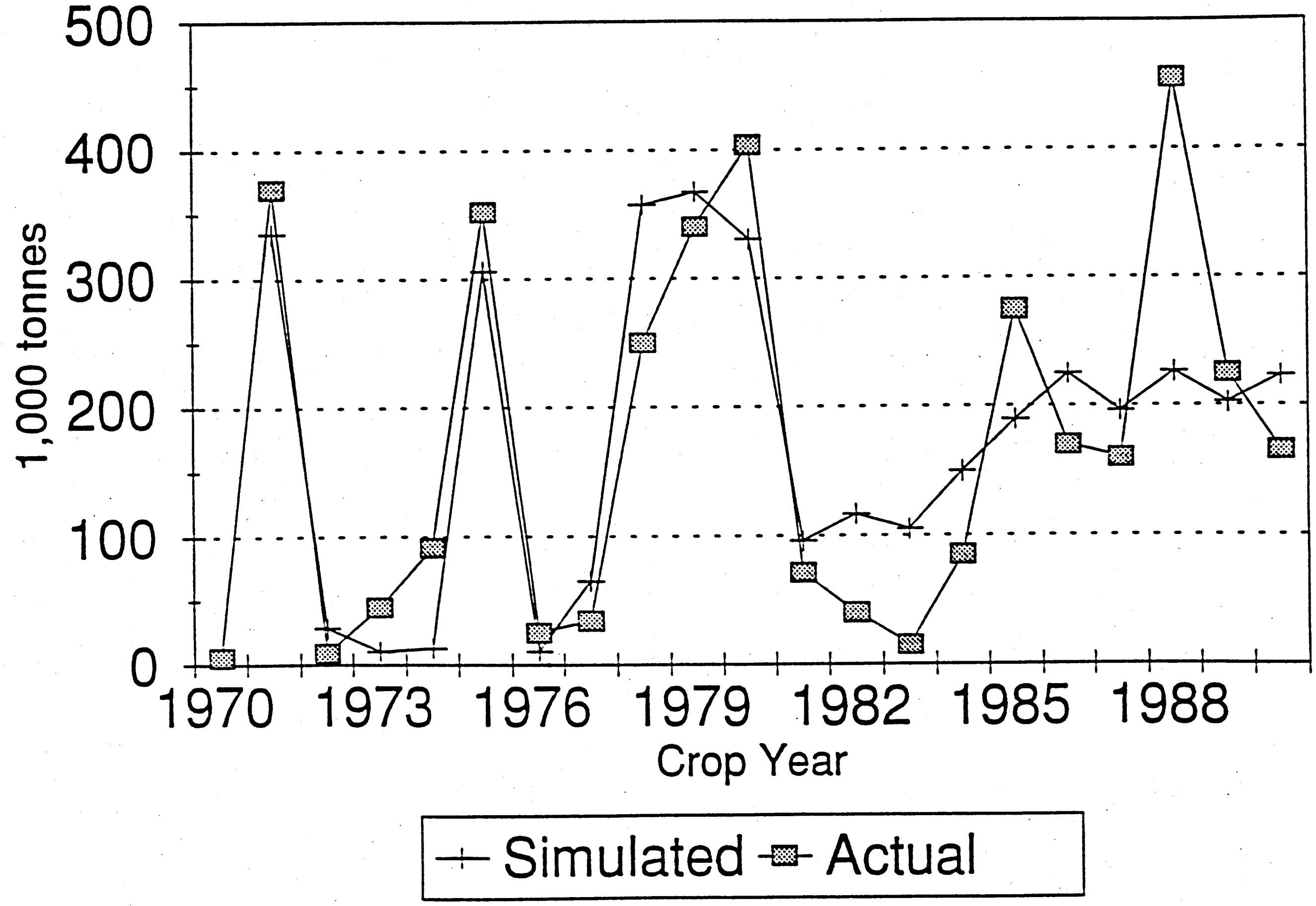


FIGURE 2.13: FARM MARKETINGS OF CANADIAN CANOLA SEED, 1970/71-1990/91

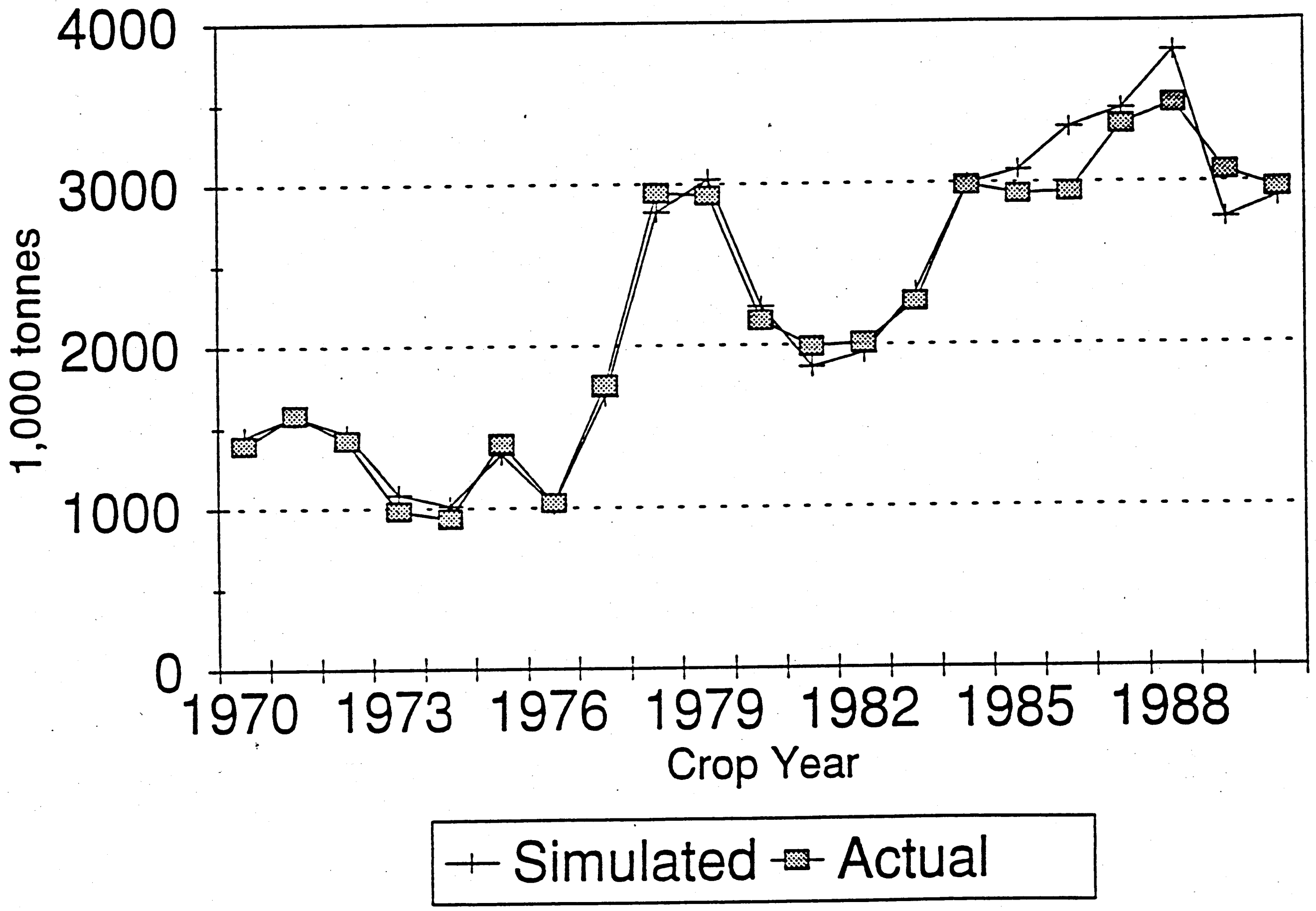


FIGURE 2.14: CANADIAN PRODUCTION OF CANOLA OIL, 1970/71-1990/91

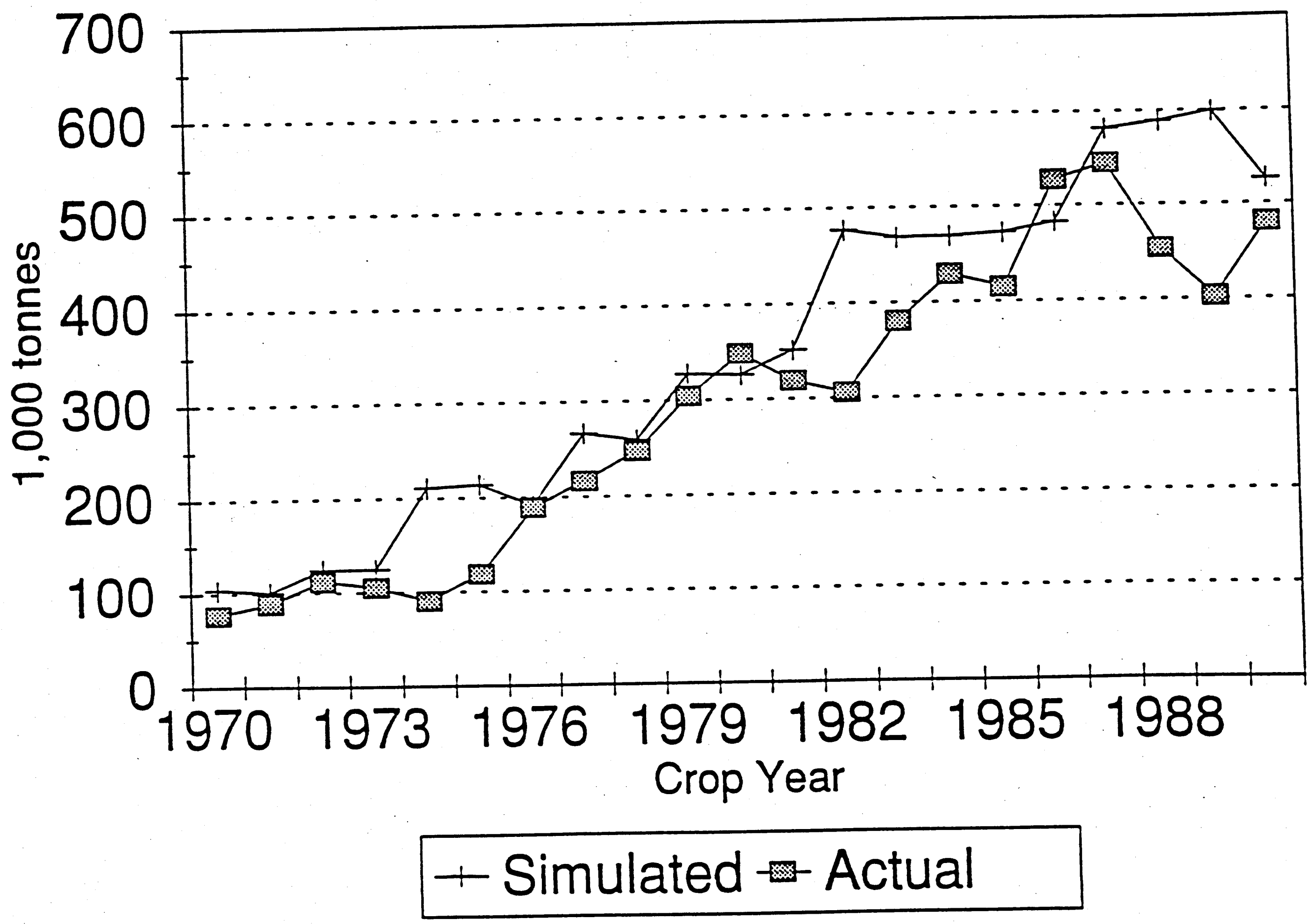


FIGURE 2.15: CANADIAN PRODUCTION OF CANOLA MEAL, 1970/71-1990/91

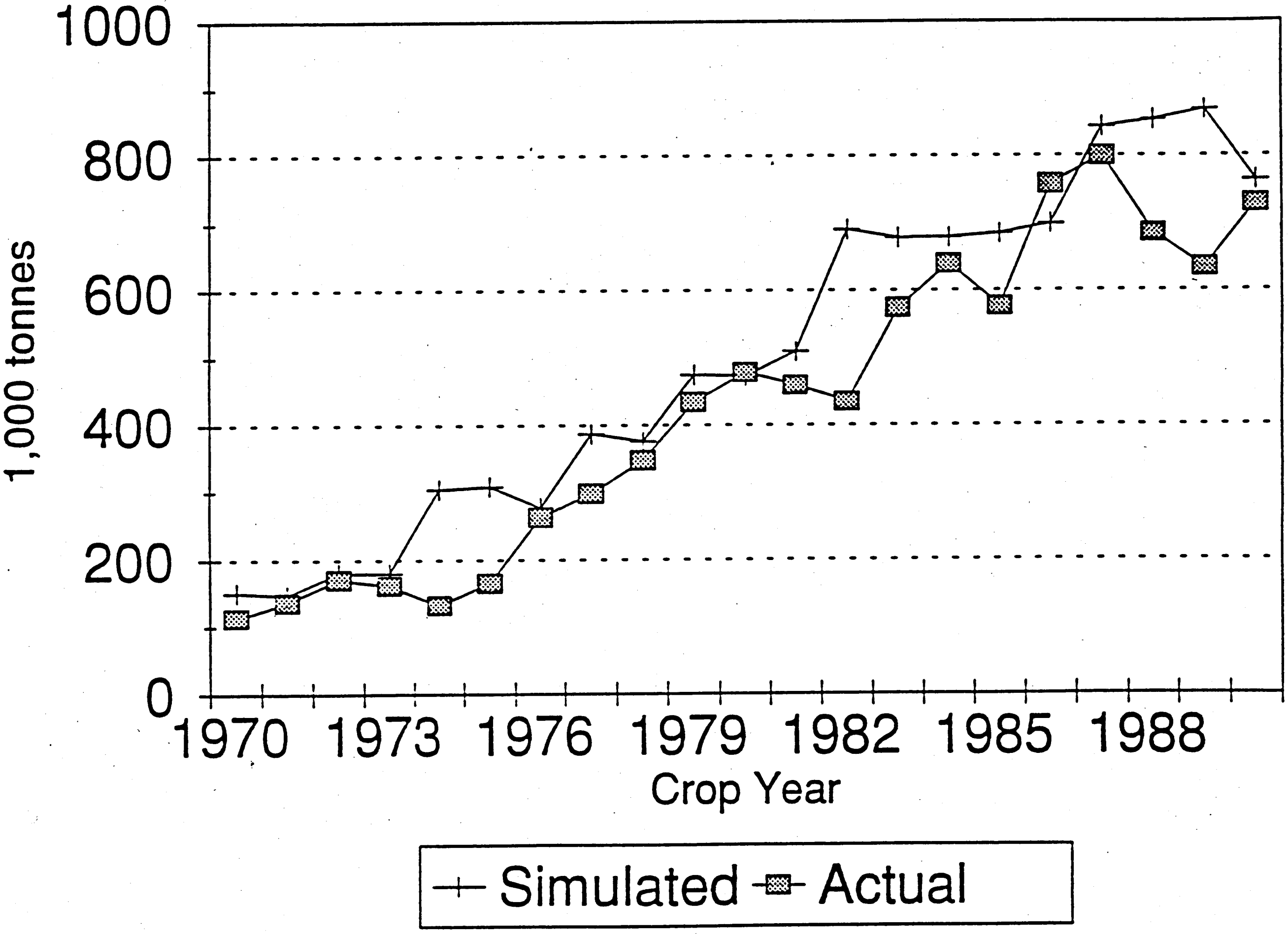


FIGURE 2.16: DOMESTIC DEMAND FOR CANOLA OIL, 1970/71-1990/91

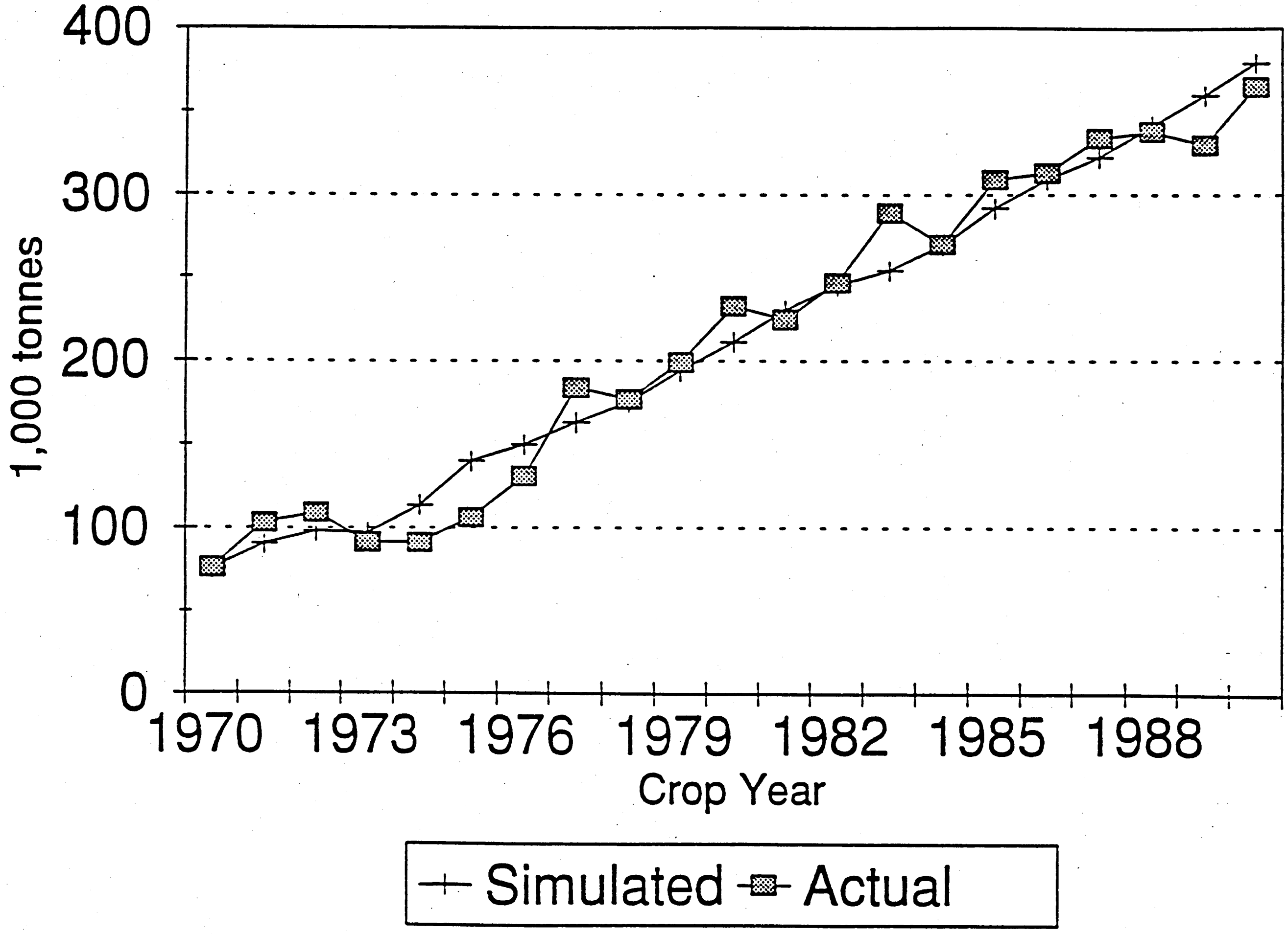


FIGURE 2.17: DOMESTIC DEMAND FOR CANOLA MEAL, 1970/71-1990/91

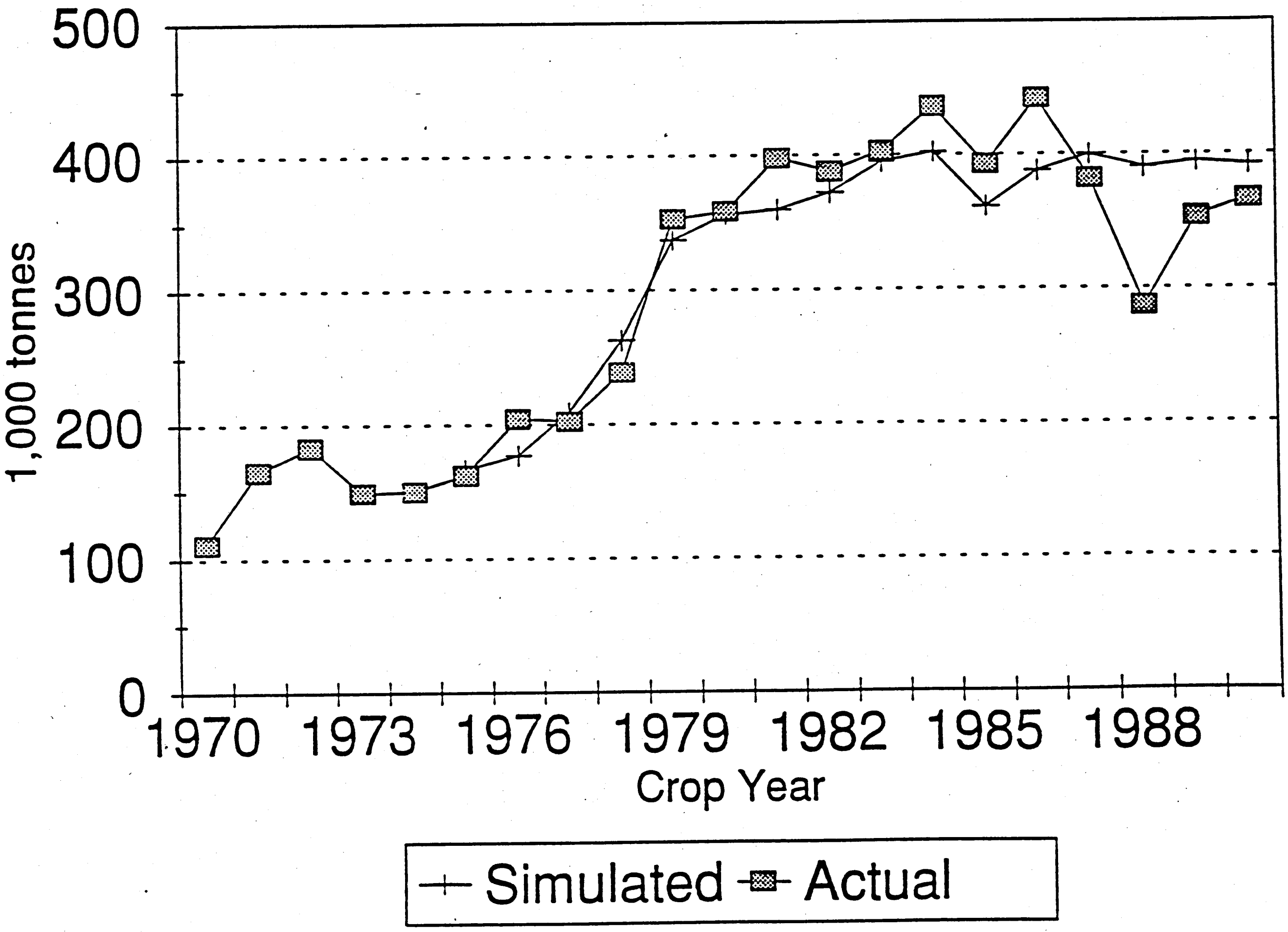


FIGURE 2.18: CANADIAN NET EXPORTS OF CANOLA OIL, 1970/71-1990/91

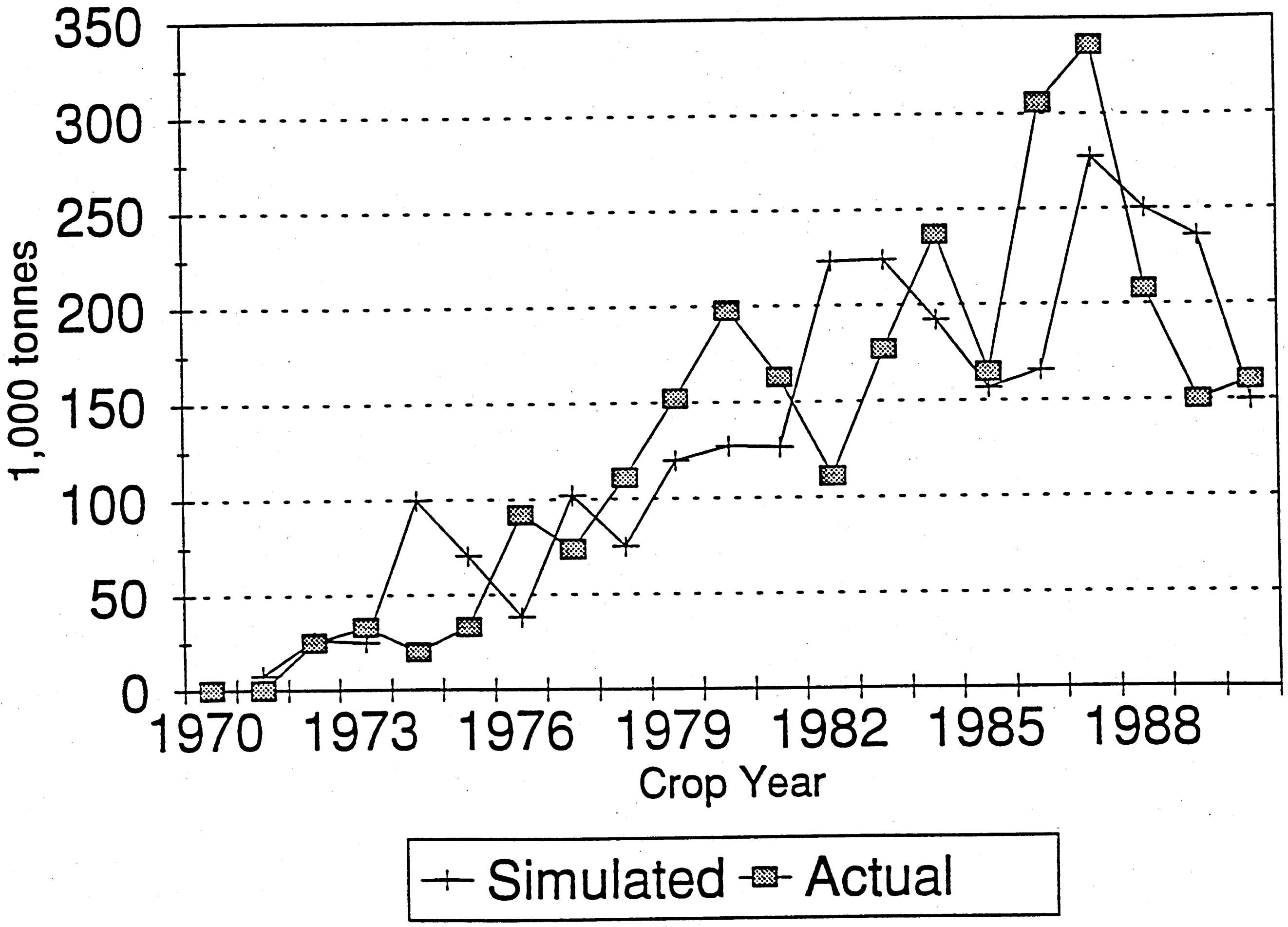
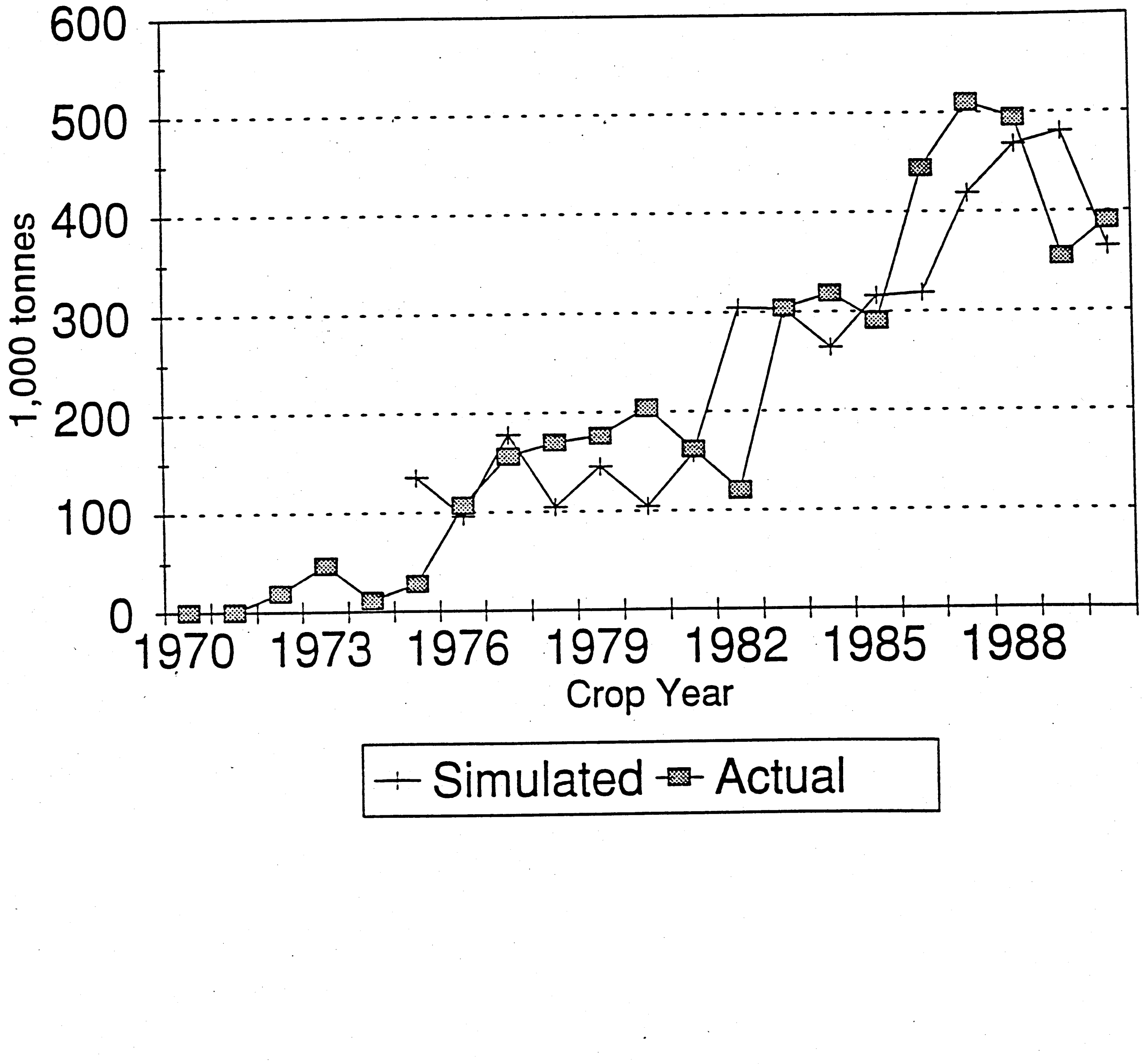


FIGURE 2.19: CANADIAN NET EXPORTS OF CANOLA MEAL, 1970/71-1990/91



2.2.4 Conclusion

The results of the canola model are typical of econometric models of sectors that display a high degree of volatility. Some of the reasons for the difficulties encountered were foreseen but it is useful to construct alternative theoretical models with a different emphasis on various components to develop a fuller understanding of a sector of the economy. The canola sector appears to be driven more by outside forces such as the Japanese demand for canola seed from behind a protective oil tariff wall than from crushing conditions and margins in Canada. The volatility of the Canadian crushing margin and the inelastic demand for canola seed make it a commodity that is likely to continue to experience major price shocks. Weather-related factors can also generate significant supply shocks. Regulatory changes, transportation constraints and quota policy changes also made modeling commercial inventories and farm inventories difficult. The high degree of volatility in these variables proved to be difficult to capture, especially on an annual basis due to the intra year variability (Appendix B).

The model predicts prices of seed, oil and meal and the level of farm marketings with reasonable accuracy and also provides acceptable estimates of total seed exports. These were deemed to be the variables which were of most interest to end users to generate export volumes and values and farm cash receipts.

The multiplier analysis is combined for the total oilseed section in Section 5.

3. FLAXSEED

3.1 Flaxseed Market

Flaxseed, or linseed as it is more commonly known in the world, is crushed to extract the oil and meal (cake). Linoil is primarily regarded as an industrial oil and because of its drying properties has found its major uses in the protective coatings industries including paints and varnishes. Linoil gets its drying properties from its high level of linolenic acid which is a triple bonded molecule that has the ability to undergo polymerization. In the case of paints this leaves a hard film which is impervious to moisture and other corrosives. It has thus been used for both indoor decoration and outdoor protective coatings for woods and other products.

Linmeal and cake are the other joint products from the crushing of seed. It makes up about 63 to 65 percent of the crushing of flaxseed. Linmeal and cake are high in protein meal and thus find their major use as livestock feeds. The percentage of crude protein by weight for the various meals range between 32 to 39 percent (Blahut, 1986, p. 32). This compares to soybeans at 42 to 50 percent. Not all meals are close substitutes because of differences in amino acids, fibre content, certain toxic compounds such as glucosinolates in rapeseed meal, etc. For example, linmeal and cake are low in lysine and thus must have lysine supplement if fed in high proportions. Both have limited use in poultry rations because the presence of vitamin C makes the feed toxic. The material is, however, excellent for sheep, dairy, beef and horses. Linmeal and cake have advantages as a feed supplement in that they contain mucilaginous material that is useful in digestion because it increases water absorption.

Linseed cake, because of its higher oil content, has been used in rations to impart "bloom" to the coat of animals. The disadvantage of cake is that its higher oil content makes it more expensive. It has thus become a specialty feed for certain rations where a higher oil content is desired. As the crushing industry has primarily shifted to solvent extraction there is less and less cake available. It is, however, possible to add oil to the meal if this is desired.

3.1.1 Domestic Production

Flaxseed production makes up a small percentage of Canadian oilseed production. It represented only 17 percent in 1990/91. Whereas canola and soybeans are relatively new crops, flaxseed is a long-established crop in Canada. It was introduced to Western Canada at the time of settlement. Its production has been fairly stable for the past two decades although annual fluctuations can be large. Flax acreage has declined relative to the high levels of the 1968-72 period when wheat stocks on the prairies were large.

Flaxseed is produced predominantly in Western Canada although some has been produced in Ontario and Quebec as late as the 1960s. Area planted to flaxseed is outlined in Table 3.1 by province for the period 1968 to 1991. Most of the crop is produced in Manitoba and Saskatchewan. Alberta had 18 percent of the acreage in 1968/72 but this has declined to 6 percent in 1991. Area planted has been unstable with Saskatchewan being more unstable than Manitoba.

Flaxseed has been traditionally thought of as a cash crop. That is, when returns from wheat had declined or were expected to decline as a result of low prices or low wheat quotas farmers would plant flax as it was a crop that they felt could be more easily marketed. It is also felt that farmers treat flaxseed as a speculative crop. That is, they produce it and store it either on the farm or in the elevator system and market it based on their reading of market price trends. This can affect deliveries and stocks.

TABLE 3.1: CANADA FLAXSEED AREA BY PROVINCE

	Manitoba	Saskatchewan	Alberta	Total
			1000 Hectares	
1968/72	331	347	148	826
1973/77	269	198	65	532
1978/82	356	202	63	621
1983/87	379	239	30	648
1988/89	283	202	16	501
1989/90	283	283	32	598
1990/91	324	344	56	724
1991/92	263	235	32	530

Source: Canada Grains Council; *Statistics Handbook*

3.1.2 Domestic Crush

Only a small percentage of flaxseed is crushed in Canada. There are two basic reasons for this. Until 1983, the Crowsnest freight rates meant that the transportation of flaxseed was subsidized, but not oil or meal. This encouraged the export of flaxseed and discouraged its processing. After 1983 and with the introduction of the WGTA all products benefit from the same rate structure. In addition, foreign tariffs discriminate against the export of linseed oil and meal and thus the crushing of flaxseed in Canada. Japan has an import tariff on linseed oil of 10 percent and 15 percent on linmeal but has no tariffs on the importation of flaxseed. The EC has an 8 percent tariff on the importation on refined linoil, but none on flaxseed and linmeal.

The critical factor affecting the decision to crush flaxseed is the existence of a favourable crush margin. The gross crush margin must exceed variable crushing cost in the short run and total costs in the long run if the firm is specialized in flax crushing. For plants that can crush other oilseeds, flexible crushing plants must find it more profitable to crush flaxseed than other oilseeds to engage in crushing flax.

Blahut (1986) hypothesized that the crush margin for flaxseed is a function of the crushing margin ratio of flaxseed to soybeans, linoil stocks and a trend variable. Jack (1988) in a study based on QP analysis showed that the removal of all tariffs and transportation subsidies would result in increased

Canadian crushings. Crushings were shown to increase from the validated level of 101 thousand tonnes to 419 thousand tonnes. This eliminated the export of seed to the EC and to Japan and resulted in the export of oil and meal to these two regions. The study also examined the effect of Canada imposing an export tax on seed. All tariffs were maintained but the transportation subsidies on Canadian seed were removed. An export tax of $60 per tonne was required in order to eliminate the export of seed and force the processing to occur in Canada. It had the effect of lowering the seed price in Canada by 12 percent. It also lowered the oil and meal prices in Canada--oil by 5.4 percent and meal by 19 percent.

3.1.3 Domestic Demand for Linoil and Linseed Meal

Linoil consumption in Canada is small relative to the total consumption of vegetable oils. Consumption has stabilized at 10,000 to 12,000 tonnes over the period 1987 to 1991(USDA). Because linoil is high in linolenic acid its primary use is as an industrial oil. The quantity of linoil demanded is dependent on the general strength of the economy especially those sectors that utilize paints. Blahut (1986) however did not find any variable that was statistically significant in explaining linoil disappearance in Canada. The major use is in industries that use coatings although there is a small but growing use for linoil as a health food.

Linseed meal makes up a very small proportion of total protein consumption in Canada. This is primarily because of a lack of availability due to limited crushings. Linseed meal utilization ranges between 15,000 to 20,000 tonnes between 1987 and 1991 (USDA). Canada has never imported linseed meal, therefore utilization is dependent on Canadian seed crushings. Irregular supply of linseed meal means that feed manufacturers discount the price of linseed meal relative to other protein meals.

3.1.4 International Trade

Canada is the world's major exporter of flaxseed. Canadian exports of flaxseed have largely gone to the EC and to a lesser extent to Japan. In more recent years with the decline in US flax production, exports to the US have increased. Because of Canada's dominance in the international flaxseed market, it is important to understand the major trends in that market.

Table 3.2 shows the world supply and disposition of flaxseed for the period 1970 to 1991. The major producers are Canada, followed by Argentina and India. Canada and Argentina are major players in the export market, while India tends to use all of its production domestically. In the export market, Canada exports the seed while Argentina exports the products (linoil and linmeal). The differing approaches of Canada and Argentina to the export market reflect different policies at home. As already stated, in Canada (until 1983) the transport of flaxseed moved at a preferred rate relative to the products. On the other hand, Argentina has adopted a policy of promoting the domestic crushing of flaxseed by imposing a tax on the export of the seed.

TABLE 3.2: WORLD FLAXSEED SUPPLY AND DISPOSITION (1000 TONNES)

Year	Area Harvest	Yield	Prod'n	Imports	Exports	Consum'n	Ending Stocks	Feed Seed Use	Food Use	Amount Crushed
1970	7163.00	0.54	3844.00	666.00	685.00	3381.00	1977.00	684.00	30.00	2667.00
1971	5789.00	0.46	2686.00	854.00	763.00	3174.00	1580.00	665.00	33.00	2476.00
1972	5039.00	0.44	2239.00	550.00	819.00	2619.00	931.00	425.00	27.00	2167.00
1973	5565.00	0.43	2368.00	349.00	450.00	2339.00	859.00	493.00	32.00	1814.00
1974	5685.00	0.41	2319.00	335.00	339.00	2257.00	917.00	518.00	36.00	1703.00
1975	5598.00	0.44	2457.00	294.00	277.00	2239.00	1152.00	483.00	38.00	1718.00
1976	5080.00	0.42	2144.00	410.00	429.00	2598.00	679.00	478.00	26.00	2094.00
1977	5817.00	0.51	2953.00	633.00	558.00	2882.00	825.00	595.00	33.00	2254.00
1978	5486.00	0.45	2467.00	566.00	582.00	2619.00	657.00	548.00	34.00	2037.00
1979	5576.00	0.48	2687.00	552.00	574.00	2501.00	821.00	477.00	17.00	2007.00
1980	4865.00	0.43	2096.00	566.00	610.00	2267.00	606.00	369.00	27.00	1871.00
1981	4621.00	0.45	2078.00	477.00	485.00	2225.00	451.00	367.00	32.00	1826.00
1982	4618.00	0.54	2501.00	557.00	509.00	2336.00	664.00	376.00	26.00	1934.00
1983	4377.00	0.49	2139.00	594.00	681.00	2393.00	323.00	398.00	30.00	1965.00
1984	4491.00	0.52	2316.00	626.00	613.00	2440.00	212.00	468.00	29.00	1943.00
1985	4491.00	0.52	2350.00	755.00	672.00	2280.00	365.00	431.00	34.00	1815.00
1986	4254.00	0.62	2658.00	797.00	787.00	2425.00	608.00	525.00	30.00	1870.00
1987	3985.00	0.57	2270.00	637.00	692.00	2305.00	518.00	492.00	35.00	1778.00
1988	3696.00	0.45	1674.00	522.00	521.00	1961.00	232.00	407.00	33.00	1521.00
1989	3740.00	0.50	1853.00	640.00	524.00	2123.00	78.00	463.00	31.00	1629.00
1990	3760.00	0.61	2295.00	535.00	486.00	2022.00	400.00	452.00	35.00	1535.00
1991	3379.00	0.60	2016.00	577.00	678.00	2002.00	313.00	479.00	40.00	1483.00

Source: United States Department of Agriculture Foreign Agriculture Service, Production, Supply and Distribution Data Base

The location of crushing activity has tremendous importance for what regions and countries capture the value-added from the processing of flaxseed and the manufacturing of products that utilize linoil and linmeal. Argentina is the major crusher with 28 percent of the world's crushing activity. India is the next most important, accounting for 20 percent of the world's crush. However, India has tended to be self-sufficient; crushing its own seed and not importing very much seed, oil or meal. The EC-12 is the next most important with about 16 percent of the world's crush. Except for the 1970s when there was a shortage of flaxseed, the EC's crushing activity has remained relatively constant. The US is also a significant crusher of flaxseed accounting for 14 percent of the world's crush. However, this is down considerably from the early 1960s when the US share was closer to 20 percent. By contrast to these countries, Canada crushes only 2 percent of the world's flaxseed.

Another important factor affecting the location of crushing has been the changes in methods by which flaxseed is crushed. There are two major approaches: the expeller method which is the oldest and simplest method and the solvent extraction method. With the expeller method, flaxseed is squeezed under pressure to force the oil from the seed. The method is unable to remove all the oil and what remains is "cake" that has between 5 and 7 percent oil content. With the solvent method, after the seed is crushed, hexane is added to remove most of the remaining oil. What remains is a "meal" that has only about 1 percent oil. The expeller method has been almost universally replaced by the solvent method in at least Europe and North America. The first plants that were built to crush flax used expeller technology and did not have the flexibility to crush rapeseed, soybeans or other oilseed crops. Therefore, as long as the plants could cover the variable costs they crushed flaxseed. The solvent extraction plants are newer and larger and since the plant lines that crush flaxseed can generally crush rapeseed or sunflower seed and certain other crops the decision of what to crush is made on the basis of maximizing profits. The relative crush margins to crushing costs determines whether flaxseed or an alternative oilseed gets crushed.

Table 3.2 shows that world flaxseed consumption has been steadily declining over the years beginning in 1970 reaching 2.0 million tonnes in 1991. This is a decline of about 40 percent in this 22 year period. It can be explained as follows. In recent years linoil-based paints have been replaced largely by water-based paints for reasons of cost and ease of application. Linoil-based paints also have the disadvantage that they tend to yellow when they dry and thus oxidize. This is not a problem for darker colored pigmented paints but for the lighter pastel colors that have been more popular in the last 20 years it has meant that paint manufacturers have tended to move away from linoils. Where an oil-based paint is still desired paint manufacturers have tended to substitute other oils with lower linolenic acid levels. The main substitute has been soyoil which has a linolenic acid level of about 10 percent. It does not dry as fast but with the use of catalysts, soyoil has become an important substitute. The main advantage is that because of its lower linolenic acid and hence iodine value it does not yellow. Linoil is also used in the ink industry again because of its drying properties. Before the development of sealed windows, which have largely replaced wood-casement windows, linoil was used to make putty to seal the glass to the wood. The last major use of linoil was for the manufacture of linoleum. In the past this was widely used as a floor covering. But with the invention of plastics, linoleum has been replaced mainly by vinyls and polyesters. The development of synthetic flooring has led to the closure of all of the plants that manufactured linoleum in North America. Three plants survive in Europe which supply all the linoleum used in North America. One mitigating factor for linoleum in the flooring market is its appeal as an "environmentally-friendly product". As a completely natural product it is completely biodegradable. In summary, the world-wide demand for linoil for all uses has been declining over the last 20 years (see Table 3.3). It has resulted in the relative decline in the flaxseed industry world-wide. The largest single user of linoil is the European Community which accounts for about one-quarter of world consumption.

However, EC consumption has dropped from around 300 thousand tonnes in the early 1960s to around 100 thousand tonnes today. Use in the United States has similarly declined. It reflects what was explained earlier about how linoil has been "crowded out" of most of its traditional markets and thus uses in Europe and North America. The exports of linoil are dominated by Argentina. However, its share has declined from about 75 percent in 1960 to about 60 percent today. The imports of linoil are dominated by the ex-USSR which has increased its imports of the oil as a replacement for its reduced crushings. As a group, the countries belonging to the EC import more than the ex-USSR. However, in recent years, exports from the EC have almost matched imports so that net imports are quite small. The world supply and disposition table for linmeal is contained in Table 3.4. It shows that meal production has declined from 1.7 million tonnes in 1970 to 950 thousand tonnes in 1991.

TABLE 3.3: WORLD LINOIL SUPPLY AND DISPOSITION (1,000 TONNES)

Year	Oilseeds	Extract'n Date	Prod'n	Imports	Exports	Consum'n	Ending Stocks	Feed Seed	Food Use	Industrial
1970	2667.00	0.35	939.00	262.00	261.00	875.00	179.00	0.00	66.00	809.00
1971	2476.00	0.35	856.00	260.00	233.00	886.00	176.00	0.00	73.00	813.00
1972	2167.00	0.34	733.00	272.00	306.00	783.00	92.00	0.00	59.00	724.00
1973	1814.00	0.34	621.00	195.00	234.00	614.00	60.00	0.00	59.00	555.00
1974	1703.00	0.34	581.00	179.00	231.00	524.00	65.00	0.00	58.00	466.00
1975	1718.00	0.34	587.00	206.00	227.00	563.00	68.00	0.00	56.00	507.00
1976	2094.00	0.34	722.00	240.00	318.00	626.00	86.00	0.00	73.00	553.00
1977	2254.00	0.35	798.00	309.00	360.00	765.00	68.00	0.00	77.00	688.00
1978	2037.00	0.35	721.00	268.00	303.00	704.00	50.00	0.00	49.00	655.00
1979	2007.00	0.35	696.00	299.00	361.00	638.00	46.00	0.00	33.00	605.00
1980	1871.00	0.35	659.00	281.00	287.00	656.00	43.00	0.00	38.00	618.00
1981	1826.00	0.33	601.00	229.00	251.00	580.00	42.00	0.00	44.00	536.00
1982	1934.00	0.33	646.00	243.00	296.00	589.00	46.00	1.00	35.00	553.00
1983	1965.00	0.34	671.00	255.00	302.00	624.00	46.00	1.00	40.00	583.00
1984	1943.00	0.33	642.00	211.00	251.00	622.00	26.00	1.00	46.00	575.00
1985	1815.00	0.33	608.00	201.00	231.00	566.00	38.00	2.00	68.00	496.00
1986	1858.00	0.34	640.00	267.00	293.00	607.00	45.00	1.00	51.00	555.00
1987	1778.00	0.35	615.00	220.00	222.00	624.00	34.00	0.00	79.00	545.00
1988	1518.00	0.34	517.00	200.00	173.00	541.00	37.00	0.00	77.00	464.00
1989	1621.00	0.34	559.00	187.00	216.00	531.00	36.00	0.00	70.00	461.00
1990	1519.00	0.34	513.00	220.00	197.00	532.00	40.00	0.00	66.00	466.00
1991	1480.00	0.34	510.00	191.00	178.00	523.00	40.00	0.00	58.00	465.00

Source: United States Department of Agriculture Foreign Agriculture Service, Production, Supply and Distribution Data Base

TABLE 3.4: WORLD LINMEAL SUPPLY AND DISPOSITION (1'000 TONNES)

Year	Oilseeds	Cr Extrac'n	Prod'n	Imports	Exports	Consum'n	Ending Stock	Seed Feed	Industrial
1970	2688.00	0.63	1694.00	780.00	588.00	1814.00	168.00	1814.00	0.00
1971	2496.00	0.64	1588.00	544.00	427.00	1700.00	173.00	1700.00	0.00
1972	2174.00	0.63	1379.00	518.00	522.00	1380.00	168.00	1380.00	0.00
1973	1825.00	0.65	1179.00	467.00	405.00	1264.00	145.00	1264.00	0.00
1974	1715.00	0.65	1118.00	525.00	479.00	1157.00	152.00	1157.00	0.00
1975	1718.00	0.65	1121.00	638.00	588.00	1171.00	152.00	1171.00	0.00
1976	2094.00	0.64	1348.00	650.00	637.00	1359.00	154.00	1359.00	0.00
1977	2254.00	0.64	1452.00	773.00	723.00	1508.00	148.00	1508.00	0.00
1978	2037.00	0.64	1313.00	686.00	673.00	1405.00	69.00	1405.00	0.00
1979	2007.00	0.64	1287.00	722.00	778.00	1238.00	62.00	1238.00	0.00
1980	1871.00	0.65	1214.00	639.00	638.00	1254.00	23.00	1254.00	0.00
1981	1826.00	0.64	1167.00	583.00	625.00	1123.00	25.00	1123.00	0.00
1982	1934.00	0.64	1245.00	663.00	695.00	1201.00	37.00	1201.00	0.00
1983	1965.00	0.65	1275.00	672.00	710.00	1241.00	33.00	1241.00	0.00
1984	1943.00	0.64	1240.00	632.00	622.00	1258.00	25.00	1258.00	0.00
1985	1815.00	0.64	1160.00	597.00	515.00	1230.00	37.00	1230.00	0.00
1986	1873.00	0.64	1192.00	661.00	601.00	1263.00	26.00	1263.00	0.00
1987	1780.00	0.63	1127.00	670.00	546.00	1261.00	16.00	1261.00	0.00
1988	1518.00	0.63	963.00	531.00	471.00	1020.00	19.00	1016.00	4.00
1989	1622.00	0.64	1044.00	596.00	506.00	1132.00	21.00	1128.00	4.00
1990	1528.00	0.64	976.00	613.00	486.00	1107.00	17.00	1103.00	4.00
1991	1481.00	0.64	950.00	610.00	430.00	1133.00	14.00	1129.00	4.00

Source: United States Department of Agriculture Foreign Agriculture Service, Production, Supply and Distribution Data Base.

Consumption has not declined to the same extent as stocks have been lower. Consumption was 1.1 million tonnes in 1991 compared to 1.8 million tonnes in 1970. As in the case of linoil, trade has remained fairly constant at approximately 600 thousand tonnes. The ratio of imports to production is high at 64 percent. It was only 46 percent in 1970. This has resulted from the changes that have taken place in the location of the world's crush. World linmeal exports are dominated by Argentina with a market share of around 55 percent. Canada's export share is around 2 percent. The US has been the other major exporter. All of these exporters have experienced a declining share of world exports over the past two decades. The dominant importer has been the EC. In 1968-1972 it had 85 percent of world imports. This declined to about 70 percent in 1988/91.

3.1.5 Price Determination

The price of flaxseed and that of linoil are closely entwined. Rotterdam is the main price setting market for linoil and Winnipeg with its cash and futures market is the main price-setting market for flaxseed. With declining flaxseed production in the United States, the Minneapolis cash market for flaxseed is likely of declining importance. Since soybean oil can be substituted for linoil in certain uses the price of soybean oil in the more dominant soybean complex affords an influence over linoil. However, the price of linoil can deviate widely from the price of soybean oil. On the other hand, the price of linseed meal follows the price of other meals more closely.

The supply of flaxseed, linoil and linmeal in the major importing and exporting regions, is felt to strongly influence the price of flaxseed. These countries and regions are: Canada, the world's major flaxseed exporter; Argentina, a major flaxseed producer and exporter of linoil and meal; EC, a major user of linoil and linmeal and importer of flaxseed; and, the United States as historically a major producer of flaxseed and user of linoil and linmeal. As a result, the price of flaxseed is felt to be largely determined by the production of flaxseed in Argentina, the United States and the EC-12 as well as the exports of Canadian flaxseed.

This is only one of a number of alternative ways to specify the price determining relationship for flaxseed. DeBlock (1985) has hypothesized that the EC-12 price of flaxseed determines the Canadian price which in turn determines the US and Japanese prices. Another alternative would be to first determine the linoil price in the EC (Rotterdam) based on the price of soybean oil and production of flaxseed variabilities and then derive the price of flaxseed as a fraction of the linseed and price. A similar model was estimated which included the price of soybean oil, Canadian flaxseed production and the per capita disposable income in the EC-12. This model yielded an R^2 of 0.51.

In the final analysis, it was felt that to specify the Canadian cash price of flaxseed was more defensible.

It should be pointed out that 1973 was found to be a pivotal year in the international market for flaxseed and in particular linoil. It was in that year that the linoil price rose dramatically in comparison to soybean oil and resulted in a permanent shift of many traditional linseed oil users to soybean oil (see deBlock, 1985).

3.2 Flaxseed Model

The Canadian flaxseed market consists of three components: flaxseed, linoil and linmeal. Canada is by far the largest exporter of flaxseed in the world accounting for over 80 percent of all exports. However, it is an insignificant producer and exporter of linoil and linmeal. It crushes flaxseed primarily for domestic consumption of meal and oil which utilize approximately 80 percent and 70 percent of production respectively. As a result domestic crush takes a very small percentage of Canadian flaxseed production. Flaxseed crushing is not a continuous activity of many of the crushing plants in Canada. Therefore, it is difficult to correctly model and estimate Canadian crushing activity, especially using an annual model.

3.2.1 Conceptual Model

The first model that was specified in the study had the world price of flaxseed determined endogenously in the Canadian seed market. In this original model production plus beginning stocks were treated as given. The demands for domestic crush, stocks and exports were assumed to be price-responsive. Hence equilibrium values for these demand categories were to be determined simultaneously with world price.

In this original model, crush demand was to be derived from the demand for the oil and meal less the gross crush margin. The gross crush margin was assumed to be positively related to the quantity crushed. The product prices for oil and meal were assumed to be exogenous as Canada is an insignificant player in the world markets for these products. The quantity of oil and meal supplied was seen to be predetermined by the quantity of seed crushed. These were assumed to be price-responsive domestic demands for the oil and the meal. Exports of the oil and the meal were to be specified as residuals (domestic production less domestic consumption) in the model.

This model was estimated with mixed results. The crush demand for flaxseed in Canada did not perform well. Independent variables had wrong signs, or were insignificant. As a result crush had to be treated exogenously. The equations for the domestic demands for linoil and meal had corrected R^2s of 0.34 and 0.44 respectively.

As a result the model did not simulate well. Of the 16 equations simulated four had PMSEs of over 1.0 and 9 had Theil Us over 1.0. This created, in particular, a problem for anyone wanting to use the model for forecasting purposes. For example the model forecast a price for Canadian flaxseed of over $1000 per tonne for 1990 when the actual price was closer to $220 per tonne. The simulated forecasts for oil and meal production, domestic demand and exports were not accurate.

It was generally agreed by the project team and Agricultural Canada economists who were involved in evaluating the model results that a different specification was required. It was accepted that because there was so little flaxseed crushed in Canada that it would not likely be possible to expect an econometric model to accurately predict linoil and linmeal quantity variables for Canada. For these reasons it was decided by mutual agreement to drop the Canadian linoil and linmeal components from the flaxseed model.

Because the EC is the major user of linoil and meal it was decided to develop a model that would determine flaxseed price endogenously in the EC. A simplified model was specified and estimated. Unfortunately it did not perform any better than the previous model.

One of the characteristics of the international flaxseed-oil-meal complex is the dominant effect of the Canadian flaxseed market. It is recognized however that the major price determining market for linoil is Rotterdam, hence the importance of the EC in the world flaxseed-oil-meal complex. In particular it is reasonable to suppose that the Canadian flaxseed market could have an influence on the international linoil market and hence on the world price of linoil. However, with a declining use of linoil in the EC, the importance of Rotterdam in determining world linoil price and flaxseed is likely on the decline. As stated previously in Section 3.1.5, one approach is to directly determine the price of Canadian flaxseed from largely supply side variables, that is, the production of flaxseed in the countries and regions that mainly trade and utilize flaxseed, linoil and meal.

The Canadian flaxseed market is unlikely to have a significant influence on the international linmeal market because this product is highly substitutable with other oilseed meals. For this reason the model focused on the flaxseed and linoil relationships and thus did not attempt to specify a linmeal price equation.

Since the USDA has discontinued collecting and reporting world and country flaxseed data, this will create some problems for the future use of the model. The only other main source of international data is Oil World. The problem is that for some of the data, USDA data and Oil World data are different.

It is important for estimating econometric models that there be identities that balance, that is, country and regional data must be reconciled. It is felt that the USDA data is superior in this regard.

The decision taken at Agriculture Canada on March 19, 1993 was that although it was important to have a model that met performance criteria for both forecasting and policy purposes, policy would take precedence. Based on the assumption that the underlying parameters of the model would only be as good as the data used to estimate the model, the decision was made to estimate the flaxseed model with the USDA-PSD data.*

In future, where USDA-PSD data are no longer available, the procedure that is recommended is to generate the required data from a coefficient that relates the USDA-PSD data to Oil World data. That is, a regression would be run of the historical USDA-PSD and Oil World data to determine the regression coefficient.

In the model that has been estimated for the study, Canadian crush has been included as one of the endogenous variables. Statistics Canada, for reasons of confidentiality, no longer reports Canadian crush volume and neither does Oil World. The USDA did provide an estimate of Canadian crush. In future, the model will be able to provide forecasts of the crush levels, that is simulated levels of the Canadian crush.

After eliminating linoil and linmeal, what remains is a simplified flaxseed model. A conceptual model is given in Figure 3.1. In the final analysis, what has been specified is a seven equation flaxseed model. In this model, the price of flaxseed and Canadian exports of flaxseed are simultaneously determined. The model treats demand for feed, seed and waste as a proportion of total seed supplies and it is not responsive to price. However, crush, commercial stocks (inventories) are treated as demands being responsive to price. The data sources and statistical procedures used in the study are contained in Appendix A.

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* USDA-PSD data refer to United States Department of Agriculture, Foreign Agriculture Service, Production, Supply and Distribution database.

FIGURE 3.1: CONCEPTUAL FLAXSEED MODEL

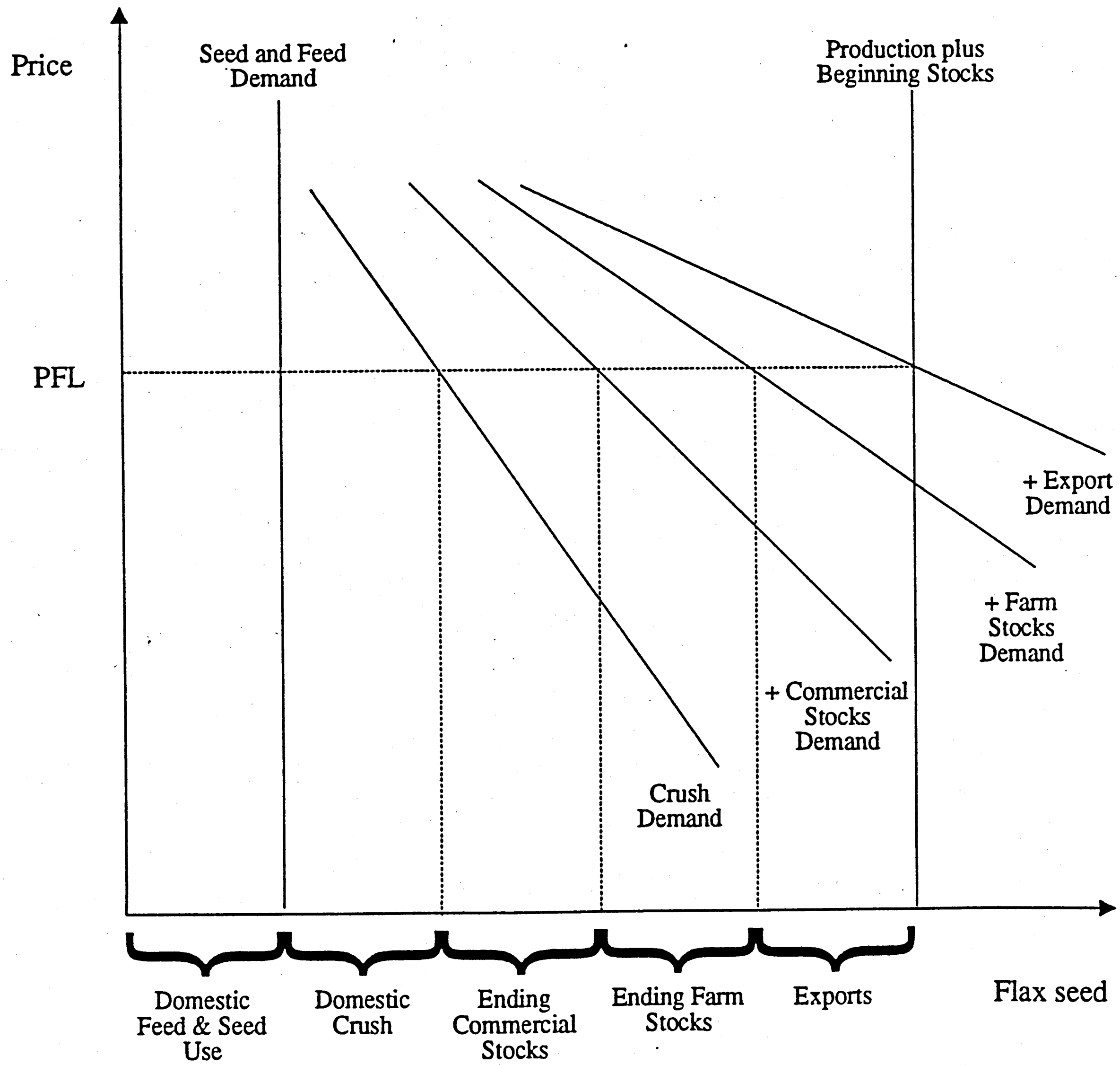

TABLE 3.5: MODEL IN EQUATIONS FORM

PFL = f_1 (PSO, EXFL, ROWSUP)	(3.1)
CSFL = f_2 (PFLD, LOGT)	(3.2)
DFFL = f_3 (QFL)	(3.3)
FIFL = f_4 ($PFLD^{-1}$, QFL)	(3.4)
CIFL = f5 (PFLD, QFL)	(3.5)
FMFL = QFL + $FIFL_{t-1}$ - FIFL - DFFL	(3.6)
EXFL = FMFL + $CIFL_{t-1}$ - CIFL - CSFL	(3.7)

Endogenous Variables:

EXFL	= exports of flaxseed, Canada
DFFL	= seed, feed and waste, Canada
PFL	= price of flaxseed, Thunder Bay
FIFL	= farm flaxseed inventories, Canada
CSFL	= flaxseed crush, Canada
CIFL	= commercial flaxseed inventories, Canada
FMFL	= farm marketings, Canada

Exogenous Variables:

PSL	= price of soyoil, Decatur in Canadian dollars
QFL	= production of flaxseed, Canada
ROWSUP	= production and lagged inventories of flaxseed in Argentina, EC-12 and United States
PSO	= price of soybeans, Canada
LOGT	= log of time trend
CPI	= Consumer Price Index (Canada) (Deflator for PFLO)

3.2.2 Estimated Equations

The flaxseed model is estimated in a similar manner as the soybean and canola models. As indicated earlier, the price of soybeans in Canada is determined by the supply and demand balance in the rest of the world which is strongly influenced from the US market. The canola model was specified in a similar manner. This structure made sense given the high correlations between the Canadian and US soybean, oil and meal prices and between canola seed, oil and meal with similar soybean prices. The flaxseed market is less dependent upon the soybean market partly because edible vegetable oils are not close substitutes for linoil and vice versa. The correlation of flaxseed and linoil prices with soybean and soyoil prices are only in the 70 percent range. See Table 3.6 for the matrix of oilseed complex price relationships. By contrast, linmeal is more readily substitutable with soy or canola meal. The correlation coefficient for PFLM and PSM is 0.92.

The price of flaxseed is determined largely by the availability, hence production of flaxseed in major producing and trading countries and regions. There is also influence from the world soybean market. Although soybean oil is not as close a substitute for linoil as it is for canola and other vegetable oils, certain users of linoil have been able to use soybean oil for industrial purposes especially when linoil prices were very high relative to soybean oil. It is thus necessary to include the price of soybeans in the flaxseed price equation and to include those variables that can create a price wedge between linoil and soybean oil. These variables would include the production of flaxseed and flaxseed inventories. Since the inventories of linoil in the EC tend to be only pipeline stocks this variable was not significant and was dropped from the estimated equation.

TABLE 3.6: PRICE CORRELATION MATRIX FOR CANADIAN OILSEEDS, OILS AND MEALS

PSL	1.000								
PSM	0.512	1.000							
PSO	0.777	0.896	1.000						
PRL	0.936	0.409	0.698	1.000					
PRM	0.515	0.879	0.882	0.448	1.000				
PRA	0.913	0.664	0.881	0.895	0.705	1.000			
PFLL	0.676	0.674	0.704	0.627	0.566	0.785	1.000		
PFLM	0.580	0.921	0.916	0.541	0.910	0.772	0.669	1.000	
PFL	0.733	0.595	0.752	0.735	0.578	0.815	0.717	0.737	1.000
	PSL	PSM	PSO	PRL	PRM	PRA	PFLL	PFLM	PFL

Source: Estimated

$$PFL = 278.72 + 0.8246\ PSO - 0.2091\ EXFL - 0.08221\ ROWSUP \quad (3.1)$$

(2.1354)*	(2.5215)	(-2.0903)	(-1.6140)
	(0.6869)**	(-0.3332)	(-0.2923)

$R^{2***} = 0.558$ RHO = 0.190

The cash price of flaxseed in Canada was specified as a function of the Canadian price of soybeans, the Canadian exports of flaxseed, and a composite variable of the production of flaxseed and lagged inventories in EC-12, the United States, and Argentina.

The price of soybeans had the expected sign and was significant. The elasticity was quite high at 0.69 indicating that changes in soybean prices have a marked impact on the Canadian price of flaxseed. It is similar to the 0.752 value between PFL and PSO shown in Table 3.6, the price correlation matrix for Canadian oilseeds. Canadian exports had the expected negative sign and was also significant. The elasticity of -0.333 percent indicates that the level of Canadian exports can have quite an impact on price. Since exports are largely a function of Canadian flaxseed production, changes in production can influence price. This implies that Canada fits the large country case.

The production and Canadian inventories variable, ROWSUP, was not significant but had the expected sign. An elasticity of -0.29 indicated the expected negative influence of higher stock levels on price.

The equation was corrected for autocorrelation using the Cochrane-Orcutt procedure. The procedure converged after 6 iterations to an L.L.F of -105.431 at RHO = 0.190.

The crush equation for Canadian flaxseed is specified to be a function of price of flaxseed (deflated) and the logarithmic value of time. This function was difficult to specify because of the low level and erratic nature of crush in Canada. Although it could be argued that it should be treated as a residual, it was felt that it was more important to estimate exports as a residual.

$$CSFL = 110.23 - 5.5127\ PFLD - 20.225\ LOGT \quad (3.2)$$

(8.4083)	(-4.5686)	(-4.8466)
	(-0.6406)	(-1.1707)

$R^2 = 0.650$ RHO = 0.252

* The first row of brackets are the t-statistics.
** The second row of brackets are elasticities calculated at the mean.
*** The R^2 in the study are corrected R^2s.

The deflated flaxseed price variable performed better than an earlier specification which used the crush margin. It was significant with an elasticity of -0.64. This suggests that quantity of flaxseed crushed is responsive to price. The trend variable was also significant with an elasticity of -1.17.

The equation was corrected for autocorrelation. The procedure converged after 4 iterations to an L.L.F of -69.834 at RHO = 0.252.

Feed, seed and waste is not very stable for flaxseed. It is questionable whether it should have been treated endogenously or exogenously. The decision was made to include it in the model and it was specified to be a function of production.

$$\begin{aligned} DFFL = {} & \underset{(4.6375)}{62.637} + \underset{\substack{(4.5653) \\ (0.4300)}}{0.07443}\ QFL \end{aligned} \tag{3.3}$$

$R^2 = 0.680 \quad RHO = 0.049 \quad D.W. = 2.062$

The production variable was significant with an elasticity of 0.43. One would hypothesize that the elasticity would have been closer to one.

The equation was corrected for autocorrelation using the standard Cochrane-Orcutt procedure. It converged after 7 iterations to an L.L.F = - 89.406 at RHO = 0.5338.

Farm inventories were specified to be a function of the reciprocal of price (deflated) and Canadian flaxseed production.

$$FIFL = \underset{(-1.6527)}{-54.324} + \underset{\substack{(1.3216) \\ (-0.410)^*}}{156.91}\ PFLD^{-1} + \underset{\substack{(3.7612) \\ (1.1609)}}{0.1575}\ QFL \tag{3.4}$$

$R^2 = 0.622 \quad RHO = 0.542$

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* The elasticity was estimated as follows: $E = \dfrac{-156.91}{4.4899 * 84.568} = -0.410$

In order to prevent inventories from becoming negative, the price variable was specified as a reciprocal. Flaxseed price was deflated by Canadian CPI. The variable had the correct sign but was not significant. The calculated elasticity was -0.410. Production was significant with an elasticity of 1.161 which is close to an expected elasticity of one.

The equation was corrected for autocorrelation. The procedure converged after 11 iterations to an L.L.F = -104.179 at RHO = 0.542.

The commercial inventories of flaxseed in Canada, CIFL, were specified to be a function of price of flaxseed (deflated) and flaxseed production. Both variables had the correct signs and the production of flaxseed was significant but the deflated price was not.

$$
\begin{array}{llll}
CIFL = & 66.484 & - 15.632\ PFLD & + 0.3319\ QFL \\
 & (0.6191) & (-1.4013) & (5.0532) \\
 & & (-0.2941) & (0.8670) \\
 & R^2 = 0.502 & & RHO = 0.826
\end{array}
\qquad (3.5)
$$

The level of year-end inventories is a blend of institutional and economic factors that are not easily modelled. The elasticity -0.294 suggests that inventories are somewhat responsive to price. The elasticity of 0.867 for the production of flaxseed is close to the expected value of one.

The equation was corrected for autocorrelation. The procedure converged after 9 iterations to an L.L.F = -118.891 at an RHO 0.826.

$$FMFL = QFL + FIFL_{t-1} - FIFL - DFFL \qquad (3.6)$$

Equation 3.6 equates farm marketings to production plus beginning inventories minus ending farm inventories minus seed, feed and waste. This is the farm-level supply disposition identity.

$$EXFL = FMFL + CIFL_{t-1} - CIFL - CSFL \qquad (3.7)$$

Equation 3.7 equates flaxseed exports to farm marketings plus beginning commercial inventories less ending commercial inventories less crush. Farm marketings are determined in the farm level identity.

3.2.3 Model Simulation

The model was evaluated by simulating the dependent variables over the data period. The dependent variable is simulated by using the estimated coefficients on the independent variables and the actual independent variable values. As with canola simulation, the predicted mean squared error PMSE and Thiel U were used to measure how well the estimated model was able to simulate the dependent variables.

Each of the simulated variables are illustrated. The price variable PFL is shown in Figure 3.2. The price predicted reasonably well. The PMSE is 0.1622 and Theil U2 is 0.3069. The forecast statistics for the flaxseed model are outlined in Table 3.7. Using 1.0 as a generally acceptable level, the majority of the variables based on the PMSE Statistics meet the standard. Only those variables that are estimated from inventory equations have PMSE greater than 1.0. It is understandable that these variables did not forecast well given the thinness of the market.

The model has done a good job of predicting Canadian flaxseed exports as shown in Figure 3.3. As equation 3.4 shows, the model predicted crush reasonably well given the low level of crush. The PMSE and Theil values were both less than 1.0. Feed, seed and waste was predicted reasonably well given the erratic nature of the variable, as shown in Equation 3.5. The PMSE values for farm marketings, farm and commercial inventories were all at or above 1.0, although the Theil value for marketings and farm inventories were acceptable. These are shown in equations 3.6, 3.7 and 3.8.

TABLE 3.7: FLAXSEED SIMULATION STATISTICS

Endogenous Variables	PMSE	Theil U2
PFL	0.1622	0.3069
EXFL	0.1870	0.5670
CSFL	0.3901	0.5630
DFFL	0.3664	1.0739
FMFL	0.1000	0.0860
CIFL	1.0550	0.9160
FIFL	1.2470	0.3000

3.2.4 Conclusion

The estimated model of the Canadian flaxseed complex generally follows the conceptual model. The price of flaxseed is determined exogenously with influences from the world production of flaxseed by major producers and exporters and importers.

The flaxseed industry is a small component of the international oilseed complex. However, since linoil (hence flaxseed) is part of the smaller industrial oil complex, flaxseed has a larger influence on the price of the industrial oils. What is generally common to the industrial oils is higher levels of linolenic acid, and because soybean oil does contain some linolenic acid (10 percent), there exists a connection between the soybean and flaxseed complexes. Further, since Canada is one of the world's largest producers of flaxseed and its largest exporter, the Canadian flaxseed economy plays a large role in the industrial oil market.

Canada processes very little of its flaxseed and uses very little linoil and linmeal. Canada also trades very little linoil and linmeal. For these reasons and because equations for linoil and linmeal performed poorly in earlier model estimations, they were deleted from the final model.

FIGURE 3.2: PRICE OF FLAXSEED, 1970/71-1990/91

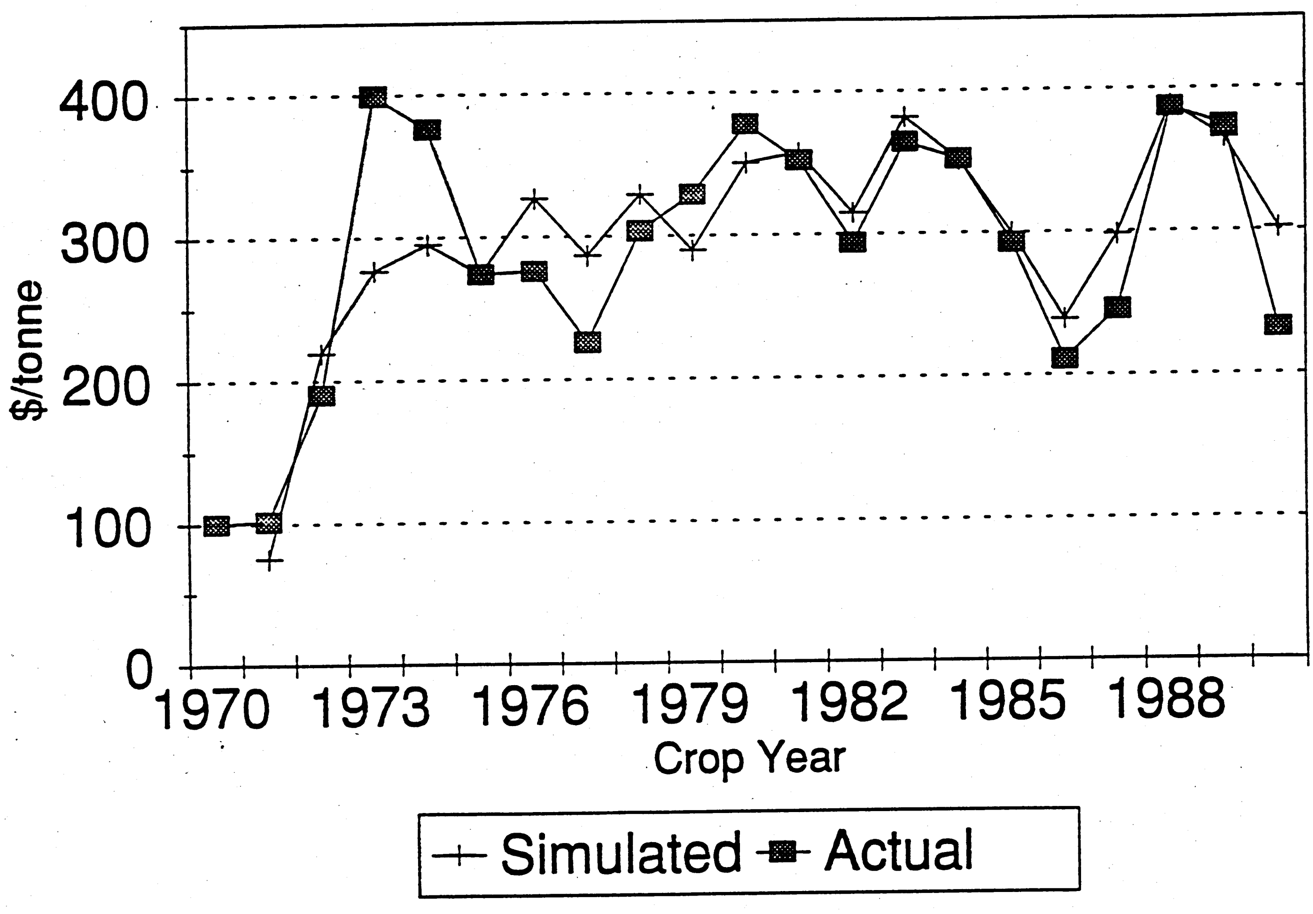


FIGURE 3.3: EXPORTS OF FLAXSEED, 1970/71-1990/91

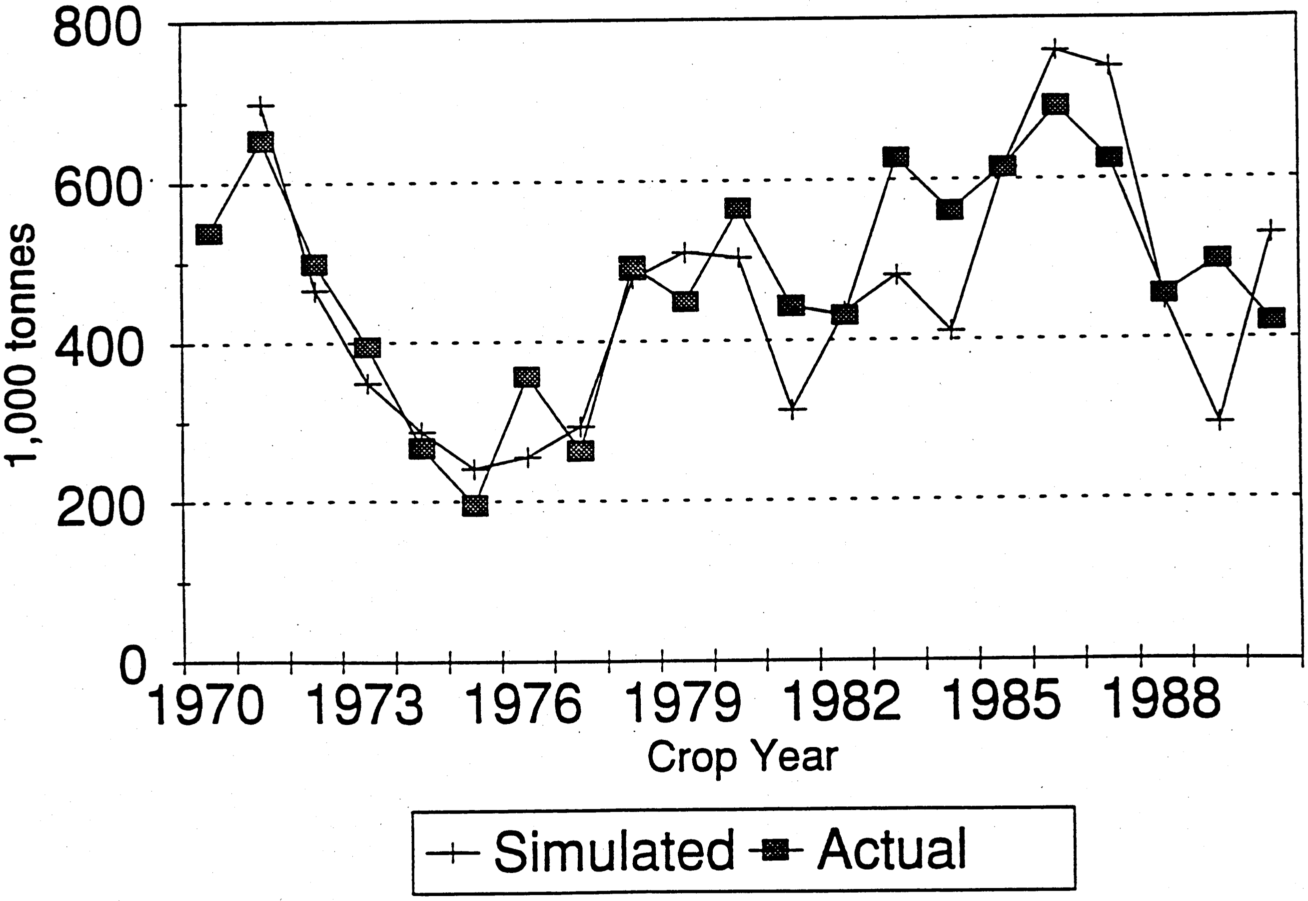


FIGURE 3.4: CRUSH, FLAXSEED, 1970/71-1990/91

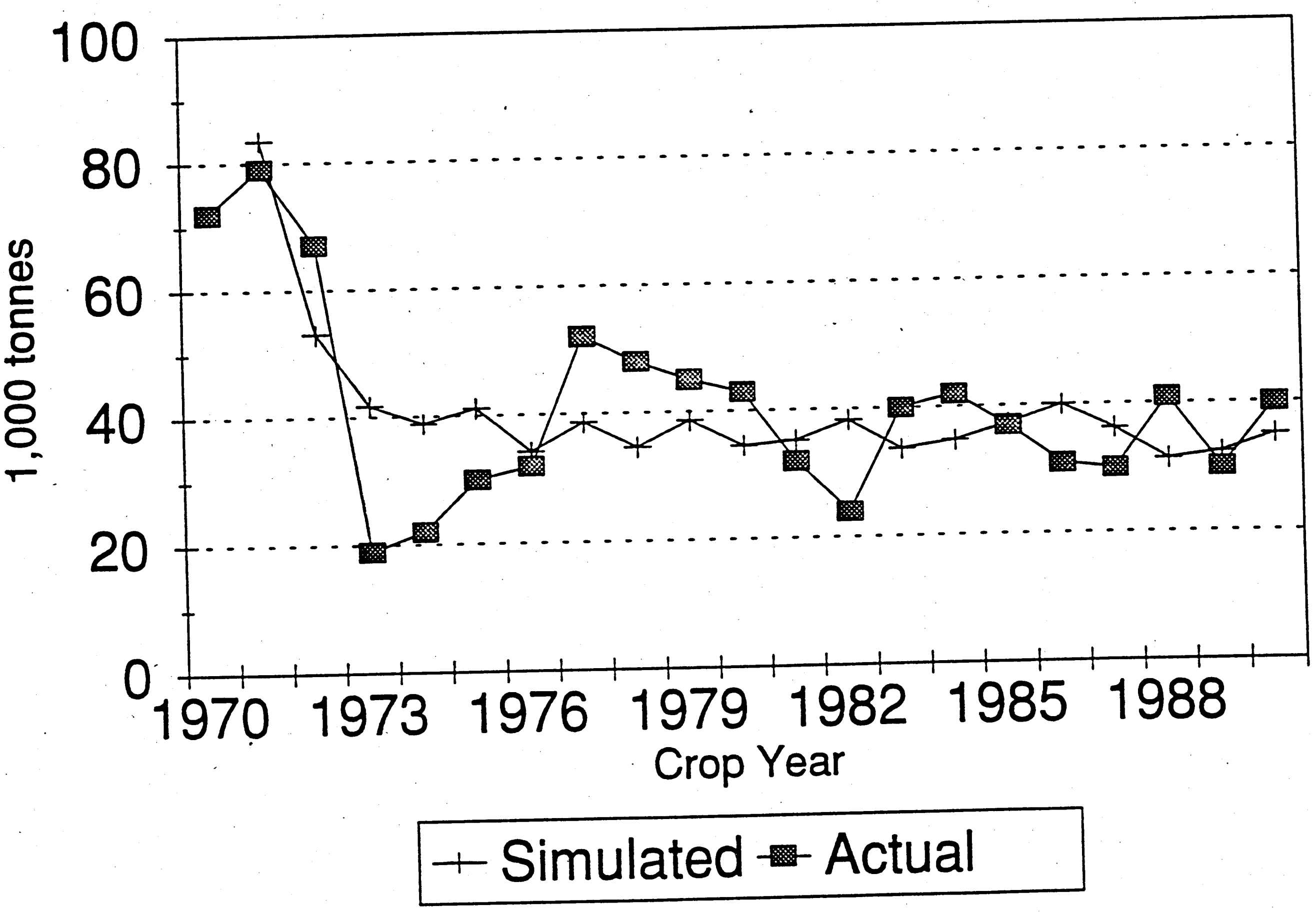


FIGURE 3.5: SEED, FEED, WASTE OF FLAXSEED, 1970/71-1990-91

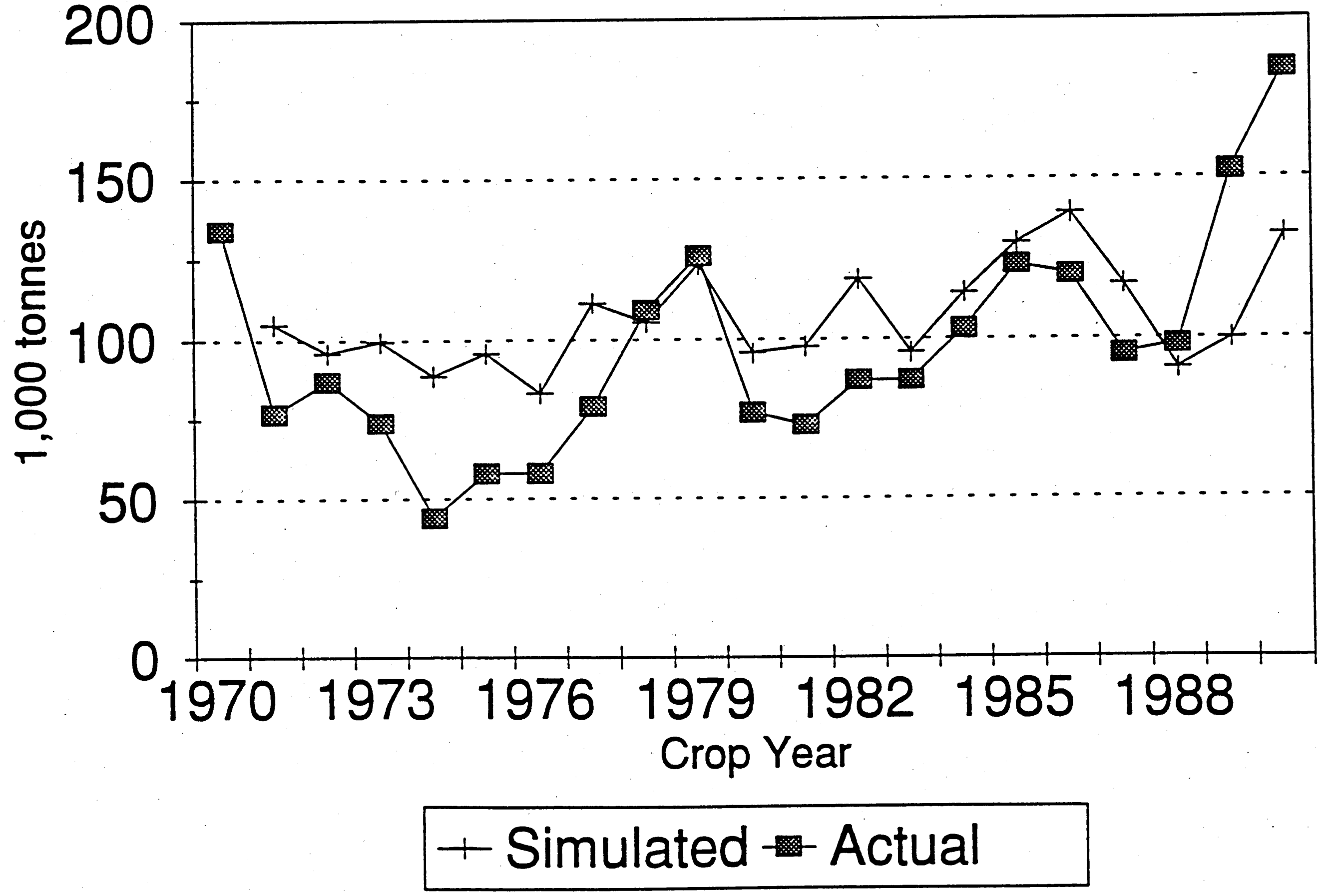


FIGURE 3.6: FARM MARKETINGS, FLAXSEED, 1970/71-1990/91

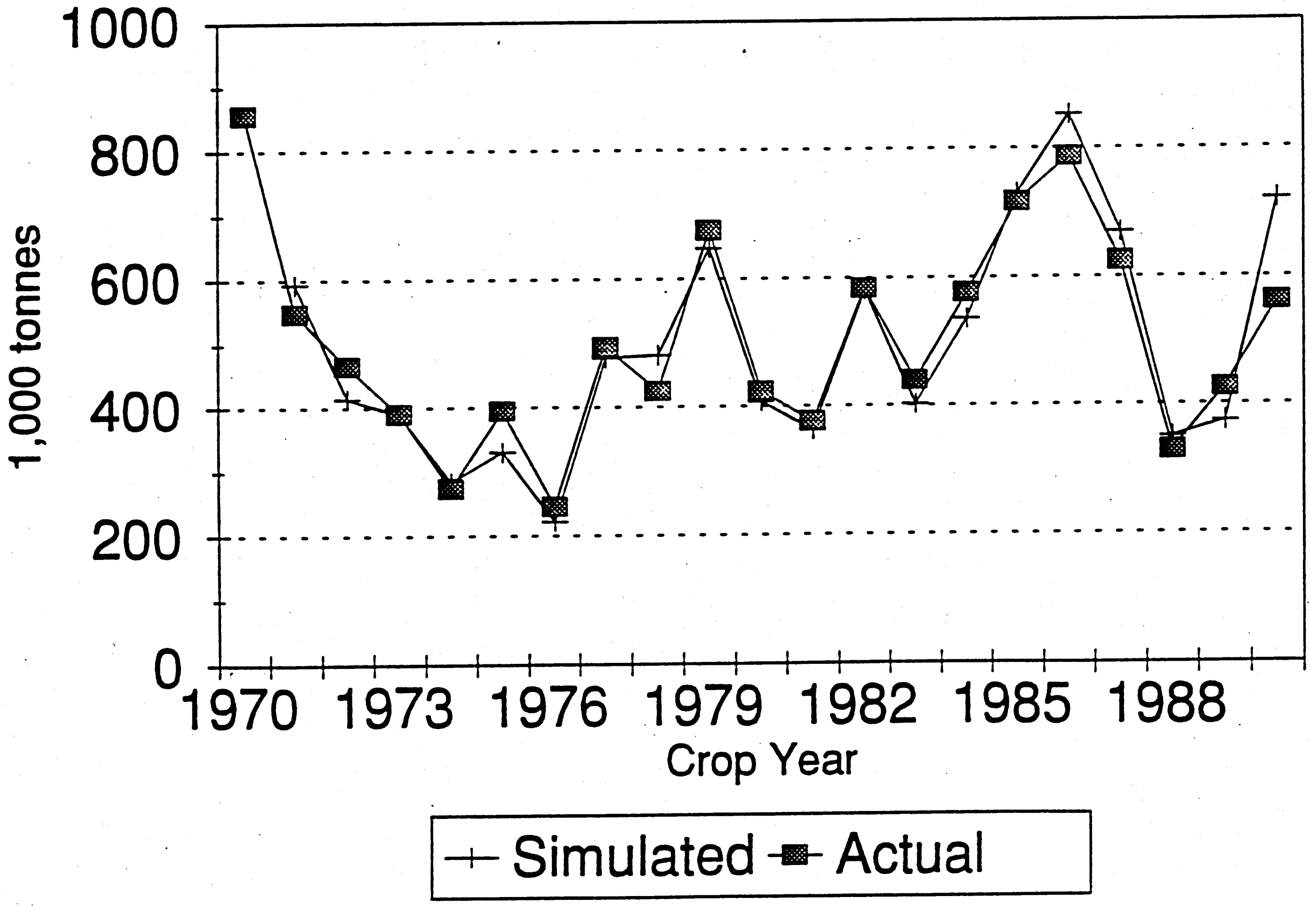


FIGURE 3.7: FARM INVENTORIES, FLAXSEED, 1970/71-1990/91

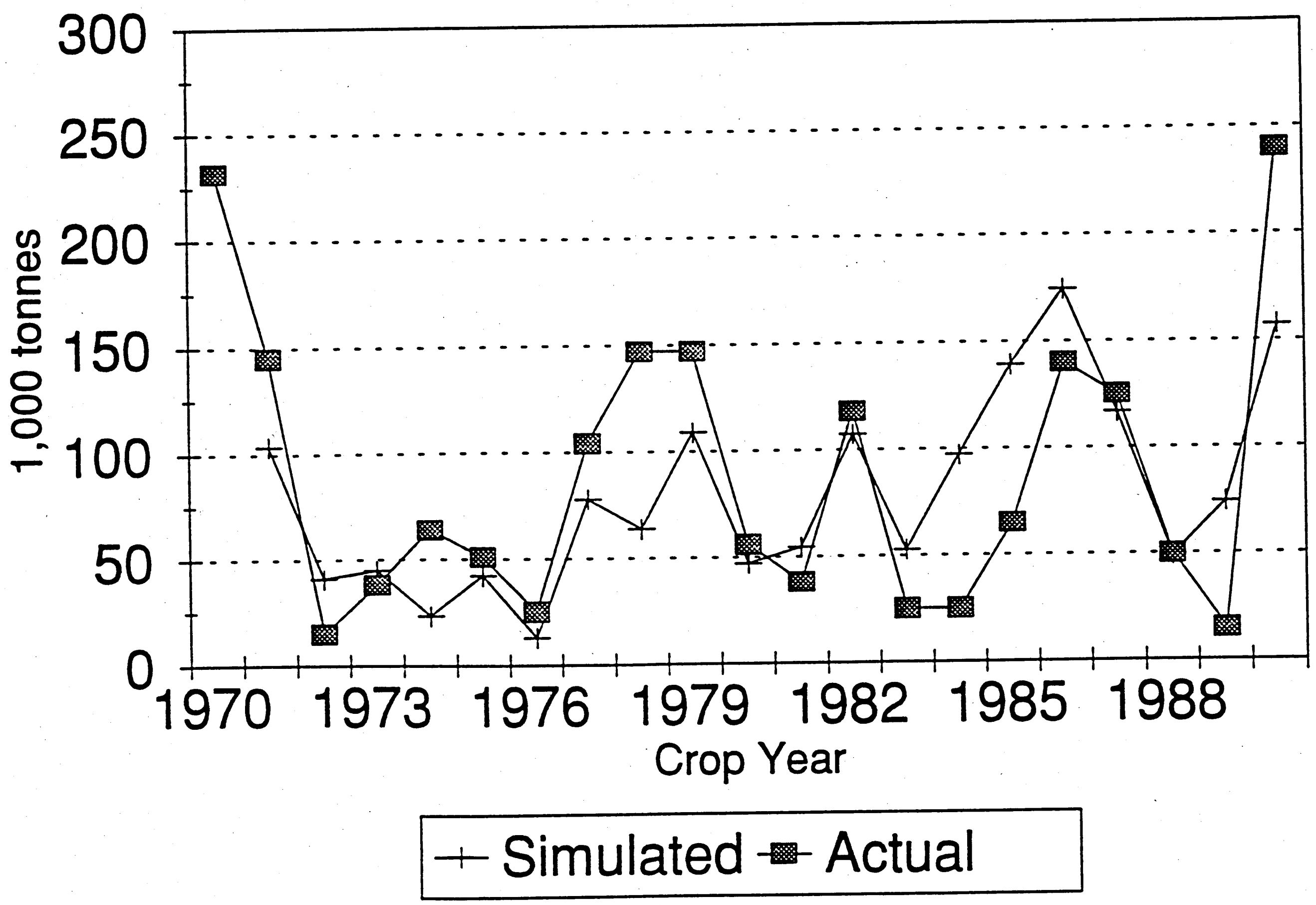
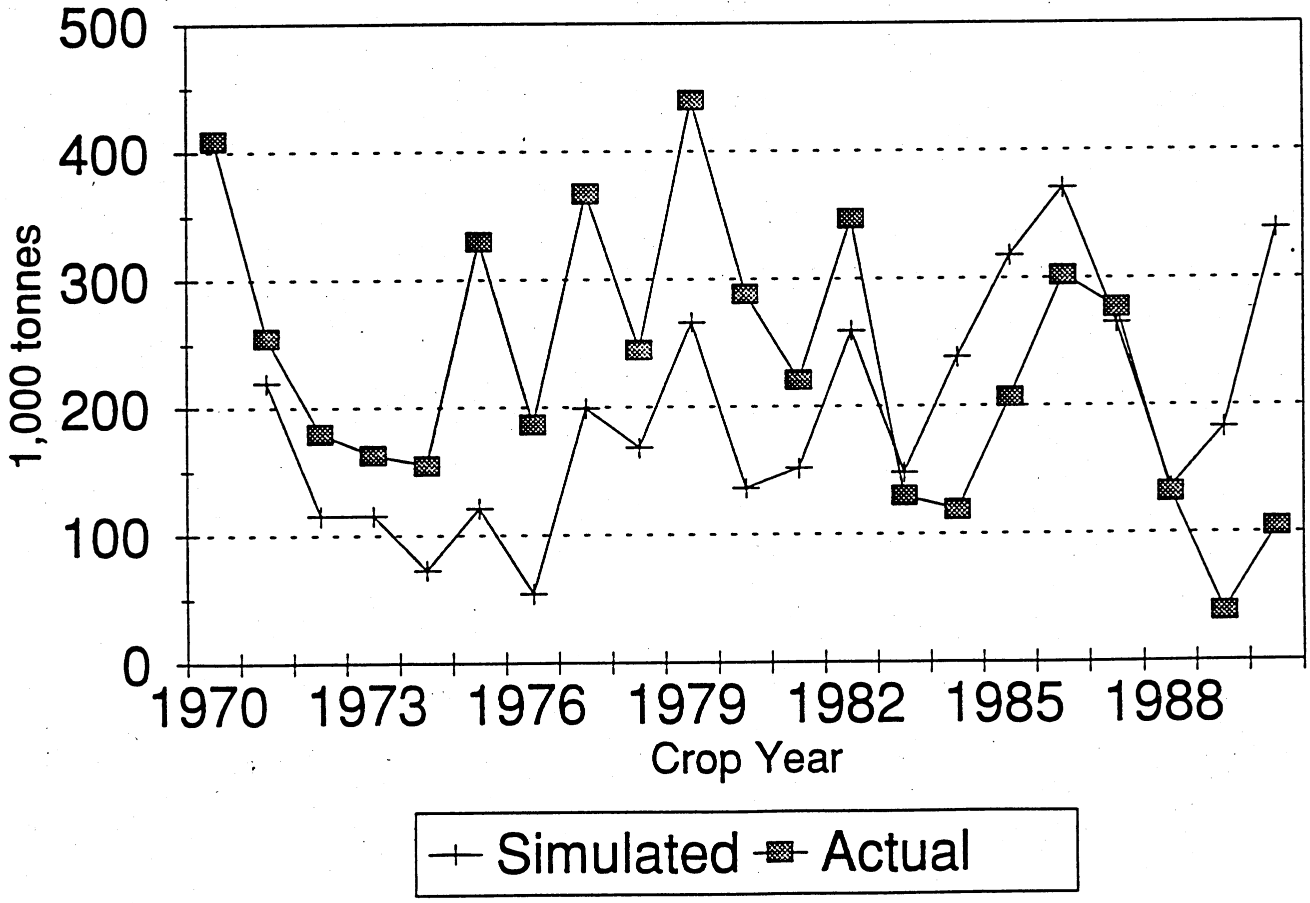


FIGURE 3.8: COMMERCIAL INVENTORIES, FLAXSEED, 1970/71-1990/91



4. SOYBEANS

4.1 Soybean Market

4.1.1 Domestic Production

Soybean production is a distant second to canola in oilseed production in Canada. (Table 1.2). Canadian production of soybeans has been about 1.2 million tonnes annually or about 25 percent of the Canadian oilseed production.

Production of soybeans is concentrated in Ontario with smaller amounts produced in Quebec (Table 4.1). While the soybean industry is important in Ontario, it is second after corn in market revenue. The 1990 gross farm receipts from marketing corn were 331.2 million dollars and for soybeans 247.4 million dollars in Ontario (excluding subsidy payments). Soybeans are grown in a crop rotation with corn in southern Ontario with an average yield of 36.5 bu/ac over the period 1986/91 (Ontario Soybean Growers' Marketing Board).

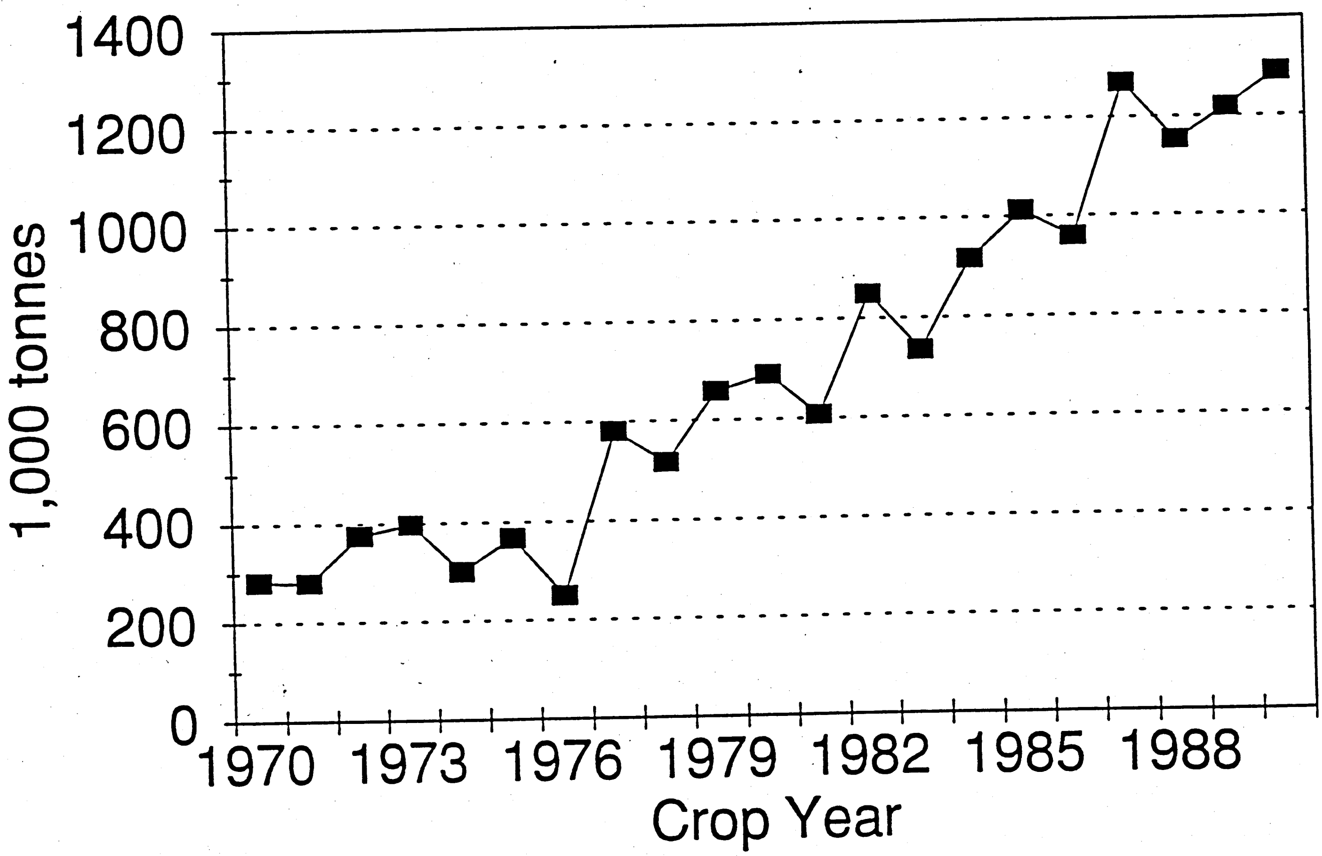
TABLE 4.1: ACREAGE OF SOYBEANS IN CANADA, BY PROVINCE: 1987 TO 1990 (THOUSANDS OF HECTARES)

Province	1987	1988	1989	1990
Ontario	453	518	522	473
Quebec	8	15	17	18
Total	461	533	539	491

Source: Canadian Grains Council, *Statistical Handbook* (various issues), Winnipeg, Manitoba

Canadian production of soybeans has increased rapidly from 1976 to 1990 as shown in Figure 4.1. Most of this increase occurred in Ontario through both higher yields and greater acreage. Recently the increase in acreage has appeared to level off in Ontario with small acreage increases occurring in Quebec, Manitoba and Alberta.

FIGURE 4.1: CANADIAN SOYBEAN PRODUCTION, 1970 TO 1990 (000 TONNES)



Source: PSD

4.1.2 Domestic Crush

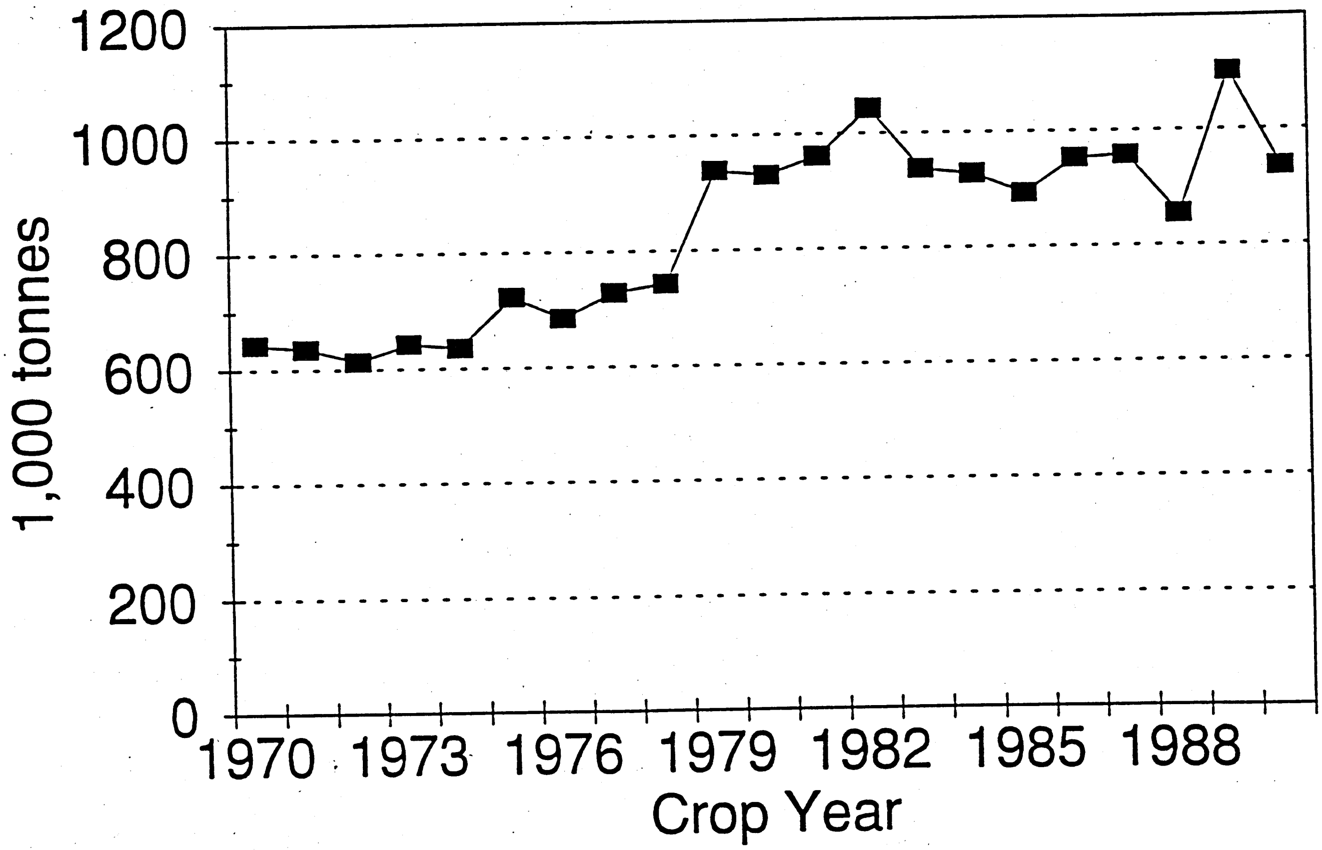
Soybeans are crushed into soyoil and soymeal. There are two crushing plants for soybeans; one is located in the Windsor-Hamilton area, and the second which only crushes a small quantity of soybeans in Altona, Manitoba. In the 1980s Maple Leaf Mills closed their small Toronto plant and opened a new plant in Windsor, Ontario. This plant is jointly owned with Lever Brothers. The annual crush capacity of soybeans in Canada is rated to be in the order of 2,520 tonnes per 24-hour day (see Table 1.3). The actual quantity of beans crushed between 1964-91 is shown in Figure 4.2. The quantity crushed increased sharply in the years 1976-79 with the new crushing plant in Windsor and since then the crush has been in part constrained by plant capacity. Plants can and do shut down; however, the annual crush does tend to be below the rated capacity level. Therefore the annual crush is determined not only by the price of the products but also by quality of soybeans, labour relationship and crush capacity.

The production of soymeal and soyoil is obviously determined by the quantity and quality of soybeans that are crushed. The conversion rate is approximately 78 percent soymeal and 18 percent soyoil for each unit of soybean and this depends on the quality of the beans in any given year. The actual quantity of soymeal and soyoil produced in Canada for the period 1980-90 is shown in Table 4.2.

4.1.3 Domestic Demand for Soyoil and Soymeal

Soyoil consumption makes up approximately 35 percent of the total demand for vegetable oil in Canada. The soyoil product is considered to be high quality by consumers and demand is not price-sensitive (Mielke, Young and Miller, 1990). Because soyoil is low in polysaturated fat, soyoil is a preferred food by a growing health-conscious population. The quantity of soyoil demanded in Canada depends upon the level of income of Canadians, price of other oil substitutes and some trend to capture the health effects of the move toward using unsaturated cooking oils. A major competitor of soyoil for the consumer dollar is canola oil, which was discussed earlier in this report.

FIGURE 4.2: ANNUAL SOYBEAN CRUSH IN CANADA, 1970 TO 1990 (000 TONNES)



Source: PSD

TABLE 4.2: SOYBEAN CRUSH AND PRODUCTION OF SOYOIL AND SOYMEAL IN CANADA: 1980 TO 1990 (TONNES)

Year	Soybeans	Soyoil	Soymeal
1980	1 010 789	168 465	794 397
1981	866 563	148 878	682 827
1982	1 026 936	175 796	815 632
1983	1 019 458	177 237	806 151
1984	884 398	158 446	691 660
1985	905 854	162 485	705 756
1986	963 862	166 668	740 225
1987	966 307	161 857	747 620
1988	854 809	149 482	655 402
1989	1 102 038	199 331	852 017
1990	935 479	164 052	719 588

Source: Canadian Grains Council, *Statistical Handbook* (various issues), Winnipeg, Manitoba.

Soymeal makes up approximately 70 percent of the animal protein meal demand in Canada. This product is used primarily in poultry and hog rations with smaller amounts used in cattle feed. Because of the increased consumption of poultry meat by Canadians, demand for soymeal has increased. Canada has not been able to meet this demand from domestic production so has relied on large imports of soymeal from the US. Total meal demand is responsive to the number and type of animals (poultry and livestock) on commercial feed particularly in Ontario and Quebec, the price of corn and the price of substitute animal protein meals.

The major competitor for both soyoil and soymeal comes from canola products. While canola oil is largely substitutable for soyoil the same is not true for canola meal. Soymeal is still considered a superior meal for most animal feed supplements.

4.1.4 International Trade

The Canadian soybean industry is only a small part of the world oilseed complex. World production of oilseeds was 214 million tonnes in 1990/91 (Table 1.1). Of this approximately one half was in the form of soybeans. The largest producer of soybeans in the world is the United States (Table 4.3).

The US produces one half of the world soybeans followed by Brazil and China. The EC is not a large producer of soybeans currently, however there has been some increase in their production. It is to be expected that the EC will further increase the production of soybeans due in part to the change in the CAP. The production of soybeans in the EC is a continuous issue at the GATT and there are some indications that the EC will change its current policy and reduce soybean production.

TABLE 4.3: SOYBEANS: WORLD SUPPLY (MILLION TONNES)

Production	1987/88	1988/89	1989/90	1990/91
United States	52.75	42.15	52.35	52.42
Brazil	18.02	23.20	20.34	15.50
Argentina	9.70	6.50	10.75	10.80
China	12.47	11.65	10.23	11.00
EC-12	1.78	1.66	1.98	2.17
Paraguay	1.10	1.62	1.58	1.30
Other	7.99	8.87	10.05	9.84
Total	103.81	95.64	107.27	103.03

Source: USDA, *World Oilseed Situation and Outlook*, FAS, FOP 11-91, November. 1991

In the world soybean trade Canada is primarily an importer of soybeans and soybean products (Table 4.4). The import of soybeans has dropped while the export of soybeans has increased, ie., the net trade of soybeans is moving in Canada's favour. The reason for this two-way trade in soybeans has to do with the crush capacity in Canada and the change in crush margins between Canada and the US throughout the year. Also the harvest of soybeans which is concentrated over a few weeks requires trade in beans depending upon the time of the year and crop conditions in Canada.

There is very little trade in soyoil. However, what Canada does import comes from the US and was subject to a 10 percent tariff. This tariff was removed with the CUSTA. Soymeal is the major soybean product which Canada imports and most if not all of this originates in the US. Canada is a deficit region for animal protein meal and because soymeal is the most desirable animal protein meal, Canada imports large quantities annually from the US, which is a surplus region of soymeal. Imports have made up about 25 percent of the annual Canadian domestic demand for animal protein meal over the last ten years.

TABLE 4.4: CANADA'S TRADE IN SOYBEANS,SOYOIL AND SOYMEAL (METRIC TONNES)

Year	Soybean		Soyoil		Soymeal	
	Imports	Exports	Imports	Exports	Imports	Exports
1981	438 142	77 646	3 511	12 309	395 751	41 138
1982	430 281	117 070	5 138	24 966	408 789	18 078
1983	270 338	61 726	5 446	21 764	468 661	11 905
1984	245 824	123 405	12 909	6 549	588 364	956
1985	122 434	174 323	6 876	3 967	616 371	1 035
1986	252 797	146 230	9 607	870	628 712	8 467
1987	134 911	186 461	7 314	787	396 492	10 747
1988	142 611	272 339	3 418	1 973	595 979	2 935
1989	294 714	193 338	9 012	2 330	536 889	1 186
1990	149 777	195 883	3 513	3 830	637 693	16 406

Source: Ontario Soybean Growers' Marketing Board, *1991 Annual Report*, Chatham, Ontario.

The quantity of soybeans crushed in Canada is a function of the soyoil and soymeal demand. Canada is clearly a deficit area for soymeal, but there is almost zero net trade in soyoil. One possibility would be for Canada to produce more beans and export the oil. However, soyoil faces a tariff moving into Japan, and the US is already a surplus region. This makes the option of importing meal a more profitable alternative.

4.1.5 Price Determination

The price of soybeans is set in Canada by the Ontario Soybean Growers' Marketing Board through negotiations with the Canadian processors. In essence the Board sets a "basis" in Canada so that Canadian processors pay the same price as American processors for US soybeans of similar quality. The Chicago market thus sets the price with exchange rates, tariffs and transportation affecting the Toronto soybean price. The marketing board also negotiates the elevator fees for Ontario soybean producers.

The price for soyoil and soymeal determine the price of soybeans because they are the products produced from the crushing of soybeans. The price for soybeans increased in the 1973-74 period in the US. This increase in price occurred because of a world shortfall in soybean production and the US trade embargo introduced by the Nixon Administration. The Canadian price of soybeans followed this increase in the US market.

Canada is a small country in the international soybean market. What follows from this is that Canada's soybean market is heavily influenced by external factors (especially in the US), and that Canadian supply and demand conditions have an insignificant effect on the international market. Thus, the Canadian price of soybeans would be the US price weighted by the Canadian/US exchange rate, and if the law of one price holds then the pass-through of the US price would be complete, less transactions costs. In the case of soyoil, a 10 percent tariff would be added to the US soyoil price; however, this was removed with the CUSTA agreement.

4.2 Soybean Model

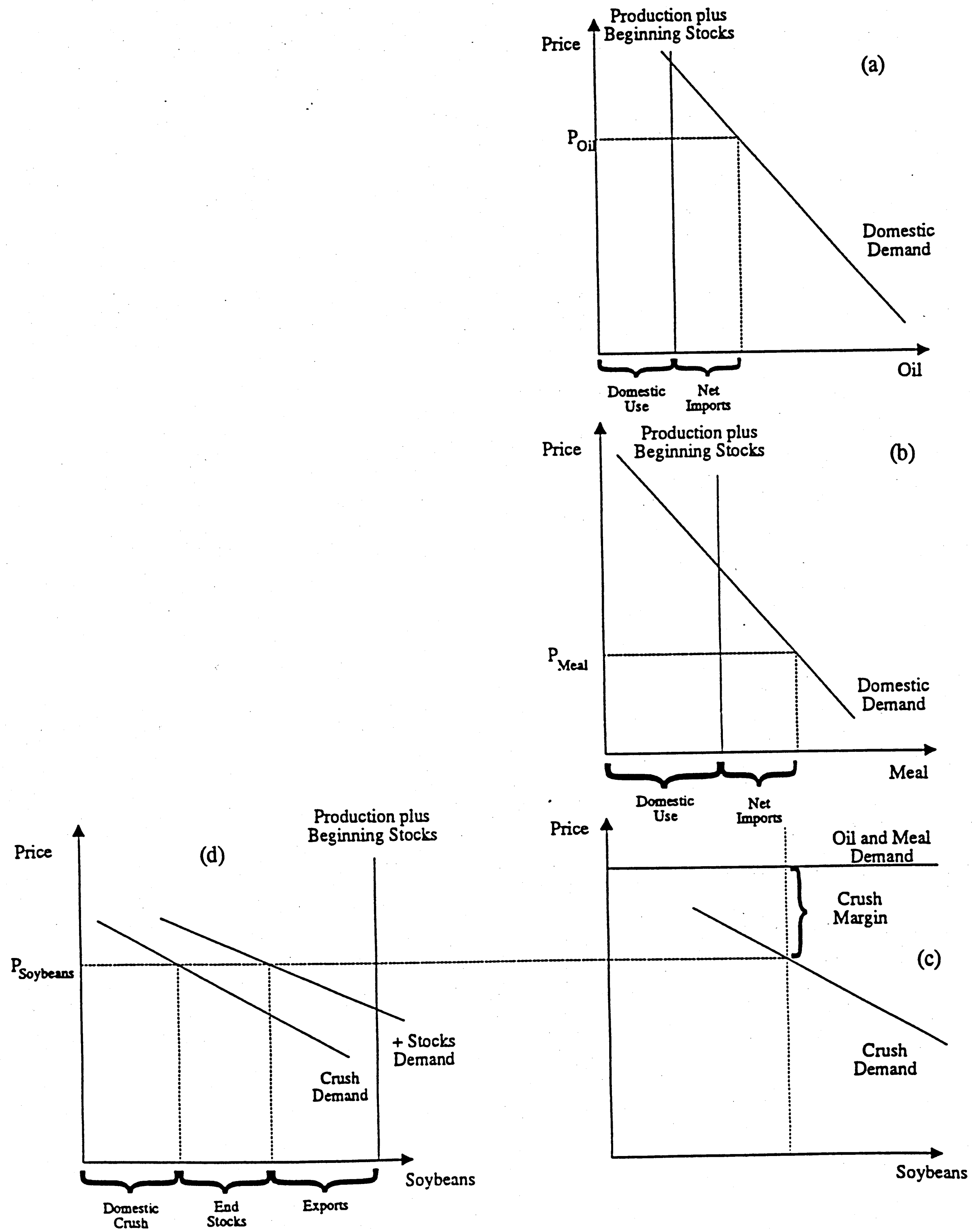
4.2.1 Conceptual Model

The conceptual model for the soybean-oil-meal complex is represented in Figure 4.3 In this model, the world price of soybeans is assumed to be determined exogenously as in panel (d). In this panel, production plus beginning stocks are treated as given. The demands for domestic crush and stocks are assumed to be price-responsive but not necessarily price elastic. Exports are thus treated as a residual.

The domestic crush demand is represented in both panels (c) and (d). In panel (c), crush demand is seen to be derived from the demand for the oil and meal less the crush margin. In panel (c), the crush margin is assumed to be positively related to the quantity crushed. In panel (c), oil and meal demand is represented as a horizontal line. This is derived from the representations of the oil and meal markets in panels (a) and (b) respectively. In each of these panels, the product price is assumed to be exogenous. This is reasonable since Canada is an insignificant net importer (ie., does not effect world price) in the world markets for these products. In these panels, the quantity of oil and meal supplied is predetermined by the quantity of seed crushed. As already mentioned, this latter variable is determined in the Canadian seed market in panel (d). There are assumed to be price-responsive domestic demands for the oil and the meal. Net imports of the oil and the meal are specified as residuals (domestic consumption less domestic production) in the model.

The model is represented in equation form in Table 4.5. This is similar to the models for canola and flaxseed except that additional price linkage equations are included to represent the relationship to US prices of the Canadian prices for soybeans, soymeal and soyoil. This recognizes the dominant position of the US in the world market for soybeans and its products. Equations 4.1 to 4.3 are price linkage equations.

FIGURE 4.3: CONCEPTUAL MODEL OF CANADIAN SOYBEAN MARKET



They link the Canadian prices for soybeans and its products to prices in the US. Equation 4.4 is an identity in which the gross crush margin is related to the prices of oil and meal and the price of soybeans. Equation 4.5 represents the relationship between the quantity of soybeans crushed domestically and gross crush margin and crushing capacity. Equation 4.6 is an inventory demand equation. Canadian soybean producers face a market price for the commodity. They, along with commercial producers face a market price for the commodity. They, along with commercial handlers and users, may choose to withhold stocks in expectation of higher prices. Hence this equation allows for speculative demand for soybean inventories. In equation 4.6, carryout stocks are considered to be a function of the production of soybeans. Equation 4.7 is the supply-disposition identity. In this equation, supply (production plus beginning stocks) is assumed to be exogenous. Unlike canola and flaxseed there is no separation of farm and commercial inventories as the data on stock levels is not available. Exports of soybeans are treated as a residual in this equation and hence is an endogenous variable. Equations 4.8 and 4.9 determine the supply of oil and meal respectively according to technical relationships with the domestic soybean crush. Equations 4.10 and 4.11 represent the domestic demands for soyoil and soymeal respectively. Soyoil is a close substitute for canola oil in cooking oil, salad dressing and in margarine production. Domestic demand for soyoil is a function of the Canadian population, domestic disposable income, price of substitutes such as canola oil, palm oil and a time trend for change of tastes and preferences as well as technology. Domestic demand for soymeal is a function of the price of the meal and substitute meals and a time trend. Equations 4.12 and 4.13 indicate that oil and meal (net) imports are obtained as residuals in the model. Equation 4.14 is the demand for feed, seed and waste and it is specified as a function of soybean acreage in Canada and a dummy variable for 1986.

This model can be solved recursively as in the case of flaxseed and canola. Since there is no equilibration of price, simulation can be conducted on a single equation basis. The statistical procedures and sources of data are outlined in Appendix A.

TABLE 4.5: MODEL IN EQUATIONS FORM

PSO = f1(PSO4, ER34)	(4.1)
PSL = f2(PSL4, ER34)	(4.2)
PSM = f3(PSM4, ER34)	(4.3)
CMSO = 0.18*PSL + 0.78*PSM - PSO	(4.4)
CSSO = f4(CAP, CMSO)	(4.5)
ISO = f5(QSO)	(4.6)
EXSO = QSO + ISO_{t-1} - CSSO - ISO - DFSO	(4.7)
QSL = 0.18*CSSO	(4.8)
QSM = 0.78*CSSO	(4.9)
DDSL = f6(PSL, PRL, POPCAN)	(4.10)
DDSM = f7(PSM, PRM, T)	(4.11)
IMSL = DDSL - QSL + ISL - ISL_{t-1}	(4.12)
IMSM = DFSM - QSM + ISM - ISM_{t-1}	(4.13)
DFSO = f8(ASO,D)	(4.14)

* coefficient based on estimated elasticity, non sample information

Endogenous Variables:

CMSO	= crush margin, soybeans
CSSO	= crush, soybeans
DDSL	= domestic disappearance of soyoil
DDSM	= domestic disappearance of soymeal
EXSO	= net exports of soybeans
IMSL	= net imports of soyoil
IMSM	= net imports of soymeal
ISO	= inventories, soybeans
PSO	= price of No. 2 soybeans, Chatham
PSL	= price of soyoil, unit export value, Canada
PSM	= price of soymeal, 44% protein, Toronto
QSL	= production of soyoil
QSM	= production of soymeal
DFSO	= disappearance of soybeans for feed, seed and waste

(continued)

TABLE 4:5 (Concluded)

Exogenous Variables:

ER34	= Canada-US exchange rate
PSL4	= US price of soyoil (US$)
PSM4	= US price of soymeal (US$)
PSO4	= US price of soybeans (US$)
X2	= disposable income, price of canola oil, trend
ASO	= acreage planted to soybeans in Canada
T	= time trend
CAP	= crush capacity for soybeans, Canada
POPCAN	= Population, Canada
D	= 1986

4.2.2 Estimated Equations

The price of soybeans in Canada is determined by the supply and demand balance in the rest of the world (ROW), which is dominated by market conditions in the United States (US). To bring these market forces into the Canadian market a price linkage equation between the US price of soybeans and the Canadian price of soybeans was specified and estimated.

The Canadian soybean price PSO was specified as a function of US soybean price PSO4 and the Canada-US exchange rate. Because we are not interested in estimating the coefficient on the exchange rate variable, we converted the US soybean price into Canadian dollars by multiplying the US soybean price by the yearly average exchange rate.

$$PSO = 4.066 + 0.918\ PSO4 \qquad (4.1)$$

$$(0.523)^{*} \quad (31.37)$$

$$(0.983)^{**}$$

$$R^{2***} = 0.98 \qquad D.W. = 2.18$$

* The first row of brackets are the t- statistics.
** The second row of brackets are elasticities calculated at the mean.
*** The R^2s in the study are corrected R^2s.

Equation 4.1 was corrected for autocorrelation using the standard Cochrane-Orcutt type procedure.

The law of one price appears to hold. We did not test to see if the coefficient on PSO4 was different from unity but the elasticity is very close to unity. The reason the estimated coefficient differs from unity is likely due to the use of annual data. The Canadian soybean price does follow the US soybean price, suggesting the two markets are closely linked.

The soyoil price in Canada was specified to be linked directly to the US soyoil price, plus adjustments for the Canadian soyoil tariff. However, neither Agriculture Canada nor the contractor were able to develop a reliable time series of Canadian soyoil prices, i.e., PSL. After some discussion it was decided that an identify between the Decatur soyoil price and the Canadian soyoil price would be used in the model specification.

$$PSL = PSL4 * \text{Exchange rate} * \text{tariff} \tag{4.2}$$

This assumes the law of one price holds between the two countries. Given the small quantities of soyoil traded between Canada and the US this assumption is not likely to have much of an impact on the overall performance of the model.

The final price linkage equation between Canada and the US is the price of soymeal. For this relationship the price of soymeal in Canada, PSM, is specified as a function of the US price of soymeal PSM4 and the Canada-US exchange rate. Again we multiplied the US price PSM4 by the exchange rate.

$$\begin{array}{ll} PSM = \underset{(1.222)}{20.801} + \underset{\substack{(13.771)\\(0.915)}}{1.0337}\, PSM4 & (4.3) \\ R^2 = 0.90 \qquad D.W. = 2.475 & \end{array}$$

Autocorrelation was not a problem in equation 4.3. The law of one price appears to hold in the case of soymeal between Canada and the US. Canada imports large quantities of soymeal each year from the US, therefore we expected a close price relationship.

The US soybean complex drives the Canadian prices in the soybean, soyoil and soymeal market. This provides justification for specifying the Canadian prices as exogenous to the Canadian supply and demand balance. The remaining equations are specified as functions of the Canadian prices; however, the Canadian prices are determined by the US market conditions.

The crush margin in Canada, CMSO, is derived from the Canadian prices of soybean, soyoil and soymeal.

$$CMSO = 0.18\ PSL + 0.78\ PSM - PSO \tag{4.4}$$

The Canadian crush of soybean, CSSO, is constrained by the available crushing plant capacity. These plants represent large fixed investments that can only be shut down at a large cost. Once the plants are running any change in throughput is determined by the addition/deletion of a shift of workers.

As the price of soyoil or soymeal rises, the margin on which the crushing plants operates will improve. One would expect that the quantity crushed would increase in response to this incentive. In the first estimation of the crush equation the crush margin variable had a negative sign, which indicates as the margin increases the quantity crushed declines. This is not a tenable conclusion. In a study on the US soybean industry, Houck found a crush margin elasticity of .2, while Mielke found a crush margin elasticity of .8 for Canadian soybean crush. In this study we imposed a crush margin elasticity of .2 on equation 4.5.

$$\begin{array}{llll} CSSO = & -49.567 + 189.41\ CMSOD & + 0.231\ CAP & (4.5) \\ & (-0.365) & (5.518) & \\ & \quad\quad (0.2) & (0.860) & \\ R^2 = 0.75 & & D.W. = 1.84 & \end{array}$$

In this model the crush capacity had an elasticity of 0.86 which is in the range we would expect, ie., as capacity increases the quantity crush increases somewhat less. This equation also suffered from the presence of autocorrelation.

The quantity of soymeal and soyoil produced in Canada were determined by multiplying the quantity of soybeans crushed CSSO by the appropriate extraction rates for soyoil and soymeal.*

$$QSL = 0.18\ CSSO \tag{4.8}$$

$$QSM = 0.78\ CSSO \tag{4.9}$$

The demand for both soyoil and soymeal in Canada were estimated as single equations. Early attempts at estimating these equations with canola oil and meal equations in a systems model were rejected. It was not possible to achieve acceptable estimates using the systems approach.

The demand for soymeal in Canada was specified to be a function of the price of soymeal, price of canola meal which is a substitute, and a time trend. Both PSM and PRM were deflated by the consumer price index (CPI). The time trend was used to pick up the scientific improvements in soymeal.

$$\begin{aligned} DDSM = \; & \underset{(4.78)}{644.24} - \underset{\substack{(-1.71)\\(-0.18)}}{51.16}\ PSMD + \underset{\substack{(1.06)\\(0.10)}}{45.26}\ PRMD + \underset{\substack{(6.66)\\(0.10)}}{42.88}T \\ & R^2 = 0.95 \qquad D.W. = 1.71 \end{aligned} \tag{4.11}$$

Both of the estimated elasticities for PSMD and PRMD were small but of reasonable comparable magnitude. Equation 4.11 also suffered from autocorrelation. The same fix-up procedure was used in this equation as was used in earlier equations.

* Equations 4.8 and 4.9 were estimated econometrically. In both equations the estimated coefficient was very close to the average numbers used in this paper. The coefficients were 0.188 for equation 4.8 and 0.788 for equation 4.9.

The demand for soymeal in Canada DDSM is highly price-inelastic. This result should not be surprising given the limited substitutes that exist for the product. In livestock rations, canola meal is substituted only in limited quantities because of the nutritional properties. The estimates confirm this, in that PRM is significant, but the cross price elasticity is very low. Similar results were reported in an earlier study by Meilke, Young and Miller (1990).

The Canadian demand for soyoil DDSL equation gave some problems. It was hypothesized that the demand was a function of the price of soyoil, population and income growth. Initially, we also included the price of other vegetable oil substitutes such as canola and sunflower oil. In the estimation phase of this project we were unable to achieve acceptable statistics on the PSL variable. In the report by Meilke, Young and Miller similar problems occurred, and they report PSL to be insignificant but with an elasticity estimate of -0.05.

Because we did not want to omit the price variable in the demand equation, we used Mielke, Young and Miller's results and their result on our demand estimates. We took the expression

$Ep = \frac{b}{Q/p}$ and estimated a value for b: $b = 0.05 \; \frac{(148.10)}{9.433} = -0.7853.$

NDDSL = DDSL + 0.01227 PSL.

The demand equation for soyoil was then specified as

$$DDSL = -336.69 + 19.16\ POP + 3.919\ PRLD - 0.7185\ PSLD \qquad (4.10)$$

(-5.04) (7.70) (3.405)

(3.10) (0.22)

$R^2 = 78$ D.W. = 2.42

The income variable was tried in an earlier specification but was dropped from the estimated equation because it was correlated with POP. The deflated price of canola oil was significant, ie., there is some commodity substitution in this market.

Inventory levels of soybeans, soyoil and soymeal were examined in the specification of the Canadian soybean block. Data does not exist for Canadian commercial inventories of soymeal and soyoil, therefore net equations were specified for these two variables. Soybean inventories are important and an equation was specified to explain the change in their level in the Canadian market. The change in the quantity of soybeans stored was a function of interest rates and production levels. The interest rate was included because it represents the cost of carrying inventories over time. Production was included because of the fixed capacity of plants to crush soybeans and a random increase/decrease in production would increase/decrease carryover.

In the model we show the inventory demand being price elastic; however, in the statistical estimation the price variable was both the wrong sign and insignificant. Therefore in the process of developing the final estimation equations we deleted the price variable.

$$ISO = \underset{(2.72)}{41.91} + \underset{\substack{(6.15)\\(0.66)}}{0.1215}\,QSO \tag{4.6}$$

$$R^2 = 0.65 \qquad D.W. = 1.65$$

Production levels of soybeans in Canada explain Canadian inventories of soybeans. It is probably the case that inventories are really pipeline stocks; ie., no speculative behavior exists in this market, and given Canada is a net importer of soybeans, this is a reasonable conclusion.

The final equation to be estimated in this block was the demand for seed, DFSO, by soybean growers. It was specified to be a function of the acreage of soybeans planted each year.

$$DFSO = \underset{(0.031)}{0.443} + \underset{\substack{(2.29)\\(0.50)}}{0.053}\,ASO + \underset{\substack{(8.29)\\(10.49)}}{154.74}D \tag{4.14}$$

$$R^2 = 0.93 \qquad D.W. = 2.04$$

Upon examination of the data it was noticed that the seed dockage, wastage, etc., which also goes into the determination of DFSO, has increased over time and that there was a particular break in the data in 1986. Therefore, we put a dummy variable into equation 4.14 to pick up this effect.

The net trade in soybeans, EXSO, soyoil, IMSL and soymeal, IMSM, were all explained by identities in the model.

$$EXSO = QSO + ISO_{t-1} - CCSO - ISO - DFSO \tag{4.7}$$

$$IMSL = DDSL + ISL - QSL - ISL_{t-1} \tag{4.12}$$

$$IMSM = DDSM + ISM - QSM - ISM_{t-1} \tag{4.13}$$

Overall the estimates were reasonable. One characteristic of the model is the lack of price responsiveness in the demand equations. While this is both disappointing and disturbing it is consistent with the results reported by Meilke, Young and Miller (1990).

4.2.3 Model Simulation

One method to evaluate a model that has been estimated is to simulate the dependent variable over the data period. In this evaluation process the dependent variable is simulated by using the estimated coefficients on the independent variables and the actual independent variable values. The reporting is similar to the format of canola and flax models.

The price variables of PSO and PSM are shown in Figures 4.4 and 4.5. Both of these variables were predicted well in the estimated model. The crush variable CSSO (Figure 4.6) demonstrates the two levels as plant capacity expanded in the late 1970s..

The domestic demand for soyoil was predicted well, even with the rather restrictive method used to estimate the model (Figure 4.8). The demand for soymeal in Canada DDSM (Figure 4.7) has some problems in the last period; however over the range of periods it simulates the actual DDSM very closely. A number of changes were made to the equation predicting DDSM; however they did not improve the simulation results.

The demand for soybean inventories ISO is simulated over the entire period with the results shown in Figure 4.15 In the period 1984-87 the model did not predict the sharp swings in inventories. It is unlikely any annual model would capture such sharp fluctuations. The remaining simulations are shown in the remaining figure. They are all driven off identities and are thus not discussed in this part of the report. The simulation of DFSO was the one exception and it simulates very well. The PMSE on both EXSO and IMSL are problematic. In the early periods the estimated model did not predict the level accurately, however, the general trend and turn points were predicted (ie., low Theil U).

The forecast statistics for the soybean model are given in Table 4.6. As shown the forecast statistics are well within the acceptable range.

4.2.4 Conclusion

The estimated model of the Canadian soybean complex follows the theoretical model in reasonable fashion. The fact that the model is not sensitive to price leaves one with some uncertainty. However, it did forecast well over the historical data period. The lack of price sensitivity is due to the small Canadian market where really the Canadian soybean complex is a subset of the US complex. In such a case the only variables that are determined in Canada are things like acreage, investment in physical plants and population.

The soybean industry is a large world-wide industry. Canada plays only a small role in this industry and is totally centered on meeting Canadian demands. Canada exports very little of the products soyoil or soymeal (in fact we import large quantities of soymeal), which may also help to explain why the estimated equations were not sensitive to price changes.

TABLE 4.6: SOYBEAN MODEL FORECAST STATISTICS

Variable	PMSE	Theil U2
PSO	0.0304	0.0262
PSM	0.0866	0.1830
CMSO	0.3421	0.7468
CSSO	0.1479	0.7799
DDSM	0.7442	0.5506
DDSL	0.0948	0.9367
ISO	0.2313	0.7098
DFSO	0.1800	0.2391
EXSO	6.2907	0.6961
QSL	0.1479	0.7799
QSM	0.1479	0.7799
IMSL	4.6338	0.7446
IMSM	0.5834	0.8296

* 1985 omitted.
** One year was very inaccurate making these statistics very high.

FIGURE 4.4: ACTUAL AND SIMULATED PRICE OF SOYBEANS, 1970/71-1990/91

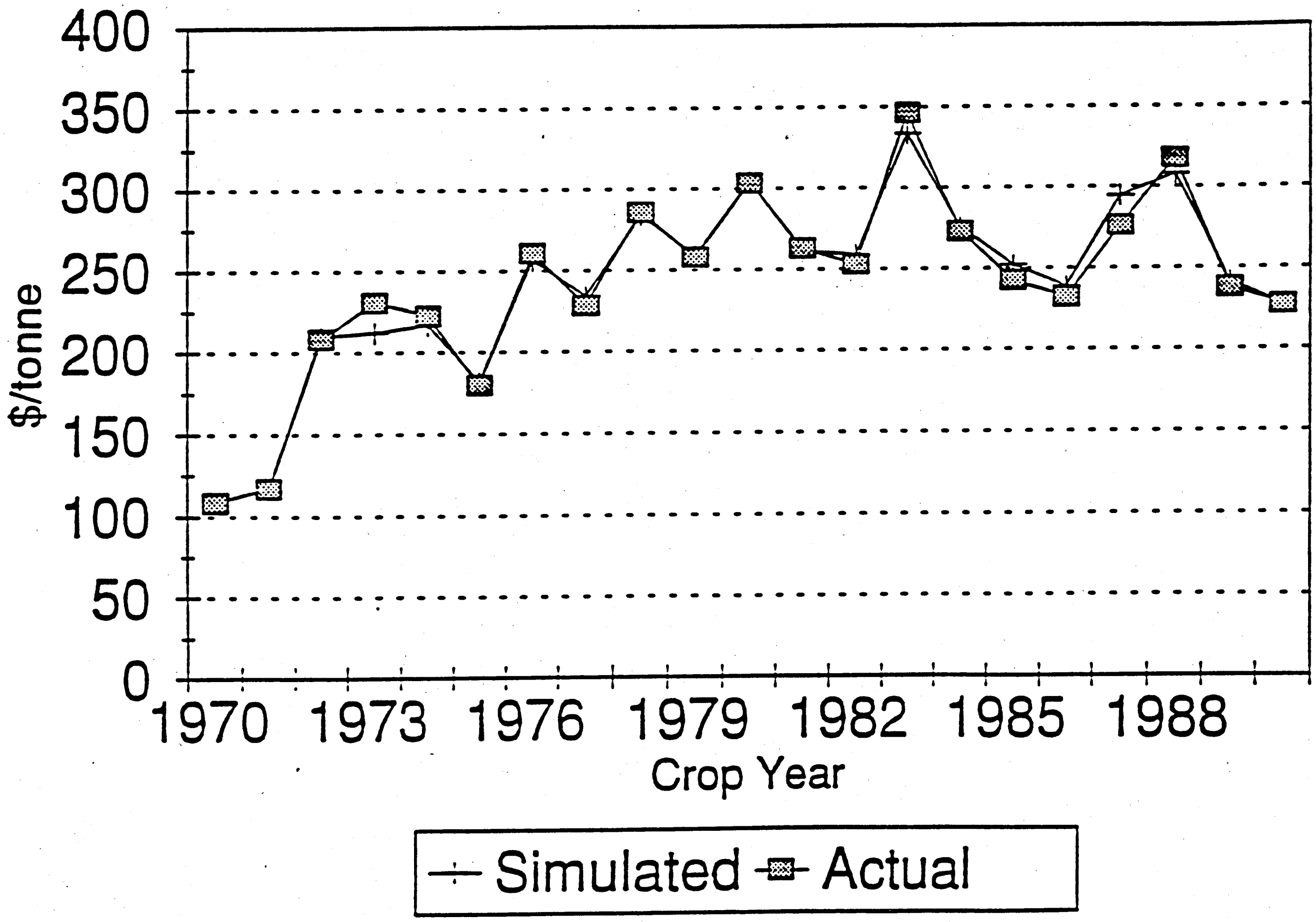


FIGURE 4.5: ACTUAL AND SIMULATED PRICE OF SOYMEAL, 1970/71-1990/91

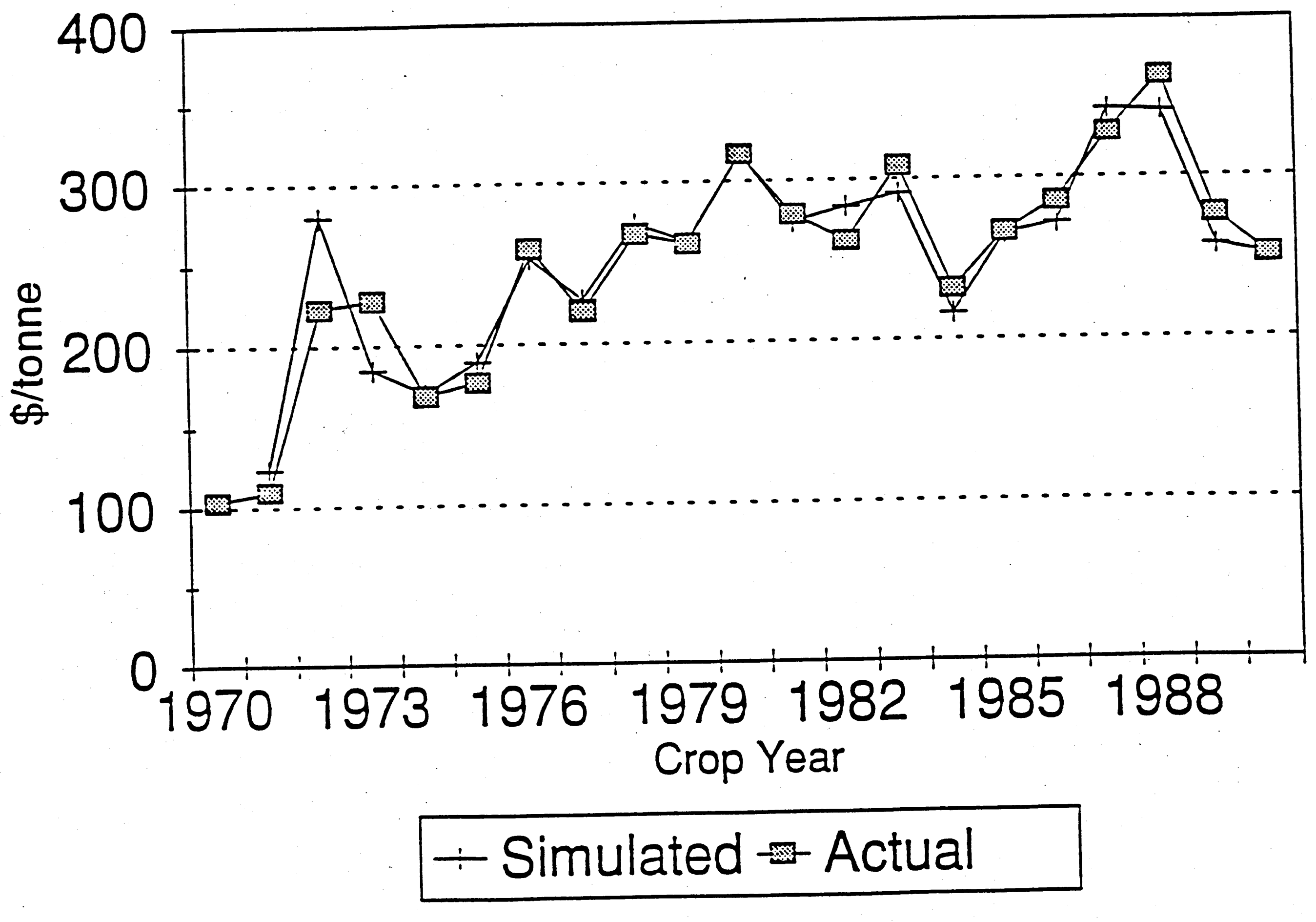


FIGURE 4.6: ACTUAL AND SIMULATED CRUSH OF SOYBEANS, 1970/71-1990/91

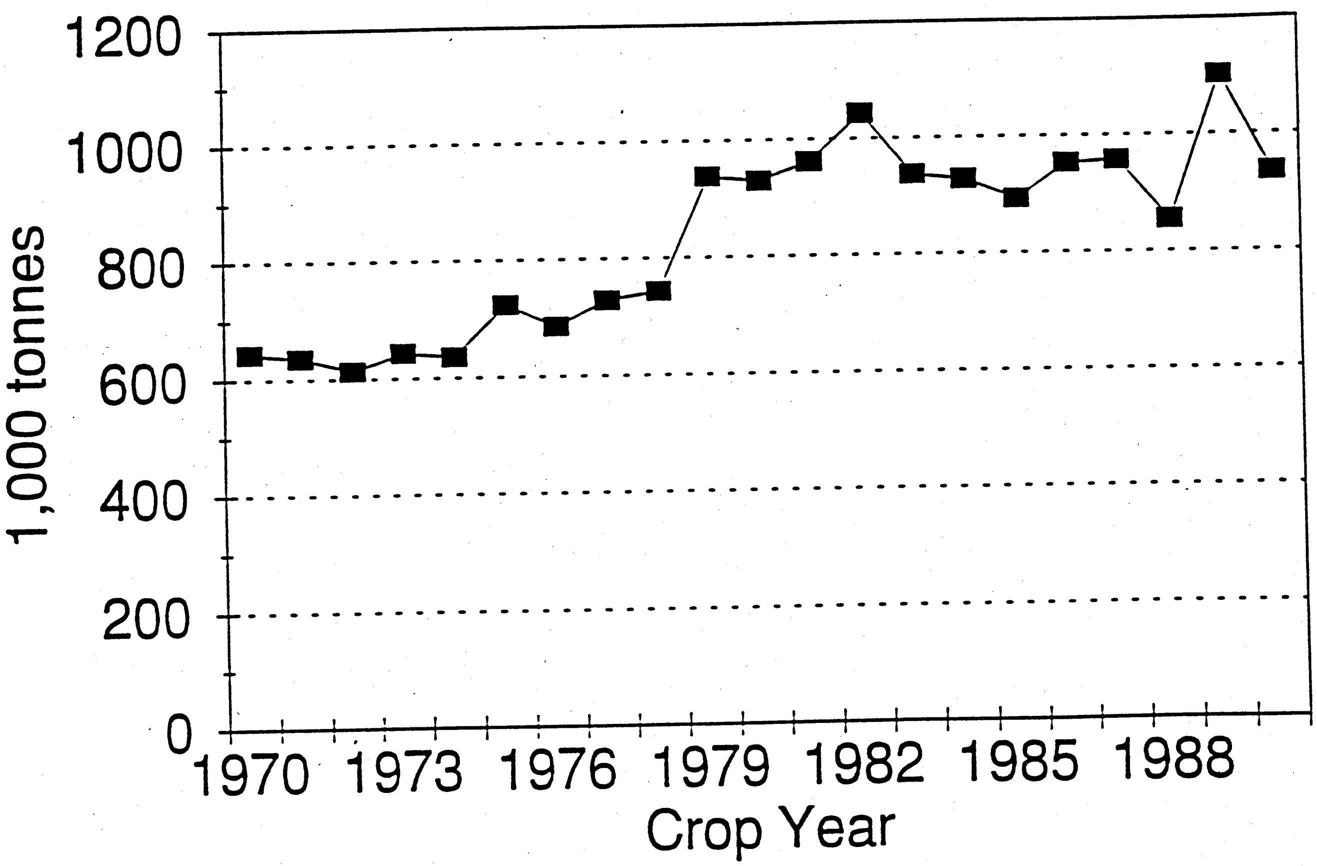


FIGURE 4.7: ACTUAL AND SIMULATED DOMESTIC DEMAND FOR SOYMEAL, 1970/71-1990/91

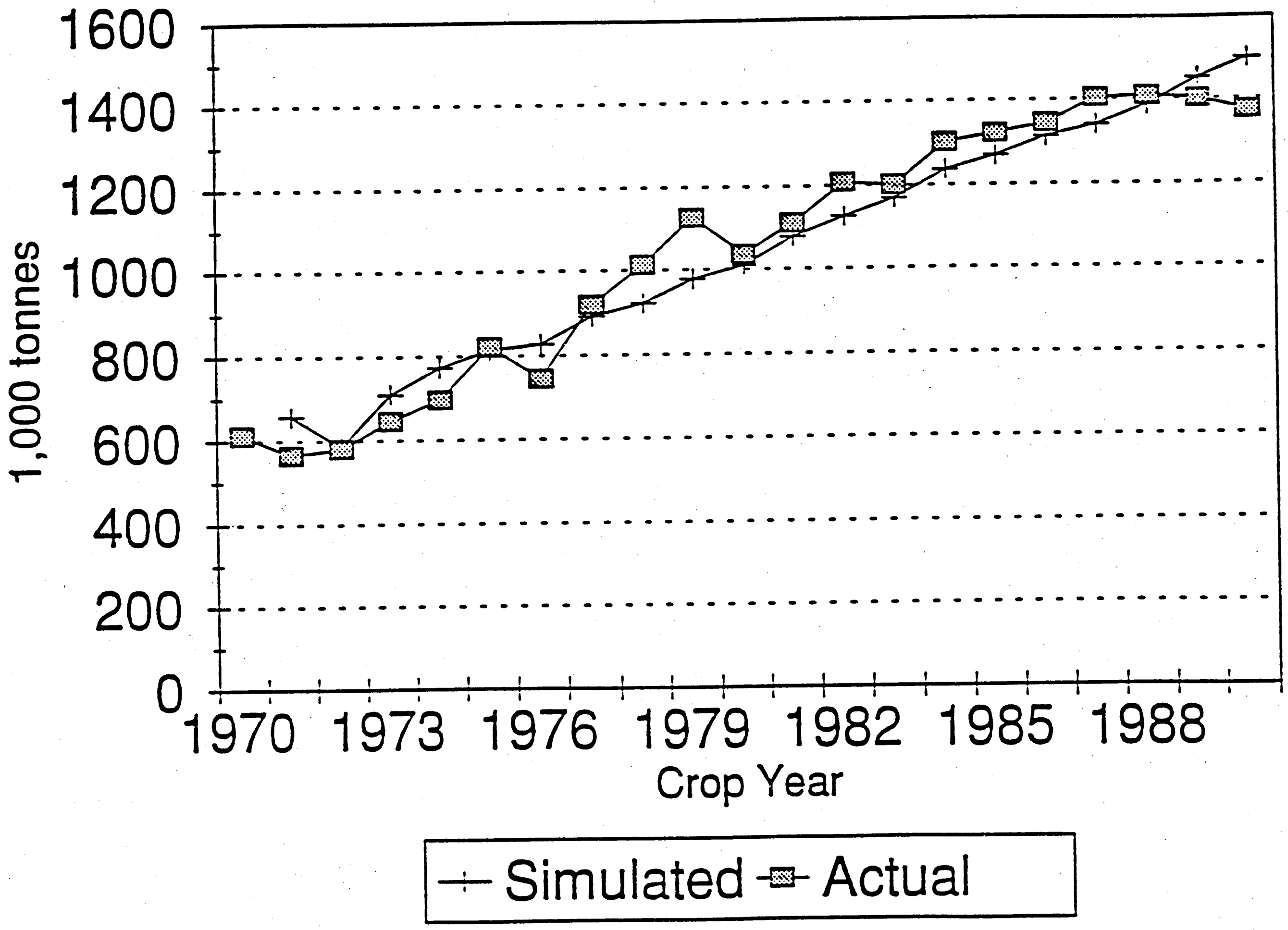


FIGURE 4.8: ACTUAL AND SIMULATED DOMESTIC DEMAND FOR SOYOIL, 1970/71-1990/91

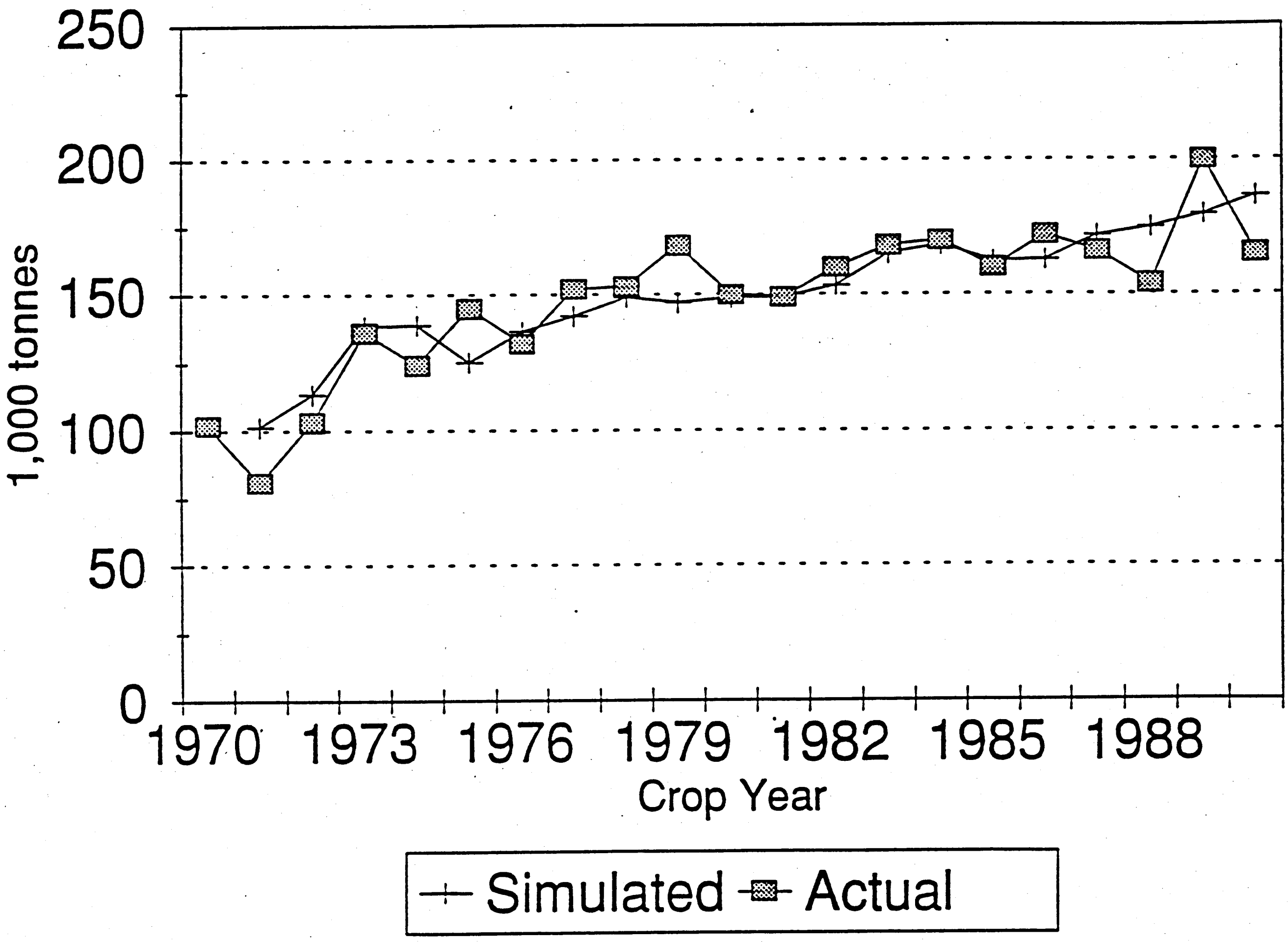


FIGURE 4.9: ACTUAL AND SIMULATED CRUSH MARGIN FOR SOYBEANS, 1970/71-1990/91

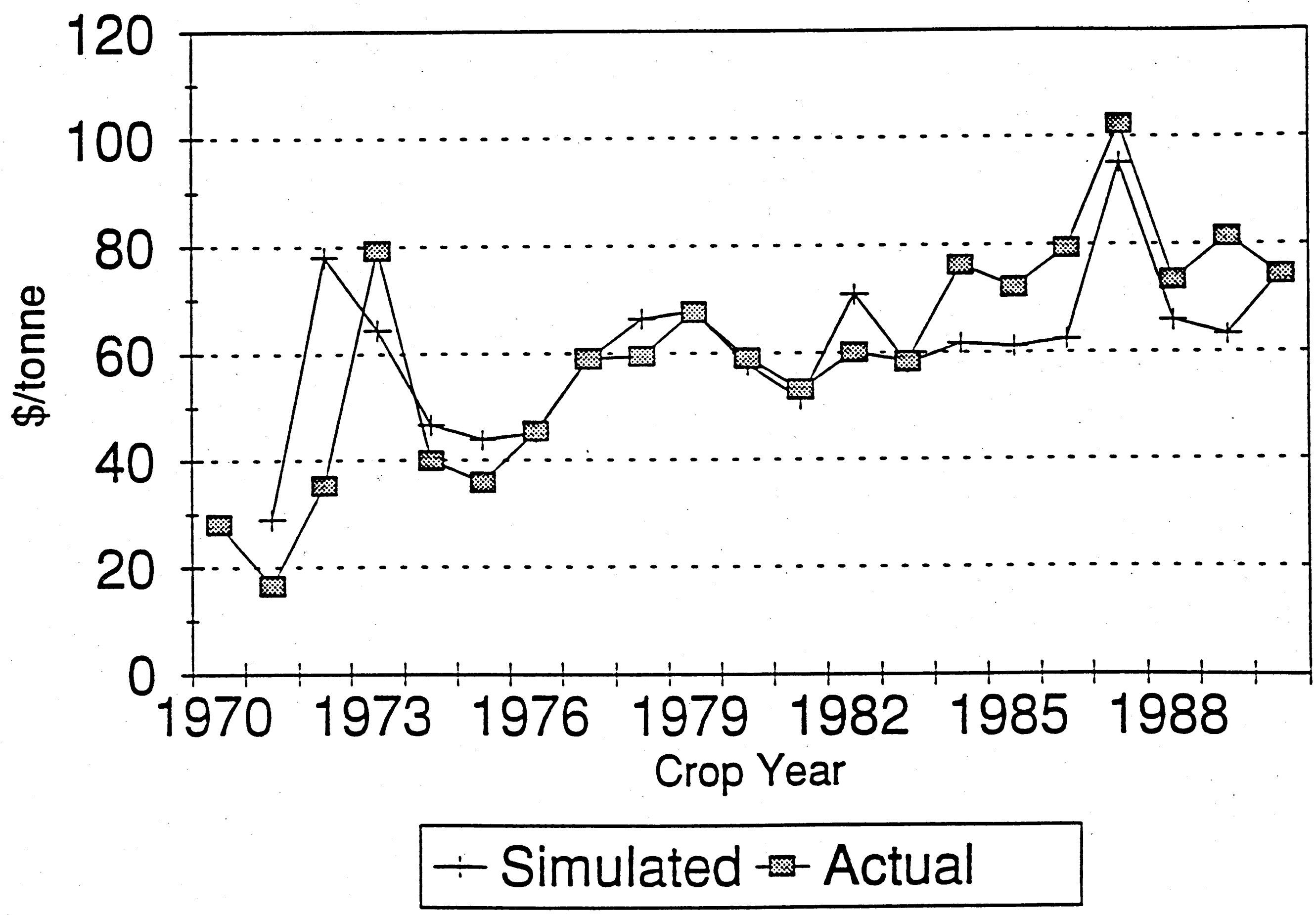


FIGURE 4.10 ACTUAL AND SIMULATED PRODUCTION OF SOYOIL, 1970/71-1990/91

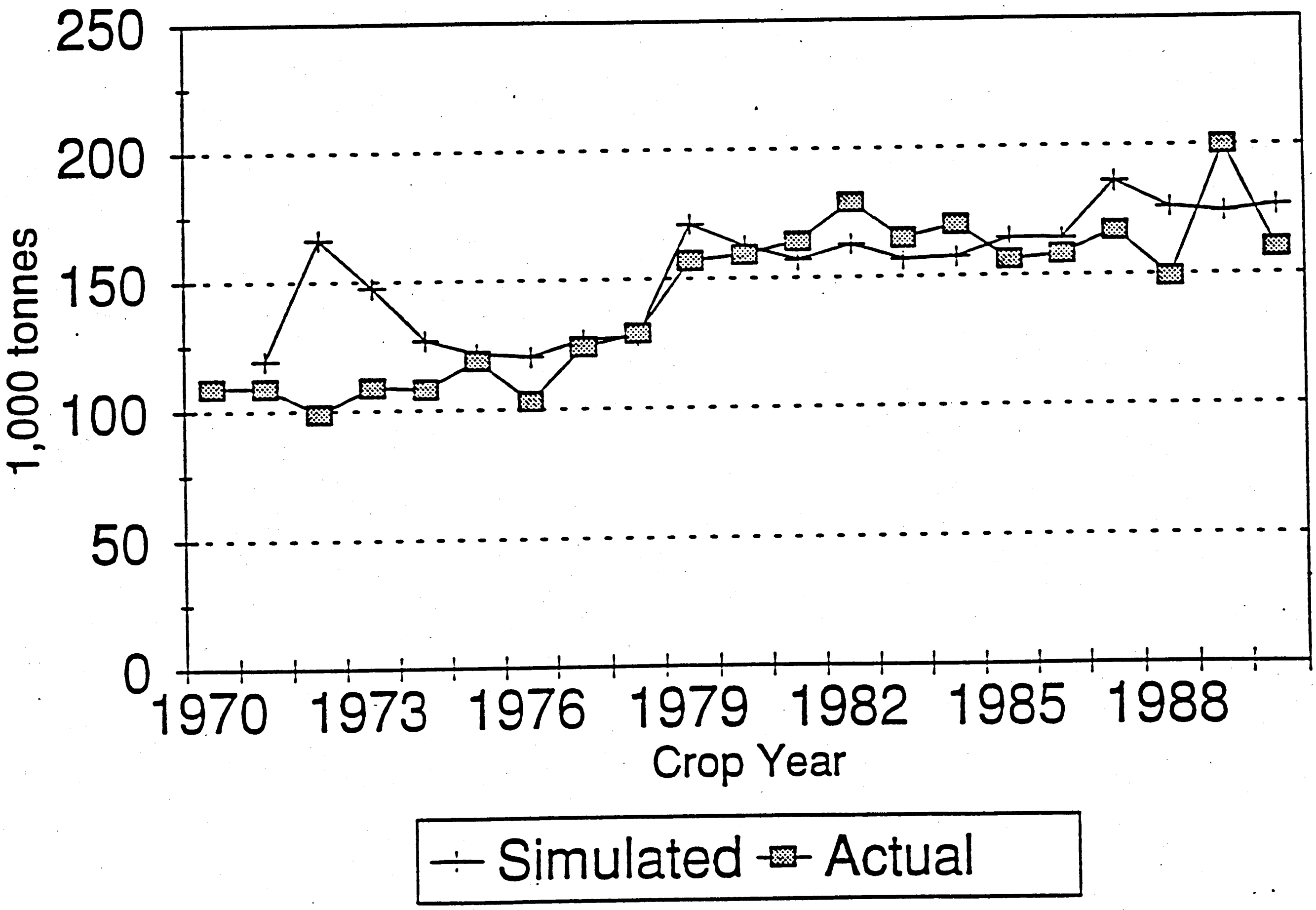


FIGURE 4.11: ACTUAL AND SIMULATED PRODUCTION OF SOYMEAL, 1970/71-1990/91

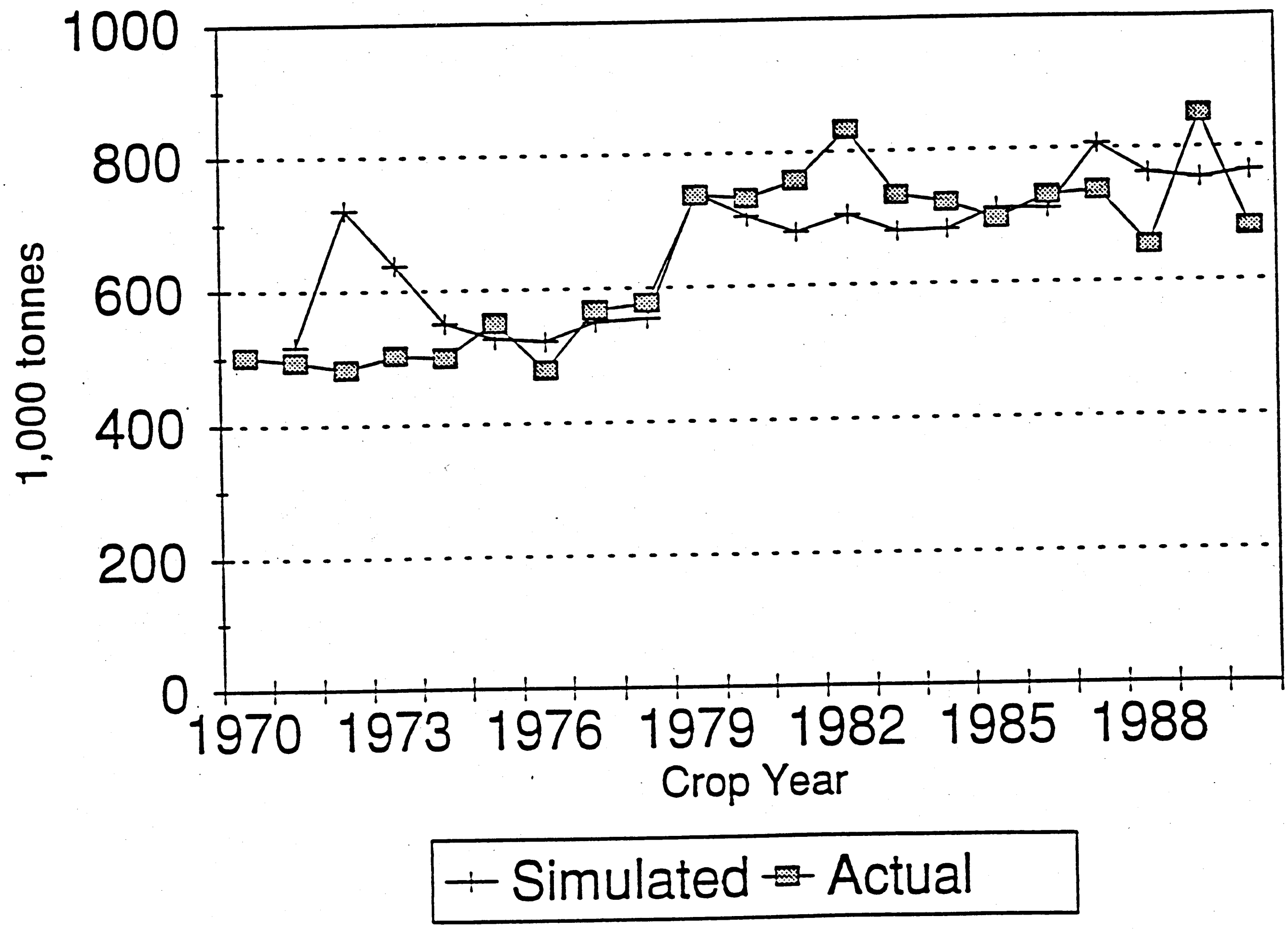


FIGURE 4.12 ACTUAL AND SIMULATED NET IMPORTS OF SOYOIL, 1970/71-1990/91

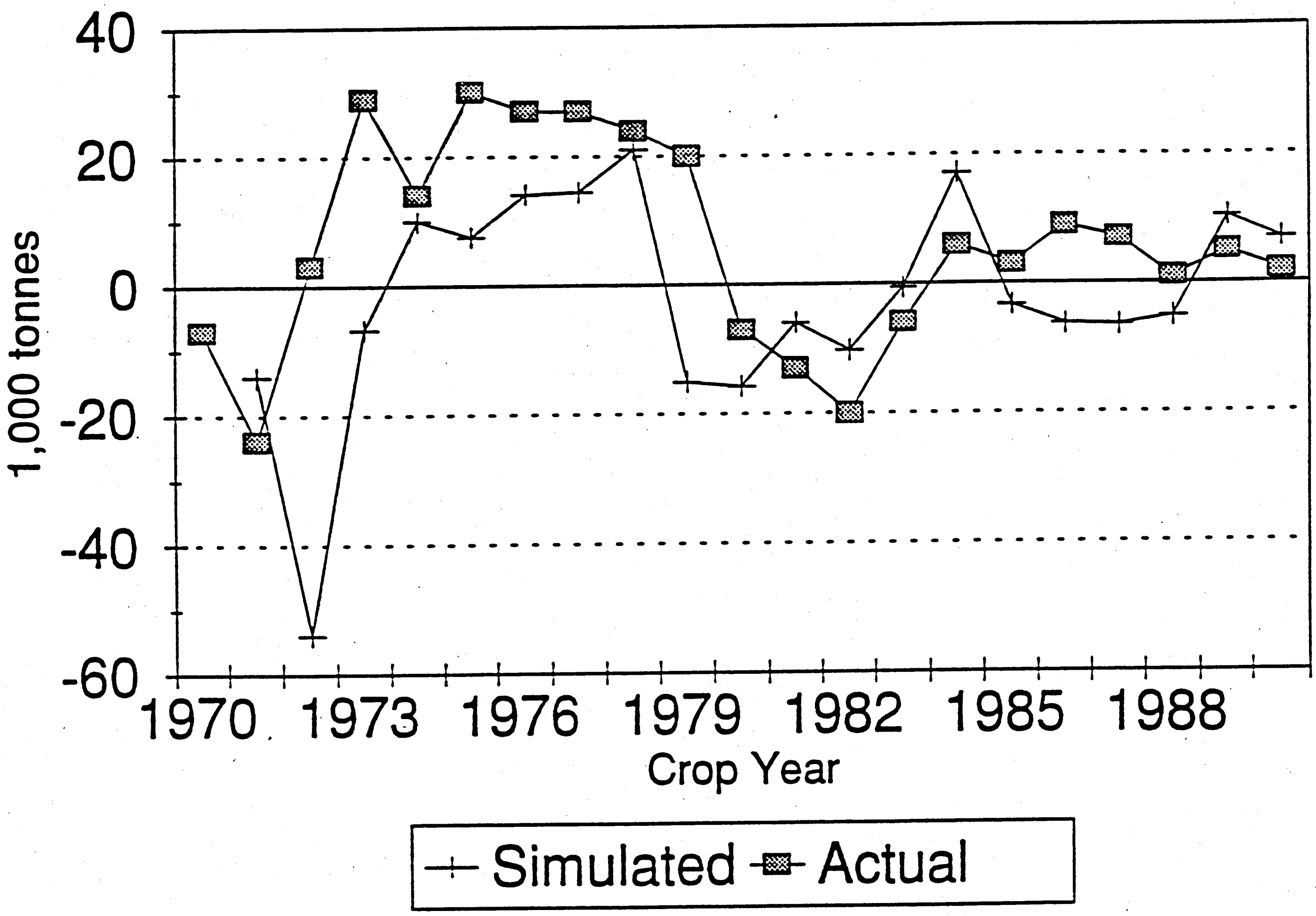


FIGURE 4.13: ACTUAL AND SIMULATED NET IMPORTS OF SOYMEAL, 1970/71-1990/91

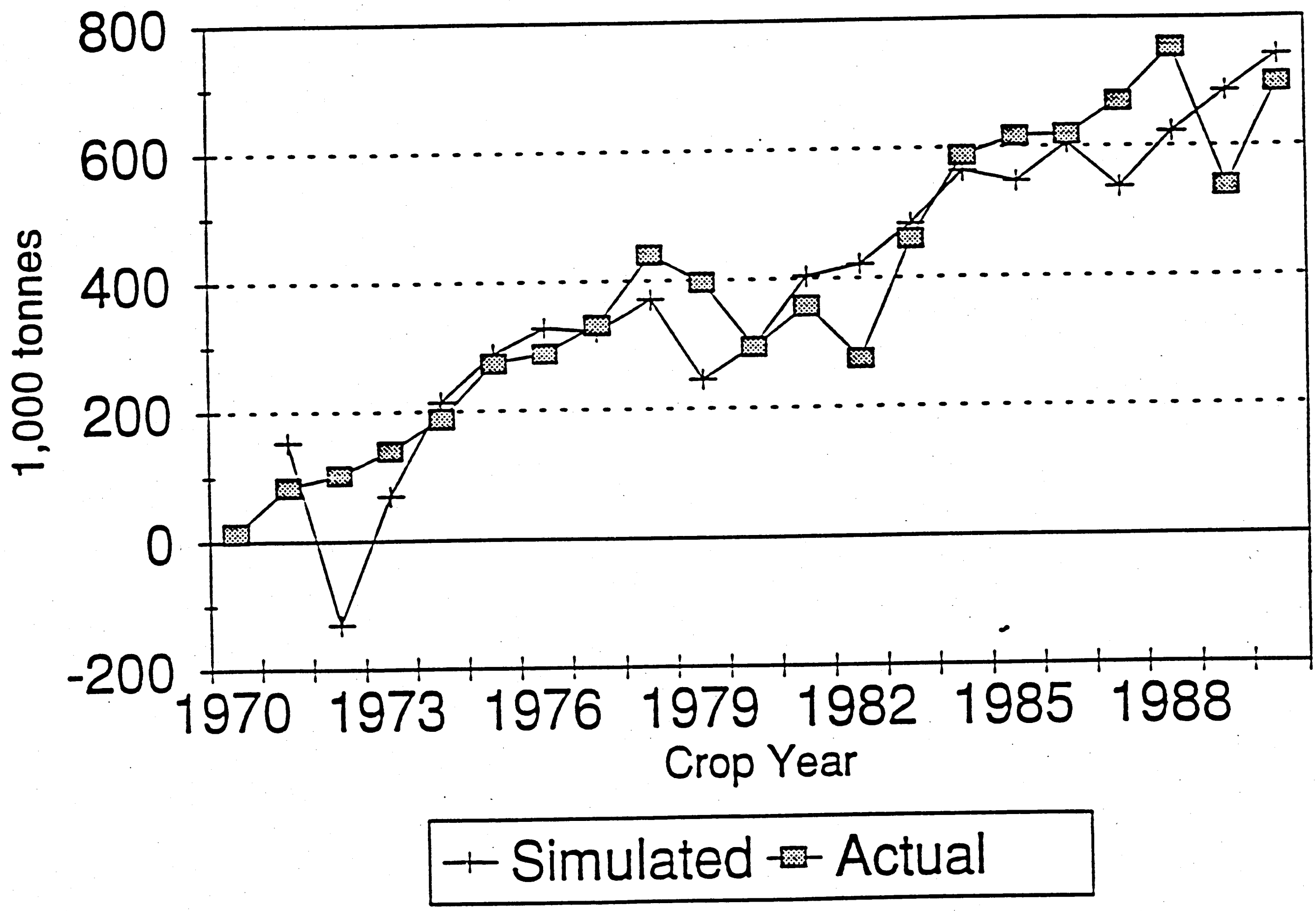


FIGURE 4.14: ACTUAL AND SIMULATED FEED, SEED, WASTE SOYBEANS, 1970/71 1990/91

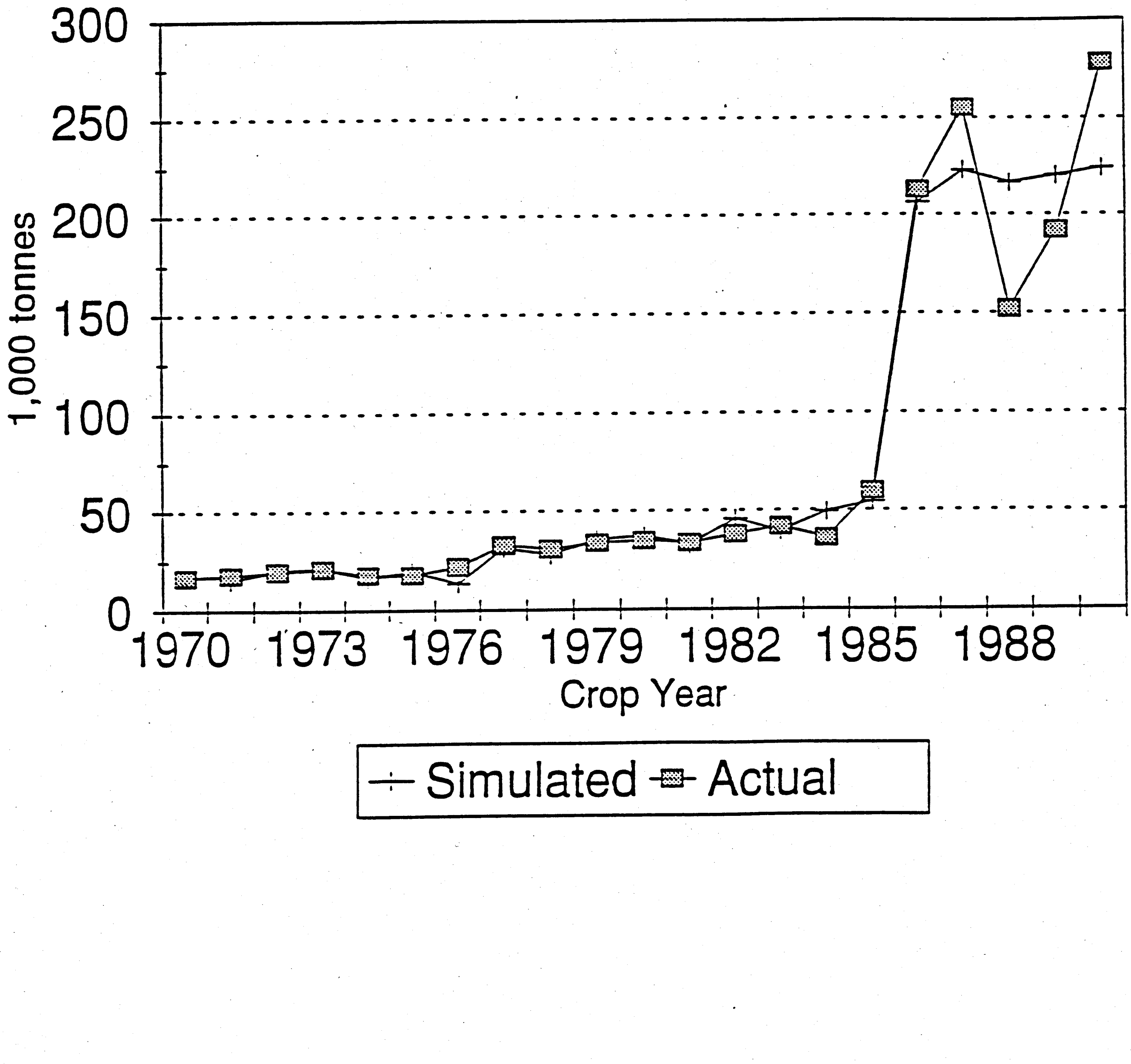


FIGURE 4.15: ACTUAL AND SIMULATED INVENTORIES OF SOYBEANS, 1970/71-1990/91

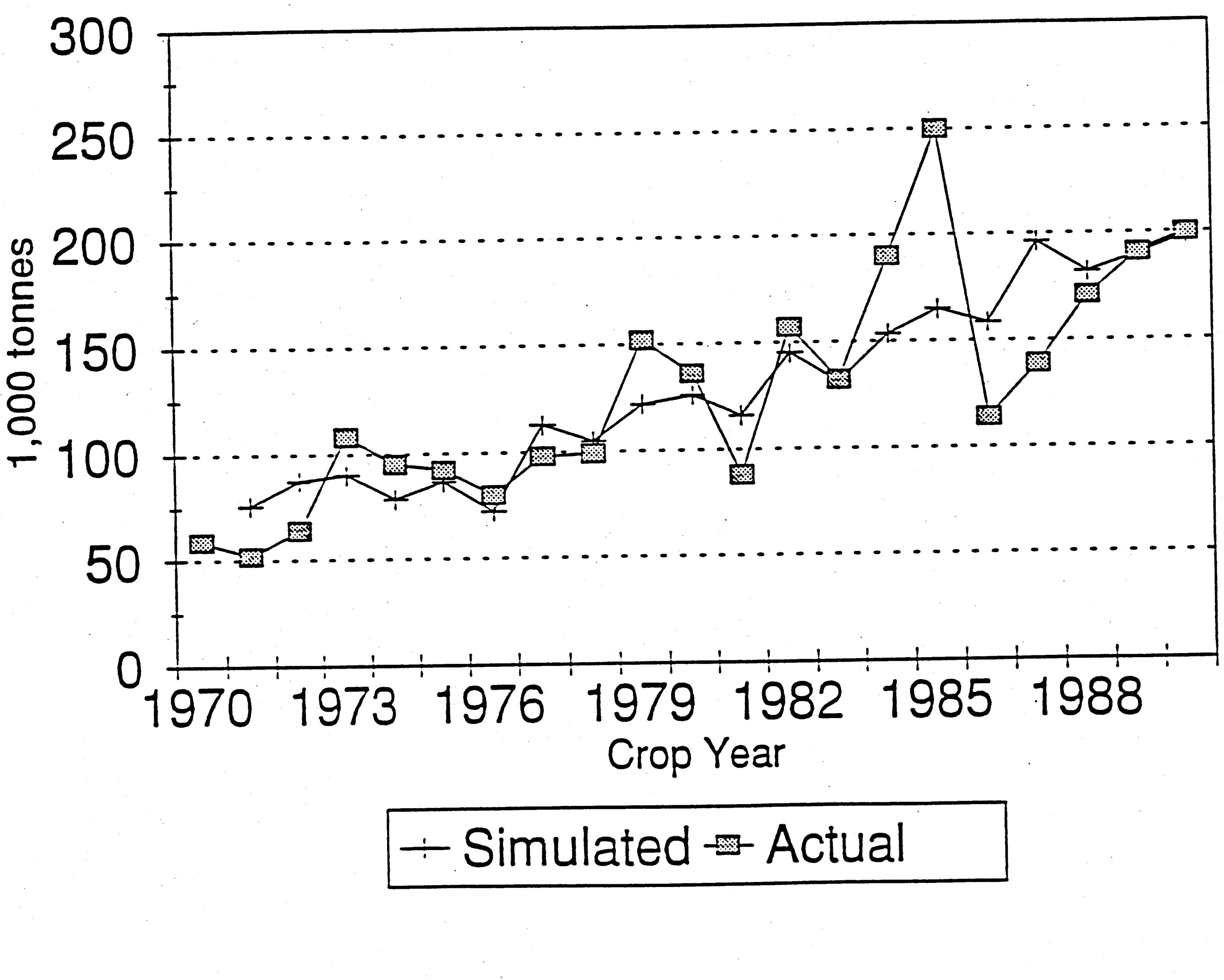
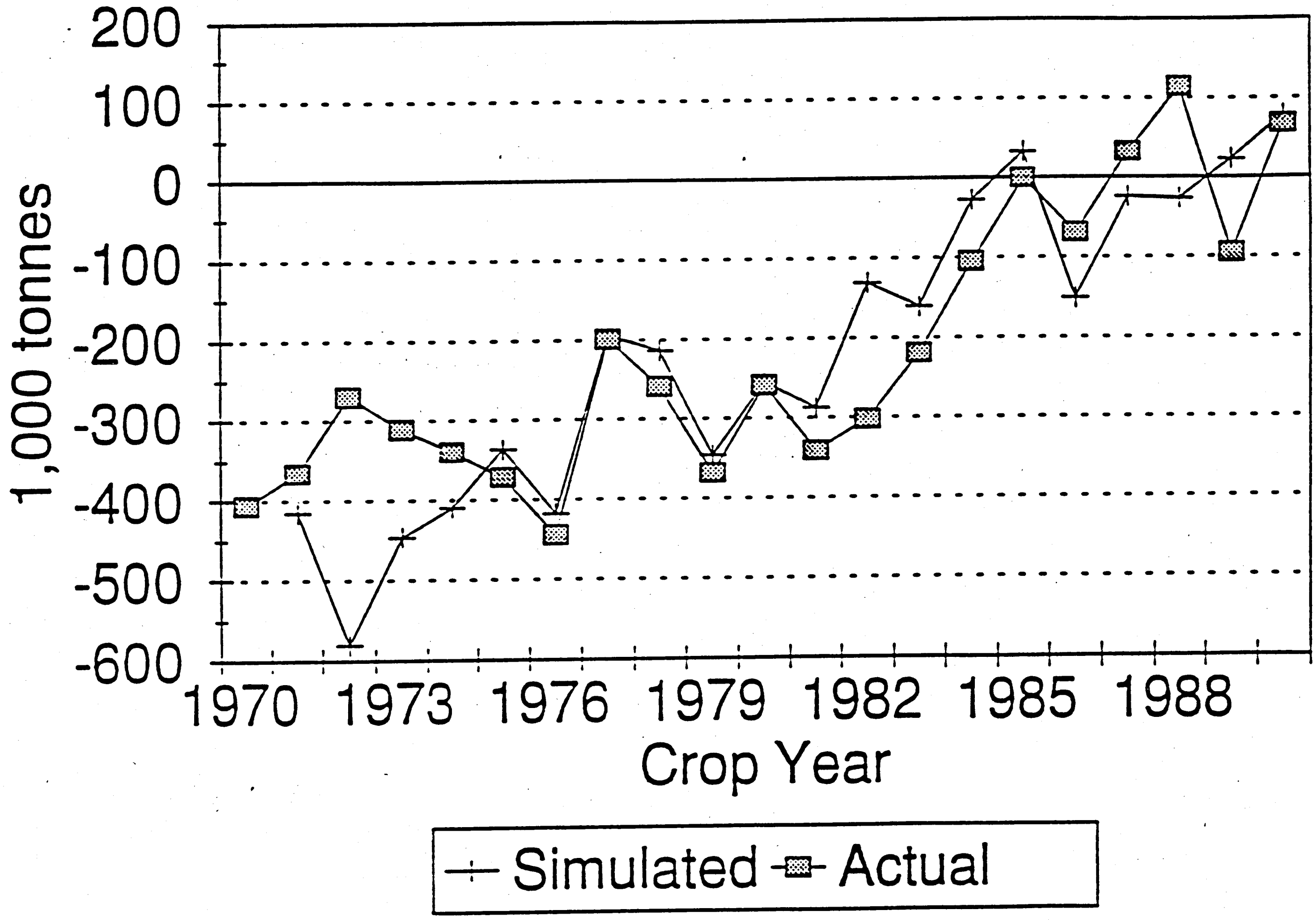


FIGURE 4.16: ACTUAL AND SIMULATED NET EXPORTS OF SOYBEANS, 1970/71-1990/91



5. MULTIPLIERS

Impact multipliers have been estimated for each of the three sub-models. These multipliers are calculated from the estimated equations in each of the models. Each of the endogenous variables is expressed as a function of the exogenous variables, so the net effect of any change in an exogenous variable can be measured on the endogenous variables. There are two aspects of the multiplier that are important in policy analysis: 1) the sign of the multiplier and 2) the magnitude of the multiplier.

In terms of the sign of the multiplier, for example it could be is used to examine the impact of a change in the US price of soymeal, PSM4. If the US soymeal price rises the domestic crush (CSSO) increases, (positive sign) and to offset this the export of soybeans (EXSO) declines (negative sign), (see Table 5.1). The price of US soybeans, soyoil and soymeal have the most net effect on the Canadian soybean model. This is to be expected because of the small Canadian industry beside the large US industry and the open boarders between the two countries.

The magnitude of the multiplier is also very important because it tells how much the endogenous variables respond to a change in the exogenous variable. For example, one tonne increase in soybean production (QSO) results in the exports of soybeans (EXSO) increasing by .83 of a tonne and inventories (ISO) by .12 of a tonne.

The flax multipliers are presented in Table 5.2. These multipliers can be interpreted as the change in the endogenous variables due to a unit shock to one of the exogenous variables. One of the key exogenous variables is production of flaxseed in Canada, QFL. For example, increased production of flaxseed by 1,000 tonnes is shown to result in increased exports (EXFL) of 407 tonnes, commercial stocks (CIFL) of 342 tonnes, farm stocks (FIFL) by 172 tonnes and negligible increases in crush (CSFL). Increases in both Canadian flaxseed production and production and stocks in EC, US and Argentina (QFL62*) are shown to result in lower price of flaxseed (PFL).

TABLE 5.1: MULTIPLIERS* FOR SOYBEAN MODEL

Endog. Var.	PSO4C	PSM4C	CAP	PRM	TREND	PRL	POPCAN
PSO	0.913						
PSM		1.0337					
CSSO	-1.4116	1.2394	0.2316				
DDSM		-0.4376		0.3673			
DDSL					42.8848	0.0318	19.1557
ISO							
DFSO							
CMSO	-0.9183	0.8063					
EXSO	1.4116	-1.2394	-0.2316				
QSL	-0.2541	0.2231	0.0417				
QSM	-1.1010	0.9668	0.1806				
IMSL	0.2541	-0.2231	-0.0417			0.0318	19.1557
IMSM	1.1010	-1.4404	-0.1806	0.3673	42.8848		

Var.	QSO	DUMMY	$ISO_{(t-1)}$	CPI	ISL	ISM
PSO						
PSM						
CSSO				-0.9211		
DDSM				0.3739		
DDSL				-0.1046		
ISO	0.1215					
DFSO	0.0533	154.7430				
CMSO						
EXSO	0.8252	-154.7490	1.0000	0.9211		
QSL				-0.1658		
QSM				-0.7185		
IMSL				0.0612	1.0000	1.0000
IMSM						

* Multipliers evaluated at 1990 values.

TABLE 5.2: MULTIPLIERS FOR THE FLAX MODEL

Endogenous Variables	Exogenous Variables						
	PSO	QFL	QFL62*	CPI	T	$FIFL_{(t-1)}$	$CIFL_{(t-1)}$
PFL	0.7703	-0.0852	-0.0768	0.1819	-0.1838	-0.1953	-0.1953
EXFL	0.2598	0.4074	-0.0259	-0.8699	0.8788	0.9340	0.9340
CSFL	-0.0345	0.0038	0.0034	0.1148	-0.9326	0.0087	0.0087
DFFL		0.0744					
FMFL	0.1276	0.7539	-0.0128	-0.4294	-0.0305	0.9675	-0.0325
CIFL	-0.0977	0.3427	0.0097	0.3256	0.0233	0.0248	0.0248
FIFL	-0.1276	0.1716	0.0128	0.4294	0.0305	0.0325	0.0325

* The multipliers for QFL62, QFL4, QFL63, and their lagged stocks are the same.

The canola multipliers are presented in Table 5.3. If the price of soybean oil (PSL) increased by 1 percent, canola oil price (PRL) will increase by .840 percent. It would result in an increase in canola seed price (PRA) of .25 percent. It would have only a small impact on the crush margin (CMRA), .08 percent, and the crush of canola (CSRA) by .09 percent. The production of canola (QRA) is shown to largely result in canola exports (EXRAO) to other regions and also in increased commercial inventory (CIRA).

TABLE 5:3: MULTIPLIERS* FOR THE CANOLA MODEL

Endogenous Variables	Exogenenous Variables				
	PSL	PSM	PSO4C	CAP	QRA
PRL	0.8402				
PRM		0.5729			
PRA	0.2530		0.5854		
CMRA	0.0831	0.3323	-0.5854		
CSRA	0.0872	0.3489	-0.6146	0.2515	
CIRA	-0.0579		-0.1340		0.2403
DFRA					0.0994
EXRAJ	-0.0618		-0.1430		
EXRAO	-0.1097	-0.3489	0.5626	-0.2515	0.6164
EXRA	-0.1715	-0.3489	0.4196	-0.2515	0.6164
FIRA	0.1422		0.3289		0.0439
FMRA	-0.1422		-0.3289		0.8567
QRL	0.0349	0.1395	-0.2458	0.1006	
QRM	0.0506	0.2023	-0.3564	0.1459	
DDRL	-0.0159				
DDRM		-0.0792			
EXRL	0.0507	0.1395	-0.2458	0.1006	
EXRM	0.0506	0.2816	-0.3564	0.1459	

Endogenous Variables	Exogenous Variables				
	$CIRA_{(t-1)}$	DI2	PCDIJD	QD	$FIRA9_{(t-1}$
PRL					
PRM					
PRA					
CMRA					
CSRA					
CIRA	0.2675	-495.7800			
DFRA					

(continued)

TABLE 5.3 (Continued)

Endogenous Variables	Exogenous Variables				
	$CIRA_{(t-1)}$	DI2	PCDIJD	QD	$FIRA9_{(t-1}$
EXRAJ			6.1458		
EXRAO	0.7325	495.7800	-6.1458	-231.9300	1.000
EXRA	0.7325	495.7800		-231.9300	1.000
FIRA				231.9300	
FMRA				-231.9300	1.000
QRL					
QRM					
DDRL					
DDRM					
EXRL					
EXRM					

Endogenous Variables	Exogenous Variables				
	HOG	IRL	IRM	T	CPI
PRL					
PRM					
PRA					
CMRA					
CSRA					-0.1534
CIRA					0.5350
DFRA					
EXRAJ					
EXRAO					
EXRA					
FIRA					0.9661
FMRA					-0.9661
QRL					-0.0614

(continued)

TABLE 5.3 (Concluded)

Endogenous Variables	Exogenous Variables (Concluded)				
	HOG	IRL	IRM	T	CPI
QRM					-0.0890
DDRL				13.6385	0.0846
DDRM	42.5180				0.1647
EXRL		-1.0000			-0.1460
EXRM			-1.0000		-0.2537

* Multipliers evaluated at 1990 values.

6. SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

6.1 Summary

In this project we developed an econometric model of the Canadian oilseed economy. The primary purpose was to have a model that could forecast price and quantitative changes for key variables in the oilseed economy as well as analyze the effects of changes in agricultural policies, both domestic and international, on Canada's oilseed processing industry.

The project consisted of developing three sub-models for the three oilseeds; canola, flaxseed and soybeans. Since one of the objectives of the study was to model the value added processing it was desirable to have each model include the seed, the oil and the meal. This was done for canola and soybeans, but in the case of flaxseed the linoil and linmeal components were excluded. It proved impossible to obtain reasonable estimates for linoil and linmeal components largely because of the low level and erratic nature of flaxseed crushing in Canada.

The study developed background information on each oilseed. This consisted of describing the structure of the domestic market including production, inventories, processing, domestic demand for the oil and meal as well as trade of the seed, oil and meal. There was also some discussion of the international market that is relevant to domestic market. In each case the study described how prices are discovered as well as the factors that influence price determination.

A conceptual model was developed for each of the three oilseeds. It laid out the theoretical relationships for price discovery and the determination of the key quantitative variables.

The structure of each of the theoretical/conceptual models was presented in equation form followed by the estimated equations. What is presented in the report is the equations for the price variables and the crushing demand function. Given the main objectives of the project these are seen to be the most important components of the model.

The overall canola model consisted of 20 equations, with 12 estimated structural equations. The model was originally specified so that the world price of canola was determined endogenously in the Canadian seed market. Given the importance of Canadian canola to the world canola market it was assumed that the demand for Canadian canola and canola products especially canola oil would be downward sloping. However the estimates of the canola model specified along these lines proved to be unsatisfactory. The model was thus re-specified to have the price of canola oil and meal determined directly by the price of soyoil and soymeal in Canada which is driven off the US soyoil and soymeal markets. The price of canola seed in Canada was specified to be a function of the price of canola oil and the Canadian soybean price. The R^2 was 0.87 indicating the strong relationship between the Canadian canola market and the US soybean complex. The demand for canola for crushing in Canada was specified as a function of the canola crushing margin and the canola crushing capacity. The results showed the canola crushing activity to be unresponsive to the annual level of the canola crushing margin but highly responsive to the available capacity.

The flaxseed model was specified so that the price of flaxseed was endogenously determined. The model consisted of 7 equations. As the quantity of flaxseed that is crushed in Canada is so small and such a small percentage of production, the estimation of the demand for seed for crushing proved to be difficult. Because of the difficulty of forecasting linseed oil and meal, they were dropped from the model. The price of flaxseed and Canadian flaxseed exports were simultaneously determined

The soybean model was specified so that Canadian prices of soybeans, soyoil and soymeal were functions of US soybean, soyoil and soymeal prices. The two markets are closely linked and this was verified by the estimated price equations. The elasticity of US soybeans with the Canadian price of soybeans is 0.98, very close to unity. The price linkage between Canadian soymeal price and the US soymeal price was 0.92, again close to unity. The lack of a reliable time series for Canadian soyoil price meant that we used an identity between the Decatur soyoil price and the Canadian soyoil price. The crush demand for soybeans was specified in a similar manner to canola to include the soybean crushing margin and the available crushing plant capacity. The crushing margin had the correct sign but was not significant. Crush capacity was highly significant. An elasticity of .2 was forced on the crush margin.

In order to validate the model simulations were carried out for each of the three sub-models. In each case the dependent variable was simulated by using the estimated coefficients on the independent variables and the actual independent values. The predicted root mean square error (PMSE) and Theil U were the two statistics used to measure the ability of the estimated model to simulate the values of the real variables. The results were that the soybean model simulated quite well whereas the canola and flaxseed models simulated less well. In the case of soybeans all but two variables had PMSE and Theil U statistics less than one. In the case of canola 5 PMSE values out of a total of 18 were greater than one but for Theil U, 7 out of 18 were greater than one. For flaxseed 2 out of 7 dependent variables had PMSE values greater than one and one Theil U greater than one.

Impact multipliers were developed for each of the sub-models. The impact multipliers were calculated from the estimated equations where the endogenous variables were expressed as function of the exogenous variables. Both the sign and the magnitude of the multipliers are important. The results are expressed in three tables. The multipliers can be used to examine various policy implications. These have been left for subsequent analysis.

6.2 Conclusions

The primary conclusion from this research is that the Canadian oilseed industry (with the possible exception of soybeans) is very difficult to model econometrically. The reason for this is threefold. First, prices of canola and flaxseed are quite variable year to year as are farm inventories. Institutional factors also impact on delivery levels and price discovery. It is unlikely that a good econometric fit can be achieved for some of these variables. Second, the data is quite poor especially for value added processing and especially for flaxseed. Some of the price series for the oils and meals are suspect. Finally, soybean oil demand and canola oil demand are going through a structural change due to human health considerations. This means that the price parameters are very unstable and difficult to estimate.

The models are especially important for certain policy impacts. The models also represent a basis for forecasting, at least short term forecasting. They do allow for the prediction of some key parameters in the value added sector. This is an improvement over currently available models. For this reason the models should improve the FARM model adding to its ability to predict impacts on the value added oilseed economy in Canada.

6.3 Suggestions for Further Research

There are a number of major world economic and agricultural trade policy developments in future that will impact on the Canadian oilseed economy, especially the value added processing sector. These are discussed briefly. They are areas for further research both in terms of using the models and extending the breadth of analysis beyond the models of this study.

First are the implications of agricultural reforms in the EC-12. The oilseed sector in the EC-12 has, since the inception of the Common Agricultural Policy in 1962, been handled differently than cereals, meats and dairy. This has led to distortions in livestock feeding where domestically cereals are overpriced compared to protein meals. This has led to increased imports of oilseeds, especially protein meals and encouraged cereal exports. Given the size of the EC-12 market, any structural change will have an important bearing on the world pricing relationships between the cereals and oilseeds complexes.

Second are the implications of NAFTA. There are strong possibilities for expanded exports to Mexico and the health food market in the US could afford increasing demand for canola oil. The environmental movement could result in the re-emergence of linoleum as a hard surfaced flooring replacing vinyls as has happened in Sweden. Since linoleum uses large quantities of linoil, this would have strong implications for the flaxseed industry.

Third are the emerging markets in the Pacific Rim, with the strong economic growth of the None-Industrialized Countries (NICs) and more recently China. It is important that long-run scenario type analyses be carried out to provide a basis for developing Canadian trade policies. There are opportunities for forging new trade relationships for Canadian primary and processed food products.

Fourth are the future developments in the former Soviet Union (FSU) and Eastern Europe. This is a large market for oilseed and especially protein meals.

These are only the more obvious areas that require analysis. Analysis for the value added oilseed sector is important given Canada's investments in crushing and refining capacity and our excellent background in basic oilseed research.

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* The list of references do not include data sources for variables as they are contained in Appendix A.

APPENDIX A

Statistical Procedures

The models were estimated as single equations using OLS, corrected for autocorrelation as indicated by the Durbin-Watson one-tailed test. The computer software, SHAZAM, was used for all estimations.

Simulation for the canola model was conducted in a recursive fashion. Simulated values were obtained, firstly, for all those endogeneous variables whose estimated equations contained only exogeneous right-hand side variables. Next, simulated values were obtained for those endogeneous variables whose estimated equations contained either exogeneous right-hand side variables and/or right-hand side variables for which simulated values had been determined in the first step. Simulation was conducted using the spreadsheet software, Quattro-Pro. Simulation for flax required simultaneous solution which was conducted in RATS. The program is provided below. A similar program was used for the soybean simulation.

In order to be able to examine the simulations of the oilseed complex as a whole, simulated values of variables exogenous to a particular model, but endogeneous to another model, were incorporated into the simulations. For example, in order to simulate the price of canola meal as a function of the price of soymeal, the *simulated* value of the price of soymeal was used as the explanatory variable. This is necessary in that any policy impacts on the price of canola meal will arise primarily through the U.S. soybean complex and in turn through the Canadian soybean complex. Although it may seem easier to have estimated the price of canola meal directly from the U.S. price of soymeal, it was felt that it was preferable to establish the linkages between the three oilseed sectors in Canada.

Simulation and model validation statistics, percent mean square error (PMSE) and Theil U2 were calculated using Quattro-Pro for the canola model. Percent mean square error is given by:

$$\sqrt{\sum_{i}^{n}\left(\frac{P_i-A_i}{A_i}\right)^2}$$

where, P_i = simulated value in year i; and A_i = actual value in year i.
Sometimes PMSE is referred to root percent mean square error.

The Theil U2 statistic is given by:

$$\frac{\sum_{2}^{n}(P_i-A_i)^2}{\sum_{2}^{n}(A_i-A_{i-1})^2}$$

The Theil U2 statistic uses the previous time period as a benchmark to assess the forecasting ability of the model. Simulation statistics for the flax and soybean models were calculated using RATS. The source file is given below for the flax model as reference. The code for the soybean model is structurally identical with appropriate variable changes.

The multiplier tables for the canola and flax models were constructed by determining the reduced-form of each model (i.e. reducing the system of structural equations to a system with endogeneous variables on the left hand side and only exogeneous variables on the right hand side). These multipliers were called impact multipliers because they measure the impact of a unit shock to a particular exogenous variable, ceteris parabis. The multiplier table can be used to check the model by examining the size and sign of the multipliers and the linkages between the variables. The multipliers were evaluated at baseline=1990.

The multipliers for the flax model are found using the RATS program below. The code for the soybean model is structurally identical with appropriate variable changes.

RATS Source File to Calculate Simulations and Simulation Statistics

[*Comments are in square brackets and italicized. These have been added to the text and are not in the format used in RATS to insert programming comments. The program was modified for the soybean model but the basic structure of the program is the same.*]

```
CALENDAR 1970
ALL 0 2000:1
SMPL 1 21
DATA(UNIT=INPUT,ORG=OBS) 1 21 YEAR QFL4 IFL4 QFL63 IFL63 QFL62 IFL62
```

[*Enter data for variables after each DATA command for variables specified. This can also be done from a WKS file using FORMAT=WKS instead of UNIT=INPUT. Then all the data can be read in with one DATA command*].

```
DATA(UNIT=INPUT,ORG=OBS) 1 21 YEAR PFL  PSO QFL CIFL FIFL CSFL
DATA(UNIT=INPUT,ORG=OBS) 1 21 YEAR DFFL FMFL CPI EXFL
DATA(UNIT=INPUT,ORG=OBS) 1 21  PSOHAT
```

[*Total supplies (= production + lagged stocks) are generated using the SET command*].

```
SET S62 2 21 = QFL62(T) + IFL62(T-1)
SET S63 2 21 = QFL63(T) + IFL63(T-1)
SET S4 2 21  = QFL4(T) + IFL4(T-1)

SMPL 2 21
```

[*The equations are defined using the FRML command. Note that the endogenous variables each have a FRML command and must appear on the left-hand side of the formula.*]

```
FRML(IDE) SID62 S62 = QFL62(T) + IFL62(T-1)
FRML(IDE) SID63 S63= QFL63(T) + IFL63(T-1)
FRML(IDE) SID4 S4= QFL4(T) + IFL4(T-1)
FRML(IDE) PFLID PFL=0.8246*PSOHAT(T)-.2091*EXFL(T)  $
      -.0822*(S62(T)+S63(T)+S4(T))+278.72
FRML(IDE) CSFLID CSFL = -5.5127*PFL(T)/CPI(T)-20.225*LOG(YEAR(T)-1969)+110.23
FRML(IDE) DFFLID DFFL = .07443*QFL(T) + 62.637
FRML(IDE) FIFLID FIFL = 156.91*CPI(T)/PFL(T) +.1575*QFL(T) - 54.32
FRML(IDE) CIFLID CIFL = -15.632*PFL(T)/CPI(T) + .33193*QFL(T) + 66.484
FRML(IDE) FMFLID FMFL = QFL(T) + FIFL(T-1) - FIFL(T) - DFFL(T)
FRML(IDE) EXFLID EXFL = FMFL(T) + CIFL(T-1) - CIFL(T) - CSFL(T)
```

[*The system of equations are associated with each other as a "group" under the group name "FLAXF" and forecasts are given variable names.*

```
GROUP FLAXF SID62 SID63 SID4 PFLID>>F_PFL CSFLID>>F_CSFL DFFLID>>F_DFFL
FIFLID>>F_FIFL CIFLID>>F_CIFL FMFLID>>F_FMFL EXFLID>>F_EXFL
```

[*The same command statement is used to form the same group under the group name "FLAXG" which is used later to calculated the multipliers.*]

```
GROUP FLAXG S62ID S63ID S4ID PFLID>>G_PFL CSFLID>>G_CSFL
DFFLID>>G_DFFL  FIFLID>>G_FIFL CIFLID>>G_CIFL FMFLID>>G_FMFL
EXFLID>>G_EXFL
```

[*FLAXF is forecast (simulated) over the sample range 2,21.*]

```
SMPL 2 21
FORECAST(MODEL=FLAXF)
```

[*PFL and its simulation F_PFL are printed.*]

```
PRINT(DATES) / PFL F_PFL
```

[*PFL and its simulation F_PFL are graphed. These commands are deleted from the text for the rest of the variables for brevity but can be re-entered into the program.*]

```
GRAPH(DATES) 2
#PFL
#F_PFL
```

[*Root Percent Mean Square Error (PMSE) is calculated.*]

```
SET ERRSQ 2 21 = ((PFL(T)-F_PFL(T))/PFL(T))**2
STAT ERRSQ
EVAL RPMSE = SQRT(MEAN)
DISPLAY ''
DISPLAY 'ROOT PERCENT MSE IS' RPMSE
DISPLAY ''
```

[*Theil U2 statistic is calculated.*]

```
SET ERRSQ1 2 21 = (PFL(T) - F_PFL(T))**2
SET ERRSQ2 2 21 = (PFL(T) - PFL(T-1))**2
STAT ERRSQ1
EVAL MEAN1 = MEAN
STAT ERRSQ2
EVAL MEAN2 = MEAN
EVAL THEILU2 = MEAN1/MEAN2
```

```
DISPLAY 'THEIL U2 STATISTIC IS' THEILU2
```

[*CSFL and its simulation F_CSFL are printed and PMSE and Theil U2 are calculated.*]

```
PRINT(DATES) / CSFL F_CSFL
SET ERRSQ 2 21 = ((CSFL(T)-F_CSFL(T))/CSFL(T))**2
STAT ERRSQ
EVAL RPMSE = SQRT(MEAN)
DIS ''
DISPLAY 'ROOT PERCENT MSE IS' RPMSE
DIS ''
SET ERRSQ1 2 21 = (CSFL(T) - F_CSFL(T))**2
SET ERRSQ2 2 21 = (CSFL(T) - CSFL(T-1))**2
STAT ERRSQ1
EVAL MEAN1 = MEAN
STAT ERRSQ2
EVAL MEAN2 = MEAN
EVAL THEILU2 = MEAN1/MEAN2
DISPLAY 'THEIL U2 STATISTIC IS' THEILU2
```

[*DFFL and its simulation F_DFFL are printed and PMSE and Theil U2 calculated.*]

```
PRINT(DATES) / DFFL F_DFFL
SET ERRSQ 2 21 = ((DFFL(T)-F_DFFL(T))/DFFL(T))**2
STAT ERRSQ
EVAL RPMSE = SQRT(MEAN)
DIS ''
DISPLAY 'ROOT PERCENT MSE IS' RPMSE
DIS ''
SET ERRSQ1 2 21 = (DFFL(T) - F_DFFL(T))**2
SET ERRSQ2 2 21 = (DFFL(T) - DFFL(T-1))**2
STAT ERRSQ1
EVAL MEAN1 = MEAN
STAT ERRSQ2
EVAL MEAN2 = MEAN
EVAL THEILU2 = MEAN1/MEAN2
DISPLAY 'THEIL U2 STATISTIC IS' THEILU2
```

[*FIFL and its simulation F_FIFL are printed and PMSE and Theil U2 are calculated.*]

```
PRINT(DATES) / FIFL F_FIFL
SET ERRSQ 2 21 = ((FIFL(T)-F_FIFL(T))/FIFL(T))**2
STAT ERRSQ
EVAL RPMSE = SQRT(MEAN)
DIS ''
DISPLAY 'ROOT PERCENT MSE IS' RPMSE
DIS ''
SET ERRSQ1 2 21 = (FIFL(T) - F_FIFL(T))**2
SET ERRSQ2 2 21 = (FIFL(T) - FIFL(T-1))**2
STAT ERRSQ1
EVAL MEAN1 = MEAN
STAT ERRSQ2
EVAL MEAN2 = MEAN
EVAL THEILU2 = MEAN1/MEAN2
DISPLAY 'THEIL U2 STATISTIC IS' THEILU2
```

[*CIFL and its simulation F_CIFL are printed and PMSE and Theil U2 are calculated.*]

```
PRINT(DATES) / CIFL F_CIFL
SET ERRSQ 2 21 = ((CIFL(T)-F_CIFL(T))/CIFL(T))**2
STAT ERRSQ
EVAL RPMSE = SQRT(MEAN)
DIS ''
DISPLAY 'ROOT PERCENT MSE IS' RPMSE
DIS ''
SET ERRSQ1 2 21 = (CIFL(T) - F_CIFL(T))**2
SET ERRSQ2 2 21 = (CIFL(T) - CIFL(T-1))**2
STAT ERRSQ1
EVAL MEAN1 = MEAN
STAT ERRSQ2
EVAL MEAN2 = MEAN
EVAL THEILU2 = MEAN1/MEAN2
DISPLAY 'THEIL U2 STATISTIC IS' THEILU2
```

[*FMFL and its simulation F_FMFL are printed and PMSE and Theil U2 are calculated.*]

```
PRINT(DATES) / FMFL F_FMFL
SET ERRSQ 2 21 = ((FMFL(T)-F_FMFL(T))/FMFL(T))**2
STAT ERRSQ
EVAL RPMSE = SQRT(MEAN)
DIS ''
DISPLAY 'ROOT PERCENT MSE IS' RPMSE
DIS ''
SET ERRSQ1 2 21 = (FMFL(T) - F_FMFL(T))**2
SET ERRSQ2 2 21 = (FMFL(T) - FMFL(T-1))**2
STAT ERRSQ1
EVAL MEAN1 = MEAN
```

```
STAT ERRSQ2
EVAL MEAN2 = MEAN
EVAL THEILU2 = MEAN1/MEAN2
DISPLAY 'THEIL U2 STATISTIC IS' THEILU2
```

[*EXFL and its simulation F_EXFL are printed and PMSE and Theil U2 are calculated.*]

```
PRINT(DATES) / EXFL F_EXFL
SET ERRSQ 2 21 = ((EXFL(T)-F_EXFL(T))/EXFL(T))**2
STAT ERRSQ
EVAL RPMSE = SQRT(MEAN)
DISPLAY 'ROOT PERCENT MSE IS' RPMSE
SET ERRSQ1 2 21 = (EXFL(T) - F_EXFL(T))**2
SET ERRSQ2 2 21 = (EXFL(T) - EXFL(T-1))**2
STAT ERRSQ1
EVAL MEAN1 = MEAN
STAT ERRSQ2
EVAL MEAN2 = MEAN
EVAL THEILU2 = MEAN1/MEAN2
DISPLAY 'THEIL U2 STATISTIC IS' THEILU2
```

RATS Source File to Calculate Multipliers

[*Multipliers are calculated on each exogenous variable. Baseline is 1990.*]

```
SMPL 21 21
```

[*Baseline 1990 is calculated.*]

```
FORECAST(MODEL=FLAXF)
```

[*One-unit shock is added to PSO and FLAX_G is simulated using the updated PSO, ceteris parabis.*]

```
EVAL PSOHAT(21) = PSOHAT(21) + 1.0
FORECAST(MODEL=FLAXG)
EVAL PSOHAT(21) = PSOHAT(21) - 1.0
```

[*The change in each endogenous variable, from the baseline, is calculated using the SET command. FLAX_G is the same model as FLAX_F but the simulations are stored in series with a G prefix instead of F.*]

```
SET MPFL = G_PFL(T) - F_PFL(T)
SET MCSFL = G_CSFL(T) - F_CSFL(T)
SET MDFFL = G_DFFL(T) - F_DFFL(T)
SET MFIFL = G_FIFL(T) - F_FIFL(T)
```

```
SET MCIFL = G_CIFL(T) - F_CIFL(T)
SET MFMFL = G_FMFL(T) - F_FMFL(T)
SET MEXFL = G_EXFL(T) - F_EXFL(T)
```

[*Multipliers for PSO are printed.*]

```
PRINT 21 21 MPFL MCSFL MDFFL MFIFL MCIFL MFMFL MEXFL
```

[*Multipliers for QFL are calculated and printed.*]

```
EVAL QFL(21) = QFL(21) + 1.0
FORECAST(MODEL=FLAXG)
EVAL QFL(21) = QFL(21) - 1.0
SET MPFL = G_PFL(T) - F_PFL(T)
SET MCSFL = G_CSFL(T) - F_CSFL(T)
SET MDFFL = G_DFFL(T) - F_DFFL(T)
SET MFIFL = G_FIFL(T) - F_FIFL(T)
SET MCIFL = G_CIFL(T) - F_CIFL(T)
SET MFMFL = G_FMFL(T) - F_FMFL(T)
SET MEXFL = G_EXFL(T) - F_EXFL(T)
PRINT 21 21 MPFL MCSFL MDFFL MFIFL MCIFL MFMFL MEXFL
```

[*Multipliers for QFL62 are calculated and printed. These multipliers will be the same for QFL63, QFL4, IFL62(t-1), IFL63(t-1) and IFL4(t-1).*]

```
EVAL QFL62(21) = QFL62(21) + 1.0
FORECAST(MODEL=FLAXG)
EVAL QFL62(21) = QFL62(21) - 1.0
SET MPFL = G_PFL(T) - F_PFL(T)
SET MCSFL = G_CSFL(T) - F_CSFL(T)
SET MDFFL = G_DFFL(T) - F_DFFL(T)
SET MFIFL = G_FIFL(T) - F_FIFL(T)
SET MCIFL = G_CIFL(T) - F_CIFL(T)
SET MFMFL = G_FMFL(T) - F_FMFL(T)
SET MEXFL = G_EXFL(T) - F_EXFL(T)
PRINT 21 21 MPFL MCSFL MDFFL MFIFL MCIFL MFMFL MEXFL
```

[*Multipliers for CPI are calculated and printed.*]

```
EVAL CPI(21) = CPI(21) + 1.0
FORECAST(MODEL=FLAXG)
EVAL CPI(21) = CPI(21) - 1.0
SET MPFL = G_PFL(T) - F_PFL(T)
SET MCSFL = G_CSFL(T) - F_CSFL(T)
SET MDFFL = G_DFFL(T) - F_DFFL(T)
SET MFIFL = G_FIFL(T) - F_FIFL(T)
SET MCIFL = G_CIFL(T) - F_CIFL(T)
SET MFMFL = G_FMFL(T) - F_FMFL(T)
```

```
SET MEXFL = G_EXFL(T) - F_EXFL(T)
PRINT 21 21 MPFL MCSFL MDFFL MFIFL MCIFL MFMFL MEXFL
```

[*Multipliers for time trend (YEAR) are calculated.*]

```
EVAL YEAR(21) = YEAR(21) + 1.0
FORECAST(MODEL=FLAXG)
EVAL YEAR(21) = YEAR(21) - 1.0
SET MPFL = G_PFL(T) - F_PFL(T)
SET MCSFL = G_CSFL(T) - F_CSFL(T)
SET MDFFL = G_DFFL(T) - F_DFFL(T)
SET MFIFL = G_FIFL(T) - F_FIFL(T)
SET MCIFL = G_CIFL(T) - F_CIFL(T)
SET MFMFL = G_FMFL(T) - F_FMFL(T)
SET MEXFL = G_EXFL(T) - F_EXFL(T)
PRINT 21 21 MPFL MCSFL MDFFL MFIFL MCIFL MFMFL MEXFL
```

[*Multipliers are calculated and printed for FIFL(t-1).*]

```
EVAL FIFL(20) = FIFL(20) + 1.0
FORECAST(MODEL=FLAXG)
EVAL FIFL(20) = FIFL(20) - 1.0
SET MPFL = G_PFL(T) - F_PFL(T)
SET MCSFL = G_CSFL(T) - F_CSFL(T)
SET MDFFL = G_DFFL(T) - F_DFFL(T)
SET MFIFL = G_FIFL(T) - F_FIFL(T)
SET MCIFL = G_CIFL(T) - F_CIFL(T)
SET MFMFL = G_FMFL(T) - F_FMFL(T)
SET MEXFL = G_EXFL(T) - F_EXFL(T)
PRINT 21 21 MPFL MCSFL MDFFL MFIFL MCIFL MFMFL MEXFL
```

[*Multipliers are calculated and printed for CIFL(t-1).*]

```
EVAL CIFL(20) = CIFL(20) + 1.0
FORECAST(MODEL=FLAXG)
EVAL CIFL(20) = CIFL(20) - 1.0
SET MPFL = G_PFL(T) - F_PFL(T)
SET MCSFL = G_CSFL(T) - F_CSFL(T)
SET MDFFL = G_DFFL(T) - F_DFFL(T)
SET MFIFL = G_FIFL(T) - F_FIFL(T)
SET MCIFL = G_CIFL(T) - F_CIFL(T)
SET MFMFL = G_FMFL(T) - F_FMFL(T)
SET MEXFL = G_EXFL(T) - F_EXFL(T)
PRINT 21 21 MPFL MCSFL MDFFL MFIFL MCIFL MFMFL MEXFL

END
```

DATA SOURCES: Canola Model

Prices are in \$/tonne and quantities are in ,000 tonnes, both on a crop-year basis. All units in U.S. currency are converted to \$CDN using ER34C (crop-year exchange rate) from the FARM model, Ag. Can.

Endogeneous variables:

PRA	Price canola seed	FARM model, adjusted from Thunder Bay cash price, as necessary, Ag. Can. (PRA3C)
PRL	Price, canola oil	1980/81-1990/91: Cereals and Oilseeds Review, Stats. Can. (22-007); Early years: Oilseeds Review, Stats. Can. (22-006); missing data estimated.
PRM	Price, canola meal	FARM model, Ag. Can. (WPRM2C) and Statistics Canada
EXRAJ	Cdn. Exports to Japan, canola seed	Statistical Handbook, Canada Grains Council.
EXRAO	Cdn. total exports excl. Japan canola seed	Statistical Handbook, Canada Grains Council
EXRA	Total exports, canola seed	FARM model, Ag. Can. (EXRA3C)
DFRA	Feed, Seed, Waste, canola seed	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
FIRA	Farm inventories, canola seed	FARM model, Ag. Can. (FIRA3C)
CIRA	Commercial inventories, canola seed	FARM model, Ag. Can. (CIRA3C)
FMRA	Farm marketings, canola seed	FARM model, Ag. Can. (FMRA3C)
CSRA	Total crush, canola seed	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
QRL	Production, canola oil	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
QRM	Production, canola meal	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
DDRL	Domestic consumption, canola oil	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
DDRM	Domestic consumption, canola meal	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
EXRL	Net exports, canola oil	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.

EXRM	Net exports, canola meal	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.

<u>Exogeneous Variables</u>

PSM	Price, soymeal	FARM model, Ag. Can. (PSM2C)
PSL	Price, soyoil	Decatur price from FARM model, Ag. Can. (PSL4C), adjusted for crop year exchange rate and Canadian tariff.
PSO4C	Price, soybeans, U.S.	FARM model, Ag. Can., adjusted by crop year exchange rate.
QRA	Production, canola seed, Canada	FARM model, Ag. Can. (QRA3C)
HOG	Number of hogs, Canada (millions)	FAO Production Yearbook
CAP	Crush Capacity	Canadian Crushers Association
CPI	Consumer Price Index, Can.	Agriculture Canada
JY	Exchange Rate, Japanese Yen/$Cdn	1970-89, National Accounts, OECD 1990, Bank of Canada Review
PCDIJ	Per capita disposable income, Japan	National Accounts, OECD.
CPIJ	Consumer Price Index, Japan 1987=Index 100	1970-89, World Tables 1991, World Bank 1990, Monthly Bulletin of Statistics, UN.
DI2	Dummy for unpriced seed	0 from 1970-81; 1 from 1982-1990.
QD	Dummy for quota restriction	See text.
IRL	Inventories, canola oil	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
IRM	Inventories, canola meal	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
T	Time trend	

DATA SOURCES: Soybean Model

Prices are in $/tonne and quantities are in ,000 tonnes, both on a crop-year basis. All units in U.S. currency are converted to $CDN using ER34C (crop-year exchange rate) from the FARM model, Ag. Can.

Endogeneous Variables:

PSO	Price, soybeans	FARM model, Ag. Can. (PSO2C)
PSL	Price, soyoil	Decatur price adjusted for crop year exchange rate and Canadian tariff, FARM model, Ag. Can. for Decatur price (PSL4C)
PSM	Price, soymeal	FARM model, Ag. Can. (PSM2C)
CMSO	Crush margin	Calculated by identity equation.
CSSO	Total crush, soybeans	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
ISO	Inventories, soybeans	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
EXSO	Net exports, soybeans	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
QSL	Production, soyoil	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
QSM	Production, soymeal	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
DDSL	Domestic consumption soyoil	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
DDSM	Domestic consumption soymeal	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
IMSL	Net imports, soyoil	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
IMSM	Net imports, soymeal	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
DFSO	Feed, Seed, Waste, soybeans	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.

Exogeneous Variables:

PSO4C	Price, soybeans, U.S.	FARM model, Ag. Can.
PSM4C	Price, soymeal, U.S.	FARM model, Ag. Can.
PRM	Price, canola meal, Canada	FARM model, Ag. Can. (WPRM2C) and Statistics Canada
PRL	Price, canola meal, Canada	1980/81-1990/91: Cereals and Oilseeds Review, Stats. Can. (22-007); Early years: Oilseeds Review, Stats. Can. (22-006); missing data estimated.
QSO	Production, soybeans, Canada	FARM model, Ag. Can. (QSO3C)
POPCAN	Population, Canada	National Accounts, OECD.
CAP	Crush capacity, soybeans	Canadian Crushers Association
CPI	Consumer Price Index	Agriculture Canada
D 1990/91	Dummy variable	0 for 1970/71-1985/86, 1 for 1986/87-
ISL	Inventories, soyoil	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
ISM	Inventories, soymeal	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
T	Time trend	

DATA SOURCES: Flax Model

Prices are in $/tonne and quantities are in ,000 tonnes, both on a crop-year basis. All units in U.S. currency are converted to $CDN using ER34C (crop-year exchange rate) from the FARM model, Ag. Can.

Endogeneous Variables:

PFL	Price, flaxseed	FARM model, Ag. Can. (PFL3C)
CMFL	Crush margin, flaxseed	Calculated by identity equation.
CSFL	Total crush, flaxseed	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
EXFL	Exports, flaxseed	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
FMFL	Farm marketings, flaxseed	FARM model, Ag. Can. (FMFL1C)
CIFL	Commercial inventories, flaxseed	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
FIFL	Farm inventories, flaxseed	FARM model, Ag. Can. (FIFL1C)
DFFL	Feed, Seed, Waste, flaxseed	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.

Exogeneous Variables:

PS0	Price soybeans Canada	FARM model, Ag. Can. (PSO2C)
QFL	Production, flaxseed, Canada	FARM model, Ag. Can. (QFL1C)
QFL62	Production flaxseed, Argentina	Oil World, various issues
QFL63	Production flaxseed, EC	Oil World, various issues
QFL4	Production flaxseed, U.S.	Oil World, various issues
IFL62	Inventories, flaxseed, Argentina	Production, Supply and Distribution database, USDA, Foreign Agricultural Service.
IFL63 database,	Inventories, flaxseed, EC	Production, Supply and Distribution USDA, Foreign Agricultural Service.
IFL4 database,	Inventories, flaxseed, US	Production, Supply and Distribution USDA, Foreign Agricultural Service.
CPI	Consumer Price Index	FARM model, Ag. Can. (CPI3)
T	Time trend	

APPENDIX B

CANOLA DATA INADEQUACIES AND PRICING AND MARKET BEHAVIOUR IN THE PRAIRIE REGION

Data Inadequacies

Modeling the canola sector presents some unique problems. There is no data on canola oil or meal prices available from published sources in the prairie region over the period. There are Canadian prices for canola oil but it is not even a complete series. Some years are missed and the price series for canola oil had to be estimated using soy oil prices to provide the missing observations.

The lack of visible prices at ports for products does not facilitate the construction of regional models. Similarly, the lack of an open price discovery system such as a futures market for oil and meal makes the calculation of crushing margins less reliable. Seed prices are basis Vancouver and oil and meal prices are basis Central Canada.

There is not a consistent published price series for canola seed in Canada. Both Thunder Bay and Vancouver cash prices are reported during the period. Thunder Bay canola price was below Vancouver canola price and this eventually lead to the ending of canola futures trading at Thunder Bay. During the early 1970s canola futures at Thunder Bay were introduced to trade alongside the Vancouver delivery point. Both contracts traded on the Winnipeg Commodity Exchange. Contract prices were often higher for delivery at Vancouver than at Thunder Bay. This partly reflected the reality that Japan was the major Canadian rapeseed customer and preferred the west coast delivery position. In addition, the increasing costs of movement for product located on an inland waterway such as the Great Lakes would lead one to expect that prices on ocean water would be higher. The CWB was achieving premium prices for wheat in Vancouver position relative to Thunder Bay during the same period.

The data available in published sources and in the FARM model stated a cash price as a Vancouver price, then as Thunder Bay Price and then it returned to being a Vancouver price. A new price series was developed for those years where Thunder Bay prices were the published prices to place it back on a Vancouver base. The price differences for the futures months at Vancouver relative to Thunder Bay were used to develop a price differential and this was added to the published Thunder Bay price to provide the Vancouver price.

Conceptually, there is a further problem in the calculation of the average closing price for the November future contract at Vancouver vs the October futures contract at Thunder Bay. The Vancouver market had more volume and trading might begin a year prior to the contract maturity. The October future at Thunder Bay may not have reportable quotes until February of the year. The result is that the Vancouver November reflects the trading prices from December 1 to November 30 while the Thunder Bay price might reflect the trading prices for the period February 1 to October 31. Depending upon what prices were in those missing months, it is conceivable that the average contract price for October futures could be above November futures even though the spot prices at the same instant in time always showed a price discount on October contracts at Thunder Bay of 25 cents per bushel or more. There is also the obvious problem that the price during the early part of the trading period would have been very thin and the prices for the time period recorded do not reflect the correct weighting.

Canola seed prices are broadcast daily on the prairies and Saskatchewan Agriculture and others have maintained a price series for a single elevator company such as the Saskatchewan Wheat Pool. Prices, however, may differ by province and within each province since the local impact of a crushing plant may have a small localized market impact. The prices offered in the prairie region reflected the relative price premiums during the early part of the period at Vancouver as elevator companies broadcasting street prices had a provision that designated freight stations would add 10 cents per bushel or at times 30 cents per bushel or more. These designated freight stations were elevator points located west of Saskatoon and the rapeseed was shipped to the higher priced market on the west coast.

During the early part of the period, there was a cash price premium for canola in Vancouver when quotas were a constraint. Commodity shortages, price squeezes and an inverted market were quite common at Vancouver for rapeseed during the early 1970s. The location of Vancouver was far from the prairie region where the production occurred. The result was that it was dependent upon the railways to move the product into position. Farm trucking to port or the movement by semi trailers was not feasible due to the distance and the relatively low value of raw commodities and the Crow Rate or WGTA payments do not apply to trucks. There are studies by Martin and Storey and others which examined the return to the long position in the canola market as a speculator during this period because of the historic near month squeezes. Another reason that the price premiums could be maintained was that a quota on delivery of canola to country elevators prevented farmers from adopting the strategy of selling the cash grain and holding buy futures to capture the price rise they were expecting. This strategy was prevented by a delivery quota which prevented or at least restricted the volume of canola which could be sold for cash.

There is an assumption of perfect competition and a single price implicit in a model which uses a single regional price. The price of canola meal and oil products in the prairie region appears to be priced in an oligopolistic manner rather than in a perfectly competitive manner. Anecdotal evidence exists that the price of canola oil and meal to local prairie users is at levels where it is just slightly preferred to soy products which must be moved great distances to serve the market (i.e. imported from the United States). The canola products sold for export are perceived to have a more elastic demand curve by the major firms and the price offered in these markets is less than prairie prevailing price plus the total movement costs which are incurred.

There is not a single price within the prairie market for canola seed as sometimes the price paid at the crushing plant is at a premiium to elevator price and sometimes it is at a discount. During part of the period when Western Grain Stabilization program was in place, a credible source of data is available. All sales of canola had a levy for WGSA deducted (usually between 1 and 2 percent). This data could be sorted on the basis of deliveries to crushing plants and deliveries to country elevators to test the hypothesis that some price differences exist within the market. The result would indicate if the prices paid by alternative canola buyers were different. This would enable a more reliable crushing margin to be calculated as the actual purchase price would be known.

There is an ongoing problem in using simple average price data and assuming that it is representative of the weighted average price paid. If the prices were to move from $400/tonne to $420 over a 21 day period and close up $1.00 per day each day, then the simple average price is $410/tonne. However, if numerous farmers were happy with the price at $400/tonne and started selling rapidly, then sales may be very slow above the price of $406/tonne and the weighted average price for the period might be $405/tonne. These inherent data weaknesses make it difficult to determine crushing margins accurately.

Producer Marketing Behavior and Factors Influencing Price Signals

Producers growing canola have numerous marketing alternatives. The canola can be sold at the street price, delivered to a crushing plant, moved to terminals via a producer car, delivered against a futures contract at a prairie inland terminal, sold on a deferred pricing contract, sold on a locked-in basis contract or sold on a deferred delivery contract. These various alternatives often result in different prices and may also require a different level of producer market knowledge and also greater physical work such as loading a producer car vs parking on an elevator weigh scale. Each elevator company may also offer a different base street price on a given day. In addition, the opportunity exists to defer the receipt until the next taxation year and the price premium paid (interest rate) may differ among the various firms. There is also the difference in freight rates which are applied from the various delivery points to the destination, which in the case of canola is dominated by the Vancouver delivery point.

Some of the other constraints faced by a producer is the delivery quota which is applied to canola deliveries. Even though canola is considered an "open market" grain, it has historically been limited in its access to the rail capacity through a delivery quota. At times in the past the quota was administered directly by the Canadian Wheat Board, but in the past decade or more, the Grain Transportation Authority has set the relative car allocation and indirectly the quota between CWB and non-CWB crops. The quota applied has also changed at numerous times. There were some periods when the quota available by direct delivery to a crusher in the prairie region was much larger than the quota for delivery to a country elevator. The quota often opened earlier during the crop year for delivery to crushers and often ended the year at a much higher level. This is important because during periods of reduced deliveries, the cash flow of producers is reduced. If the quota at the country elevator is 12.3 bushels per acre but to the crushers is 40 bushels per acre as it was during the 1979-80 crop year, then if a farmer had produced a 25 bushel crop on 400 acres, it would require 813 acres to deliver the entire crop to the elevator but only 240 acres to deliver the same canola to the crushers. This has obvious impacts on the potential cash flow of producers. If the producer is in a productive area where wheat yields are high, then it is important to be able to deliver wheat on the available quota acres as often wheat quotas are quite low. If the producer only uses a few acres to deliver canola then more acres can be assigned to wheat and wheat can be sold earlier in the year.

The quota acres have also changed over the period. The base quota was changed to a bonus acre system in the early 1980s. This allowed farmers who grew more of the traditional crops to get a bonus when the cropping intensity exceeded 75 percent on the land which was annually cropped. (See the 1985 Guide to Farm Practice for a description of how the Bonus guota acreage system operates.) This change in the quota sysem had the implication of expanding guota acres in areas where the cropping intensity tends to be higher such as in the black soil zones on the prairies where canola tends to be produced.

There were also other quota changes which implicitly influenced the availability of quota acres for canola. One of these was the introduction of the barley contract. This allowed a quota of 92 bushels per acre of barley delivery for producers who contracted to deliver their barley to the CWB. This again reduced the constraint of quota on canola deliveries since barley and canola are produced in many of the same regions. The reduced constraint on quota acres for barley made more acres available for canola, wheat and other crops.

There are also other anomalies such as one year when the quota acres assigned to canola and flax were made ineligible to be assigned to another crop such as wheat or barley. The alleged problem was that producers would sell their canola early in the crop year by assigning a large number of acres to canola at the beginning of the crop year. Then as the quota opened for canola, the acres were no longer required and they would be reassigned to deliver another crop such as wheat.

Recently, some canola which is delivered for crushing in Central Canada is exempt from quota at certain delivery points such as the Canola Gathering Station at Humboldt. This allows a farmer to use zero quota acres to sell all of their canola production and to have all of the remaining acres available to deliver other crops. In December 1992, the delivery quotas on canola and flax were removed.

A producers decision to deliver the crop is sometimes a decision to sell the physical stocks and replace the stocks with paper (by purchasing canola futures). If prices increase by $50.00 per tonne, the producer achieves the same gain on the futures contract as would have been achieved by holding grain in the bin. Both present the same alternative to sell at a profit if the price increases.

Another practice which was prevalent on the prairies was for farmers to deliver grain to the elevator and place it on storage rather than selling it. This could eventually result in plugged elevators if the canola was not moved. The practice evolved whee farmers would waiver the right to recall their grain from the elevator in exchange for free storage. This canola could then be shipped to the port and sold. When the physical product was sold, the firm would purchase canola futures to enable it to capture the price increase if one should occur. The farmer would need to be paid if price increased by $2.00 per bushel. In the meantime, the canola had not required financing while it was in transit to the port position. Now the firm selling the canola could earn interest on the money but a long canola position on the futures market was required.

During the late 1970s and early 1980s the price for canola on the futures market often had deferred prices which were at significant premiums to the nearby futures. This may be partly due to the hedging pressure on the deferred futures months because of the unpriced canola seed in the system. The amount of unpriced seed increased to very high levels in the early 1980s. Some elevator companies refused to accept canola unless the farmer sold it due to an inability to place a buy hedge on a futures month at a secure margin. Firms then began to set a limit of 90 days as the period that unpriced canola could remain in the system before being prices. The start date is 1982. The Canadian Grain Commission has regulations that insure that all firms now adhere to this practice.

Grain handling and transportation were also facing a capacity constraint. The transportation constraint resulted in regulations for elevator companies that an actual sale of canola for export must be made at Vancouver in order to maintain the rail car allocation. Cash canola could not be purchased by a speculator and delivered against a futures contract. This resulted in a cash price which was at a discount to futures prices as companies sought sales to maintain rail car allocations and market share. There was one other anomaly. The regulatory systsem allowed producer cars to deliver canola against a futures contract. Canola sold to elevator companies had to be for shipment on exports in order to receive an allocation of rail cars. In addition, each elevator company had to take a certain proportional allotment of canola from producer cars. This meant buying the canola delivered via producer cars at the higher near month futures price and selling it for export at the cash price. This was later changed by introducing a cash call market and a requirement that shippers of producer cars also sell on the cash market rather than being allowed to deliver against the futures. This regulatory wedge between cash and futures prices remains at Vancouver.

This brief overview of the system and the changes to quota policy and other regulations over the past few decades should help one to understand that the delivery of canola to the elevator by a farmer is a function of many policy variables which have been subject to change. Carryover from last year, the current crop produced plus both price and quota variables will influence the flow of canola into the commercial system. There is also an element of expected price as sometimes the current price looks very attractive relative to the price available in the fall by using the futures market. There is also the volume of wheat carryover which might indicate the level of quota constraint in the region and the need for cash flow. A level of realized net income for the prairie region may also serve as a measure of the need for current income. The level of interest rate and the amount of outstanding debt are other alternatives to consider as variables which are proxies for the need for cash.

The variables explaining canola marketings were developed using this description of the canola market. The major constraining years were indicated by a dummy variable of 1 when the elevator quota was 15 bushels per acre or less. Lack of success with some of the other variables resulted in some change where inventories are estimated but marketings are a residual.

An additional dummy variable was tried which took a value of 1 after 1982 when the bonus acres were to the quota system. This had the impact of reducing the constraint of quota acres in the major regions where canola is produced. No specific dummy variable was attempted for the addition of the special two tonne per acre CWB barley quota. The results were reasonable but problems with other equations resulted in some respecification. In addition, dummy variables may be reasonable for explaining the past but forecasting the future is not their strong point.

Price expectations of producers were incorporated to attempt to estimate marketings and levels of farm and commercial inventories. Price expectation is probably best indicated by the price of June canola futures vs November futures during the months of April and May and the first 10 days of June. This is when producers may decide to hold the canola in expectation of a price increase as the price of the current crop year may be above the expected price level for the crop which is being planted. Interest costs and price as an approximation of basis costs were also used in seeking to explain inventories and marketings.

Volatility in the Canadian Canola Crushing Industry

Various forms of volatility exist within the Canadian canola crushing industry, particularly on the prairies where the opportunity to shift to crushing soybeans is not a realistic option. Price variabilitv for the seed as well as in the end products of meal and oil can, at times, lead to extreme volatility in the crush margin. Availability of seed is also cited as having an impact on the crush margin and thus industry volatility. In times of low supply, crushers may be required to pay price premiums in order to obtain seed for crushing. Low availability for seed also impacts through forcing some firms to operate below their optimal crushing capacities. If adequate seed supplies are not available at certain times of the year crushing facilities may run at lower than optimal capacity thus affecting the crush margin. These and other examples are often cited in the Manitoba Wheat Pools Annual report on canola crushing by CSP Foods Ltd. The following table illustrates, through the use of net earnings from operations, the extreme volatility in canola crushing by CSP Foods Ltd.

In 1981, CSP foods had net earnings from their canola crushing operations of over $14 million. By 1982 net earnings from crushing began to deteriorate with the highest loss from crushing operations occurring in 1984. A low supply of available seed from the 1983 harvest resulted in only fifty-five percent of available crushing capacity being used throughout April to August of 1984. As a result of these and other factors, CSP Foods reported a net loss from operations at almost $14 million for the 1984 crush year. By 1987 net earnings from crushing operations began to turn around. In 1988, CSP Foods reported a $7.7 million return for their operations. Unfavorable results again hampered the industry from 1989 to 1991 where losses were reported due to factors such as unfavorable crush margins, increased competition in meal sales, as well as difficulty and increased cost in obtaining adequate seed supplies.

TABLE B.1: CSP FOODS LTD.: NET EARNINGS FROM OPERATION

1981	$14,225,000
1982	($2,399,000)
1983	($8,544,000)
1984	($13,981,000)
1985	($2,042,000)
1986	($3,068,000)
1987	$788,000
1988	$7,719,000
1989	($4,281,000)
1990	($2,950,000)
1991	($2,600,000)

Source: Manitoba Wheat Pool Annual Reports. The brackets indicate losses.

Not only can volatility in the canola crush margin occur through variables such as factor prices or seed availability, but also from the nature or composition of the seed itself. Table B.2 illustrates the variability in oil and meal yield using quarterly production data. The yield of oil per pound of canola crushed can vary quite substantially from month to month, or in this case quarter to quarter. The period for which data is readily available is the mid 1970s. From August to October of 1974 the average yield of oil from each pound of canola crushed was 38 percent. The average oil yield for the April to August quarter of 1976 was almost 42 percent from each pound of canola crushed. These changes in the relative composition of canola seed may be due to the introduction of new varieties, frost or other factors which influence quality. This difference in oil yield of 4 percent may appear small, however, when taken in the context of quarterly production, it can and does have fairly significant effects on crush margins. For example, the average price of rapeseed oil, according to the Oilseeds Review, was approximately 40.9 cents per pound for the quarter August to October 1974. Had oil yield for this time period been 42 percent as opposed to the 38 percent actually observed, approximately 5,663,000 additional pounds of rapeseed oil would have been produced. This constitutes a value in excess of $2.3 million which would obviously have dramatic effects on the level of gross margin for the quarter. The impact is almost two more pounds of oil per bushel of canola or almost 80 cents per bushel.

According to the above analyses numerous factors can affect crush margin levels in the canola crushing industry. These factors however, are not limited to annual variations. As seen with oil content yields, up to four percent variation was present between two different quarters. This four percent would have made a large impact on crush margin. Seed availability and its effect on seed price as well as effects on capacity utilization can impact on monthly gross margin levels.

TABLE B.2: QUARTERLY CRUSHING DATA

Date	Rapeseed Crushed (pounds)	Oil Produced Production (pounds)	Meal (pounds)	Oil Yield (Percent)
Aug 74 - Oct 74	149,650,000	57,190,000	87,054,000	38.22%
Oct 74 - Jan 75	155,700,000	61,805,000	88,602,000	39.69%
Jan 75 - Apr 75	178,750,000	70,020,000	101,642,000	39.17%
Apr 75 - Aug 75	124,300,000	50,149,000	70,508,000	40.35%
Aug 75 - Oct 75	189,200,000	75,922,000	108,760,000	40.13%
Oct 75 - Jan 76	219,500,000	89,789,000	125,514,000	40.91%
Jan 76 - Apr 76	192,850,000	78,968,000	107,700,000	40.95%
Apr 76 - Aug 76	163,800,000	68,711,000	58,181,203	41.95%
Aug 76 - Oct 76	243,750,000	99,468,000	153,542,732	40.81%
Oct 76 - Jan 77	249,300,000	102,480,000	157,361,072	41.11%
Jan 77 - Apr 77	379,950,000	157,583,000	241,005,232	41.47%
Apr 77 - Aug 77	338,900,000	138,280,000	142,323,598	40.80%

Source: Statistics Canada, Oilseeds Review, various issues.

This was illustrated by CSP Foods Ltd., using only 55 percent of its available crushing capacity throughout the months of April to August 1984 and as a result suffered its largest loss in net earnings for the ten year period. Modeling the canola crushing industry using annual data can therefore seriously jeopardize model accuracy. Monthly or daily fluctuations in the variables affecting crush margin are extremely important to consider. They can mean the difference between whether crush for the month should proceed or not and if so, to what capacity. With the use of annual data these short-term fluctuations are ignored.