IMPLICATIONS OF BOVINE SOMATOTROPIN ON PERFORMANCE AND STRUCTURE FOR WESTERN CANADIAN DAIRY FARMS

By Kenny K.H. Chow

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Abstract

BST is experimentally found that it could increase milk production by 10 percent. This bio-technology may be attractive for dairy farmers to adopt. The objective of this study is to examine some of the potential effects of BST administration on western Canadian dairy farms. The effects include: BST profitability on gross margins of the farm operation; short-run adjustments on milk production levels, herd size, and input combinations for the dairy and cropping enterprises; milk quota values; milk prices; and likely long-term impacts in terms of structural changes in the dairy and related agricultural sectors.

Some farms representative of dairy farms in prairie region are classified in this study. A linear programming model is developed to examine BST effects to the representative farms. Two scenarios are assumed regarding BST adoption: milk quota and no milk quota purchase scenarios. Modelling results show that BST is profitable to be adopted on western Canadian dairy farms under either assumed quota scenarios. Both quota scenarios have unique advantages, in terms of gross margins and assets investment of the farms, regarding BST adoption. Input combinations for the dairy and cropping enterprises do change. The respective share of each feed used for rations are changed, although the types of feed remain constant. Cash crops acreage and labour hours hired on the farm are also affected by BST adoption. The respective changes on cash crop acreage and hired labour hours depend on the type of quota scenario assumed.

Results also show that milk quota values would increase after BST is introduced to the sector. Conversely, milk prices would be insignificantly affected in the intermediate-term. In the short-run, BST is likely to have some small effects on dairy farm and cow numbers. However, the long-term implications of BST adoption may be more significant. The bio-technology would reinforce the trend of fewer but larger dairy herds in the sector. Furthermore, the impacts of BST adoption on related sectors such as; beef, cropping, and farm inputs are likely to be minor.

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CHAPTER ONE INTRODUCTION

1.1 Background

1.1.1 Nature of the Dairy Industry in Western Canada

The dairy sector in western Canada (i.e., Manitoba, Saskatchewan, Alberta and British Columbia) has a small share of the total national dairy sector, relative to central Canada (i.e., Ontario and Quebec). The value of milk production in the region represents approximately 22 percent of the total for the Canadian dairy sector. However, the value of dairy production in western Canada is significant (i.e., $ 673 million in 1988, Agriculture Canada, Communication Branch 1989).

There is a significant amount of government intervention in Canada's dairy industry. In particular, dairy farmers operate under a policy of supply management. At the national level, the Canadian Dairy Commission regulates the industrial milk[1] market, determines the targeted production level, and the amount of Market Sharing Quota (MSQ) for industrial milk in Canada. At the provincial level, milk marketing boards or milk control boards are responsible for controlling fluid milk market production and marketing. These provincial agencies regulate fluid milk production, the prices paid to producers for fluid milk, distribute the provincial share of MSQ among dairy farmers and manage the marketing of dairy products.

On the producer side, dairy farmers have to acquire milk quota (for both industrial and fluid milk) in order to sell milk. Although milk quotas are allocated by provincial

[1] Industrial milk is a term used to represent milk that is utilized in the production of cheese, yogurt, ice cream, etc.

milk boards, farmers can transfer the rights to sell milk through quota transactions. Therefore, herd size expansion or contraction is closely related to quota transactions.

While milk is produced in all provinces, the structure of the dairy sector differs significantly between regions in Canada. The dairy sector in western Canada is unique, relative to other parts of Canada. As noted earlier, the dairy sector in this region is smaller than that in central Canada (i.e., Quebec and Ontario). Table 1.1 provides a historical record of the number of Canadian dairy farms, by province. The total number of dairy farms in either Ontario or Quebec is almost ten times as great as the number in each western Canadian province. Similarly, the total numbers of dairy cattle in western Canada are less than in central Canada. Due to the size differences for the dairy sectors in various regions, the allocation of industrial milk production varies substantially among different regions, with the central region having a proportionally larger share (Appendix A, Tables A-1 and A-2). A comparison between MSQ shares and provincial population is provided in Table A-7.

There are many other structural differences between dairy sectors in different regions of the country. Cropping patterns for dairy farms vary because of climatic and soil type differences between regions. The soil and climate conditions in Quebec and Ontario are appropriate for growing corn for use in dairy rations. Conversely, dairy farmers in western Canada rely on cereal grains such as wheat, oats and barley.

1.1.2 Structural Trends in the Western Canadian Dairy Sector

The Canadian dairy sector has been undergoing structural adjustments for many years. In particular, the trend has been towards fewer but larger dairy farms (The Canadian Dairy Commission 1975-1990; Agriculture Canada, Communication Branch 1989; Statistics Canada 1971-1986a). This trend has been exhibited in all regions. In western Canada, the numbers of dairy farms and dairy cattle (including cows and heifers) have decreased during the last ten years (Tables 1.1 and 1.2). However, the percentage decrease in cattle numbers is smaller than the decrease for farms numbers, except in Saskatchewan. As a result, the average herd size in the region has increased throughout the period of 1977-87.

The productivity of the western Canadian dairy sector, measured in terms of milk produced per cow per year, has also increased over the same period (Table 1.3). Over the period of 1976-87, milk production (measured as milk sold per cow per year) increased between 35 and 102 percent in the provinces, representing an annual average increase of 2.9 to 8.6 percent. These increases in milk production have been due to better herd and health management, increased use of artificial insemination and improved farm equipment and milking technologies.

1.2 Economic Problem Statement

A new factor may soon be introduced that will affect the dynamics of the western Canadian dairy sector. In particular, farmers may soon have access to synthetically produced bovine somatotropin (BST). This hormone is produced by the pituitary gland

Table 1.1 Historical Numbers of Dairy Farms, by Province

Year	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Eastern Canada[a]
1977	1334	2081	960	1742	15880	25838	2119
1978	1274	2014	995	1593	14698	24662	2038
1979	1230	1992	990	1528	12943	23848	1994
1980	1174	1882	910	1413	12217	21785	1887
1981	1183	2026	877	1378	12065	21921	1901
1982	1141	1890	870	1292	11752	20485	1879
1983	1131	1841	862	1231	11483	19811	1852
1984	1095	1760	834	1234	11190	19179	1807
1985	1080	1707	830	1199	10890	18569	1777
1986	1063	1628	822	1158	10231	17898	1705
1987	1061	1614	756	1130	10238	16984	1690

[a] Eastern Canada consists of Newfoundland, Nova Scotia, Prince Edward Island and New Brunswick.

Source: The Canadian Dairy Commission, 1975 to 1990.

Table 1.2 Historical Numbers of Dairy Cows and Heifers (000's), by Province

Year	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Eastern Canada[a]
1976	114.0	214.0	111.0	126.0	915.0	1110.0	122.9
1977	116.0	210.0	112.0	125.0	903.0	1018.0	122.8
1978	118.5	209.0	114.0	121.0	872.0	991.0	126.0
1979	124.0	215.0	104.5	112.0	844.0	960.0	122.5
1980	129.0	224.0	107.5	113.0	820.0	965.0	124.8
1981	127.5	220.5	109.0	115.0	835.0	988.0	132.3
1982	132.5	209.0	107.0	112.0	844.0	980.0	130.9
1983	128.0	194.0	100.0	107.0	809.0	938.0	129.3
1984	125.0	190.0	95.0	105.0	809.0	922.0	128.4
1985	122.5	181.0	86.0	99.5	782.0	881.0	126.6
1986	113.5	175.0	73.5	94.5	723.0	830.0	125.8
1987	112.5	178.0	73.0	94.0	705.0	807.0	123.9
1988	115.0	176.0	73.0	95.5	705.0	816.0	124.0

[a] Eastern Canada consists of Newfoundland, Nova Scotia, Prince Edward Island and New Brunswick.
Source:The Canadian Dairy Commission, 1975 to 1990.

Table 1.3 Milk Sold Per Dairy Cow (Litres/Year) less Farm Separated Cream, by Province

Year	Manitoba	Saskatchewan	Alberta	British Columbia
1976	2990	2120	3030	4880
1977	3050	2200	3160	4920
1978	3140	2230	3170	4860
1979	3410	2350	3140	4970
1980	3510	2390	3140	5050
1981	3477	2514	3359	5334
1982	3624	2746	3709	5174
1983	3794	2998	3885	5203
1984	3964	3329	4167	5580
1985	4140	3386	4298	5754
1986	4482	4233	4756	6475
1987	4718	4299	4715	6597
Total Percentage Increase	57.8%	102.8%	55.6%	35.2%
Annual Average Increase	4.8%	8.6%	4.6%	2.9%
Annual Average Increase (l/year)	144	181.6	140.4	143.1

Source: Agriculture Canada, Policy Branch 1985 to 1988.

in cattle. The hormone has several effects, one of which is to stimulate milk production. It has long been known that injections of BST will cause increased milk production in cattle, with experiments by Asimov and Krouze dating back to 1937. However, until recently the hormone could only be extracted using glands from slaughtered animals, making commercial use of BST impractical (Bauman and Epperd 1985; McNaughton 1988).

During the last decade, genetic engineers have successfully used recombinant DNA technology to produce bacteria that are capable of synthesizing BST in large quantities at a relative low cost (Kennelly and DeBoer 1988; Legates 1989). This development has significantly increased the commercial feasibility of the biotechnology.

Commercial introduction of BST for use by Canadian and American dairy producers has been delayed pending approval by the appropriate regulatory agencies in each country. However, the potential economic effects of commercial introduction have been examined in several studies. These studies have addressed issues related to potential adoption rates (e.g., Zepeda 1990), effects on farm level profitability (e.g., Trelawny and Stonehouse 1989) and impacts on sector performance and structure (e.g., Fallert et al 1987). However, most of the studies have addressed these issues from the perspective of the American dairy sector, or in the case of Canadian studies, the Ontario dairy sector.

Assuming that BST is made available to dairy producers in western Canada, there are some unanswered questions related to several issues. One very important question relates to the short-term profitability of the new technology. At the present time, there is some uncertainty concerning the potential impact on farm level profits. The impact on

profit will be determined by the production response resulting from use of BST, as well as the cost of the technology and changes in any other costs.

A second question relates to the impact on production decisions if BST is adopted by producers. It is likely that producers will alter their decisions concerning the level of total milk production and the combination of inputs used to produce that output. This situation is further complicated by the presence of supply management. Given that additional milk quota may be required in order to increase production for a particular farm, it is not clear whether BST will result in changes to the optimal level of milk production by farmers, or simply a reallocation of inputs while maintaining current production levels.

A related question concerns the impact of BST on quota values. In the Canadian dairy industry, milk quota can be considered as a non-substitutable input in the production of milk. Although quota is not actually a productive input, milk production will not occur in practice without it. If milk production is profitable, quota takes on a positive value to producers. Economic theory would suggest that if adoption of BST improves farm level profitability, there will be a corresponding effect on quota value and price. At present, this impact is unknown.

A final question relates to the impact of BST adoption on the long-run structure of the western Canadian dairy sector. Any changes to profitability at the farm level will have effects on the optimal structure of dairy farms in this region. Whether BST use will result in changes to the ongoing structural adjustments in this sector, or simply reinforce these trends, is not known at the present time.

1.3 Study Objectives

The economic questions considered in the previous section provide the focus for the research plan of this study. In particular, the overall goal of this study is to examine the economic impacts of BST adoption by dairy producers in western Canada. These impacts include changes in profitability (in terms of farm profit margins), milk production levels, input use, and long-term structural adjustments. Within this overall goal, there are several specific research objectives.

The first objective of this study is to develop and construct an economic model that is capable of reproducing the physical and financial performance of representative western Canadian dairy farms over a multiple year planning horizon. This model is used throughout the study to examine the impacts of BST adoption.

The second objective of this study is to define several dairy farm operations that are representative of dairy farms located in western Canada. Important physical and/or financial characteristics are used in defining these farms. These representative farms are modelled using the economic model, as indicated above.

The third study objective is to model the adoption of BST by the representative dairy farms. In particular, the short-term impacts of BST adoption on farm gross margins, optimal production levels, herd size, ration composition, crop mix, etc., will be assessed using the results of the economic modelling procedure. A related objective of the study is to assess the impact of BST adoption on values for milk quota.

The fourth objective is to examine whether BST has any impacts on dairy production costs and milk prices. In Canada, milk prices are set by milk control boards

at the federal and provincial level and are based on production costs for a sample of dairy farms. Assuming a significant adoption rate for the technology, if BST has an effect on production costs, the changed would be reflected in farm level milk prices.

The final objective of the study is to assess the potential long-run impacts of BST adoption. These impacts include possible structural changes in the dairy and related agricultural sectors that arise from the short-term adjustments attributable to BST adoption.

1.4 Hypotheses

Given the specific research objectives specified above, several hypotheses are tested in this study, as follows:

1. It is hypothesized that if adopted, BST increases the total gross margin for western Canadian dairy farms.
2. It is hypothesized that, in the short-run, BST adoption will result in farmers changing input combinations (e.g., feed and labour) for dairy production. In addition, farm cropping enterprises would be adjusted accordingly.
3. It is hypothesized that the value of milk quota will be affected by BST adoption. In particular, quota values will increase.
4. It is hypothesized that BST will have impacts on dairy production costs and therefore milk prices.
5. It is hypothesized that the long-run structure of the dairy sector and related agricultural industries in western Canada will be affected by BST, as both the number and size of dairy farms will change.

1.5 Outline of the Study

The remainder of this thesis is divided into five chapters; that is, Chapters Two through Six. Chapter Two presents a review of literature dealing with the BST technology itself and the effects of BST adoption. Chapter Three provides a discussion of the conceptual framework (i.e., economic theory and analytical technique) from which the empirical methodology used in this study is developed. Chapter Four is devoted to a discussion of the representative farms, data sources and specification of the empirical model for analysis. Chapter Five presents the results of the analysis and a discussion of their implications. Both short-run and long-run economic implications of BST adoption will be examined based on the results for the representative farms. Finally, the conclusions for the study are summarized in chapter Six. In this chapter, limitations of the study and suggestions for further research are also provided.