ABSTRACT

A SIMULATION ANALYSIS OF PLANNED
DAIRY FARM DEVELOPMENT IN EASTERN QUEBEC

By

Robert St-Louis

Serious criticisms concerning the use of public funds for regional development programs in Eastern Quebec suggested the need for this study. Among the proposed major regional programs were a number of dairy development strategies. The consequences of these strategies at the farm level were chosen as the primary objective of this thesis. Towards this end the study included an investigation of the current problem situation in the dairy subsector and an appraisal of various policy alternatives for increasing profitability of dairy enterprises in the area.

In the first part of this study, the planning issues in the dairy subsector were examined. A series of factors combine to create a serious low productivity and income problem in dairying in Eastern Quebec. These factors were (1) limited supply of highly productive resources, (2) lack of growth of effective demand for milk, (3) limited job opportunities outside of farming in the region, and (4) poor performance of both the dairy processing industry and the dairy input suppliers.

Increases in resource productivity were singled out as a major possible source of increasing income from dairying. Associated with this, however, is the fact that large quantities of resources (especially human resources) now committed to dairying would be forced to shift to

other uses. From the standpoint of regional agricultural planning, the area where information most seriously falls short of the needs was shown to be with respect to milk demand projections.

The second part of this thesis analysed alternative regional dairy strategies. These included (1) the establishment of specialized dairy replacement stock farms, (2) improved feeding practices, and (3) farm consolidation and community pasture programs. Additional alternatives considered were (4) subsidizing replacement purchases and (5) artificial insemination. The focus was to compare these alternative strategies from the farmers' point of view. This was done in two steps; first, by analysing field data on dairymen's intentions concerning the various alternatives, and second, through use of a simulation model to project changes in net cash income and cow productivity on two synthesized farms. Primary data from a survey conducted in the area were used.

The analysis of the respondents' intentions indicated the following. Most dairymen recognized that limited availability of good quality feed was a serious problem in the region. A major concern of the majority was improving the producing capacity of their cows. There was disagreement, however, as to whether artificial insemination might be more appropriate than purchasing replacements to increase the supply of more productive cows.

The simulation experiments provided the following results. Those based on low feeding rates indicated that limited availability of good quality feed may be an important factor accounting for low dairy farming income. Those simulated under improved feeding rates, to the contrary,

showed some potentials for increasing income from dairying. On the basis of the present value of cash flows discounted at 6 per cent, A.I. was found to rank first on both the large and the small simulated enterprises, but only by a slight margin over purchased replacements for the larger farm. The practice of buying replacements appears, however, to require more capital than other herd improvement practices.

The major policy implications emerging from the study were the following. If policy makers chose to promote buying replacements, increased credit may be a major associated need. Since regional dairymen have strong preferences for raising their own replacements, additional incentives might be required to make them shift to buying replacements. If greatly increased promotion is seriously considered, the returns to this development strategy could be evaluated by benefit-cost analysis.

With respect to future research the following issues appear important; (1) analysis of the development potentials of dairying in other areas of Canada as compared to Eastern Quebec, (2) the impact of recent milk supply restrictions on regional dairying, (3) the effects of collective bargaining on the distribution of the rewards for increased productivity in the industry and (4) the likely effects of various planning strategies on the regional milk supply and demand balance.

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CHAPTER I

INTRODUCTION

General Problem Situation

During the last fifteen years both the Federal Government of Canada and most provincial governments have shown greatly increased concern over serious disparities of income between regions as well as between areas within regions. This concern has resulted in greater public involvement in regional development programs. The most recent major legislation dealing with the problem of rural poverty in Canada is the Agricultural Rehabilitation and Development Act (ARDA) passed in 1962.[1] Essentially, the ARDA is an arrangement for federal-provincial cost-sharing of approved projects for the development of depressed rural areas. These projects are activated by provincial project proposals and sanctioned by enabling agreements on the part of participating provinces.

This thesis is concerned with one such project proposed for Eastern Quebec, an economically depressed area in the province of Quebec.[2] As a result of this project a multi-sector planning study was undertaken in

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[1]Past and current Canadian policies addressed to the problem of rural poverty in Canada are reviewed by Hadley Van Vliet, "Canadian Approaches to Rural Poverty," Journal of Farm Economics, vol 49 no 5 December, 1967, pp. 1209-24. See also Helen Buckley and Eva Tihanyi, Canadian Policies for Rural Adjustment: A Study of the Economic Impact of ARDA, PFRA, and MMRA (Queen's Printer, Ottawa, Canada), Special Study No. 7, prepared for the Economic Council of Canada, October, 1967.

[2]Other projects financed by ARDA are concisely described by L E Poetsche, "Regional Planning for Depressed Rural Areas--The Canadian Experience," Canadian Journal of Agricultural Economics, vol. XVI, no. 1, February, 1968 pp. 8-20

1963 and completed in 1966 at a cost of $3.8 millions.[3] The completed regional development plan included a series of recommendations for specific government action to induce improvements in the performance of existing industries and to facilitate the emergence of new economic activities in the secondary and service sectors. Agriculture, fisheries, forestry, mining and tourism presently constitute the backbone of this regional economy (Table 1).

The most serious criticism which was addressed to this regional project emphasized that no feasibility studies had been made for the individual projects recommended in the plan.[4] This weakness was recognized by public authorities who are now responsible for financing its implementation. Specifically, in the 1968 public document describing the nature of the inter-governmental agreement covering the implementation of the Eastern Quebec plan, there is a clear expression of the need for further research on the programs recommended. The mandate reads as follows:

> The impact of the implementation of each program or group of programs (proposed in the Eastern Quebec Plan) has to be measured and assessed, and if necessary these programs have to be modified in order to achieve better results.[5]

This dissertation follows this mandate, assessing a number of the proposed programs for the first planning period (1968-75). This research

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[3]All monetary data included in this study are expressed in Canadian currencies. They can be readily expressed in United States currencies by using the following ratio: $1 (USA)= $1.08 (Canada).

[4]Hadley Van Vliet, op. cit., p. 1216. R. Capel, "Development Plan for the Pilot Region: Lower St.Lawrence, Gaspe and Iles-de-la-Madeleine," Book review published in Canadian Journal of Agricultural Economics, vol. XVI, no. 1, 1968, pp. 98-100.

[5]Department of Forestry and Rural Development, Lower St.Lawrence, Gaspe and Iles-de-la-Madeleine Area of Quebec: Federal-Provincial Rural Development Agreement (Queen's Printer, Ottawa, Canada), 1968, p. 56.

TABLE 1. The Importance of Economic Sectors in Eastern Quebec Based on Employment, 1963.

Sector	Persons Employed by Sector	
	Number[a]	Proportion
	('000 persons)	(per cent)
Primary	22.0	30.5
Agriculture[b]	13.0	18.0
Forestry, fisheries and mining	9.0	12.5
Secondary	13.2	18.3
Food and beverages	1.8	2.5
Pulp and paper	0.6	0.8
Lumber, construction and others	10.8	15.0
Tertiary	37.0	51.2
TOTAL	72.2	100.0

Source: Development Plan for the Pilot Region; Lower St. Lawrence, Gaspe and Iles-de-la-Madeleine, A Summary, by Bureau d'Aménagement de l'Est du Québec, and Rural Development Branch, Department of Forestry and Rural Development, Ottawa, June 1967.

[a]The estimates for agriculture are especially tentative because farming relies very heavily upon members of the farm operator's family as a source of labor in Eastern Quebec. A more relevant measure of the relative importance of specific sectors of economic activity in the regional economy would be the proportion of total income generated in each sector. Unfortunately, reliable data on only a few sectors of economic activity are available.

[b]Some sectors of economic activity hire workers for only a few months in a year. As a matter of fact, the number of persons employed in all sectors, with the possible exception of some activities in the service sector, fluctuates heavily over the year in the region. Since primary activities are more seasonal than others in the region, it must be emphasized that this table probably overestimates the importance of primary activities. These data are thus very crude indicators of the relative importance of specific sectors of economic activity in the region.

studies only the group of programs advocated for increasing the productivity and profitability of dairy farming enterprises in the region. Some alternative dairy development strategies are also evaluated.

Importance

Dairy farming is presently an important source of income for a large portion of the rural population in Eastern Quebec. Sales of dairy products accounted for about 50 per cent of gross farm income in the region in 1966. Evidence indicates, however that a large majority of the people involved in dairy farming in the area barely earn a subsistence income despite the fact that dairying is heavily subsidized.

The planners' stated objective for the dairy farming industry is to increase productive efficiency. In order to achieve this objective they propose two general groups of programs. The first group of programs aims at creating exit opportunities for the people who want to discontinue farming. The second group of programs aims at increasing supply of adequate resources for the people who wish to further commit themselves to dairy farming. The planners believe that both groups of programs must be pursued simultaneously because of the limited prospects of a larger market for regional milk production.

The planners'[6] objective for the regional dairy farming industry is one over which reasonable individuals may disagree. This dissertation intends to present evidence as to whether or not the policies

[6]Henceforth we shall use the term "planners" to mean the group of researchers who participated in the planning effort conducted in Eastern Quebec from 1963 to 1966 the term "plan" to mean the policy recommendations that they advocated and the term "region" to specifically refer to Eastern Quebec.

proposed are likely to achieve increased productive efficiency rather than to directly challenge the objective itself. What is not known yet is the following: Do the benefits to be generated by the proposed dairy development strategies in the area justify the costs of these actions? If not, are there alternative strategies that can be justified on that basis? These questions cannot be appropriately answered without sound empirical evidence on the expected impact of various projects on farm income.

Planners have not yet fully explored the likely impact of their policy recommendations within benefit-cost or other appropriate analytical framework. The reasons which might explain this situation are not altogether clear. There is some evidence indicating that the ARDA authorities failed to supply the planners with guidelines for project appraisal.[7] Benefit-cost accounting was made a requirement for approval of projects by ARDA only after the development plan for Eastern Quebec had been completed.

The thrust of this thesis is to show that reasonable estimates of the likely impact of alternative dairy development strategies on dairy farmers' income can be obtained. These estimates are essential to provide basic data for an economic appraisal of the various projects.

Objectives

The specific objectives of the study are the following:

1) to review the general regional problem situation and set forth the nature of the regional planning effort undertaken;
2) to determine the most important difficulties currently faced by the regional dairy industry;

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[7]Hadley Van Vliet, op. cit., p. 1216

in the regional plan for solving the problems of the dairy farming industry;

4) to present evidence on regional dairymen's expressed preferences regarding the policy alternatives considered in this study. These policy alternatives include (á) the establishment of specialized dairy replacement stock farms, (b) improved feeding practices, and (c) farm consolidation and community pasture programs. Other alternatives considered are (d) subsidizing replacement purchases and (e) artificial insemination.

5) to determine which set of policy alternatives might most contribute to increasing the income of representative dairy farming enterprises;

6) to indicate how the findings generated in this study might be used to develop an extensive benefit-cost analysis of alternative dairy development programs.

Methodology and Source of Information

The model used in the analysis is based on a simulation technique developed by Robert F. Hutton.[8] It is a general purpose model designed to simulate the performance of a synthesized dairy enterprise under experimental conditions. The model is particularly useful for projecting changes in profitability and productivity of a dairy enterprise associated with variations in herd size, feeding rations, replacement practices, cost of feed and price of milk. A detailed description of the structure of the model

[8]Robert F. Hutton, A Simulation Technique for Making Management Decisions in Dairy Farming: Narrative, Flow Chart and Computer Code Description, Agricultural Economics Report No. 87, U.S. Department of Agriculture, Economic Research Service, February, 1966.

will be presented later in the study.

This study focuses on a limited number of alternative dairy development strategies for improving the performance of the regional dairy farming industry. The model is used to simulate two synthesized dairy farms under the conditions which might prevail in the region under the various policy alternatives considered. In this study two main criteria are used to evaluate the likely consequences of the regional dairy development strategies at the farm level. They are the net cash income per year of the dairy enterprise and the average production per cow per year. The model is used to project these performance criteria under alternative dairy herd improvement and/or feeding practices. The measured contributions of respective dairy development programs to the increases in net cash income from dairying and in average yearly milk production per cow is then presented as a guideline for comparing the policy alternatives considered.

Most of the information used in this study comes from two sources. The first consists of the regional planning documents dealing with the agricultural sector and their supporting studies.[9] The second source consists of primary data obtained from a sample survey which was undertaken

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[9]Development Plan for the Pilot Region: Lower St.Lawrence, Gaspe and Iles-de-la-Madeleine, A Summary, by Bureau d'Aménagement de l'Est du Québec, and Rural Development Branch, Department of Forestry and Rural Development, Ottawa, June, 1967.

Esquisse du Plan: l'Agriculture, published and edited by the Bureau d'Aménagement de l'Est du Québec, 1967.

Plan de Développement, Région Pilote: Bas St-Laurent, Gaspésie et Iles-de-la-Madeleine, Chapitre II, "Objectif de Modernisation des Secteurs de Base Traditionnels, Deuxième Partie: Le Secteur de l'Agriculture," Cahier 3, published and edited by the Bureau d'Aménagement de l'Est du Québec, June, 1966.

for this research project.[10] Many other sources of information are also drawn on in documenting the current problem situation faced by the regional dairy industry.[11]

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[10]Henceforth, the survey will be referred to as Eastern Quebec Dairy Farms Survey, 1969.

[11]Numerous quotes from French documents are presented in this study. Their translation is mine.

PART 1

Regional Planning in Canada: The Case of Eastern Quebec

CHAPTER II

EMERGENCE OF ECONOMIC PLANNING IN CANADA

Government policies to offset regional agricultural disadvantages span the history of Canada. Federal policies directed to price and income support, crop-failure assistance, and many other agricultural policies formed part of the measures used for promoting agricultural development through the post-Confederation period (from 1867 on). Combining with various provincial programs more or less oriented towards agriculture, they provided a broad overlay of rural welfare measures which eventually became major components of the current general agricultural policy in Canada.

Those measures have apparently failed to eradicate the generalized hard-core poverty problem that still subsists in many rural areas in Canada. In the early 1960's legislators were prone to believe that economic planning within a regional framework might succeed where general policies had failed. This belief was instrumental in leading to the Eastern Quebec pilot planning study, the first major attempt on the part of the Canadian Federal Government to search for special solutions to the economic and social problems of a severely depressed area.

The Meaning of Development Planning

The regional development plan for Eastern Quebec can first be examined by observing the underlying concepts conveyed by economic planning and by describing the conditions that surrounded its emergence in Canada.

The many definitions of development planning stem from the very fact that both development and planning mean different things to different people. For instance, if one were to agree with Myrdal's contention that "the movement of the whole social system upwards is what all of us in fact mean by development,"[1] and define planning as the "coordination of policies in order to attain and speed up development,"[2] he could then argue that almost every country of the world is presently planning the path of her development. If, on the other hand, one were to adopt a more pragmatic point of view, he might agree with Stolper's proposition that "the actual planning problem consists of mobilizing and allocating resources for growth in the best manner that time and circumstances permit."[3]

For the purposes of this study, development planning means systematic and coordinated research undertaken either for or by public decision-makers in order to find a set of strategies that are likely to contribute the most to whatever economic and social objectives a country is striving

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[1]Gunnar Myrdal, Asian Drama: An Enquiry into the Poverty of Nations (New York: Pantheon, 1968), vol. 111, p. 1869.

[2]Ibid., p. 1864

[3]Wolfgang F. Stolper, Planning Without Facts, Lessons in Resource Allocation from Nigeria's Development (Cambridge, Mass.: Harvard University Press, 1967), p. 52.

for. The set of strategies may include both private and public investment projects, changes in public regulations, creation of new institutions and/or changes in the functions of on-going institutions, and much more. The way in which the research is conducted may or may not involve those people on whose initiative the implementation of a plan is likely to rest. The expression "likely to contribute" was purposedly introduce in the definition to point out that--in Lewis's words--"a plan is essentially a set of guesses about the future, since the assignment of priorities requires uncertain estimates of likely results, benefits and costs."[4]

On the Role of Planning

The role of planning cannot be discussed in the abstract. In market economies, the role of planning for higher productivity in the private sector lies in finding a set of strategies which will most likely induce private persons to employ their time and resources more productively, given that the set of strategies is consistent with (1) the objectives of the society, (2) the quantity of resources and the amount of time available to implement these strategies, and (3) the specific interest of that part of the society which will most directly be affected by the set of strategies.

There is no standard list of the ways and means whereby a government can contribute to raising the rate of growth in the private sector

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[4]W. Arthur Lewis, Development Planning, The Essentials of Economic Policy (New York: Harper and Row, 1966), p. 25.

of an economy. In this study, the role of planning is defined to include a combination to the following elements:

1) Exploring and assessing alternative objectives set out by public decision-makers and others in order to find out which of these objectives are consistent and can be achieved by the appropriately defined aggregate unit of a nation;
2) Developing alternative sets of strategies which are consistent with the chosen objectives and which are most likely to induce the desired growth in the private and public sectors of the economy;
3) Seeking information and analytical methods which are appropriate for evaluating the relative merit of alternative sets of strategies;
4) Setting forth specific projects and programs to carry out chosen sets of strategies;
5) Presenting decision-makers and the public with sound estimates of the total economic and social impact for each alternative set of strategies; and finally,
6) Estimating the commitments of public and private funds that each alternative set of strategies entails.[5]

These elements, viewed singularly or in combinations, are most commonly used in defining the role of economic planning in market economies. Whether or not more is expected from economic planning (such as rationing a commodity during a war period) seems to depend upon (1) the

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[5]More specific elements which fit into these categories can be found in W. Arthur Lewis, op. cit., p. 22.

system of values held by a society, (2) the relative size of the public sector as compared to the private sector, (3) the nature and the degree of suddenness of problematic situations, (4) the status of the planning group in regard to other government agencies and (5) the means of government intervention which are constitutionally recognized at a point in time.

Planning in Canada

Planning in Canada is in its early infancy. In the 1950's the need for greater coordination of public policies affecting the growth of the Canadian economy began to be expressed in both the political and the academic circles.[6] Many people felt that one of the major problems that the Federal Government and the provincial governments would have to focus upon in the 1960' was that of significant income disparities between provinces and between areas within provinces. It was also felt that the general front of Canadian welfare policy originating in the late 1940's had contributed little more than temporary alleviation to

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[6]The need for coordination of Canadian agricultural policies has recently been stressed by McCalla, in whose opinion "A conglomeration of quasi-independent policies, without a broader set of coordinated objectives makes the adjustment of Canadian agriculture to changing market situations particularly difficult." See Alex F. McCalla, "A Review and Appraisal of Agricultural Policies in Canada," published in Agricultural Policy (Proceedings), Thirteenth Annual Workshop, Canadian Agricultural Economics Society, June 19-21, 1968, University of Guelph.

a self-perpetuating problem and that the costs of solving social problems through welfare measures had been increasing too rapidly.[7]

The changes in public policy orientation were slow to come.[8] It appears however, from the few changes that took place in the early 1960's, that most levels of government in Canada are committing themselves to a modest attempt to solve the problems of income disparities on an area basis. This approach is apparently based on the value judgment that the various regions of the country should be expected to share in the growth in total output and income of the nation as a whole. It is also based on the belief that it might be easier to achieve a coordination of economic policies on a local basis than at higher levels of decision-making.

The surging commitment on the part of public decision-makers to search for solutions to the income disparity problem on an area basis gave rise to three main difficulties. On the one hand, the concept of economic regions--differing from political district boundaries--could not be readily defined in unequivocal terms. On the other hand a choice had to be made between the objective of maximizing the rate of growth of output and productivity for the benefit of a region without regard for the impact of its development on that of other regions and that of securing an appropriate balance in economic development among the various regions which, at the same time, would be consistent with

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[7]H. Van Vliet argues that the Canadian concept of welfare policy reflects "the broader concepts of social welfare stimulated by European precedents, especially U.K. implementation of the cradle-to-the-grave philosophy of social security." See H. Van Vliet, op. cit., p. 1210.

[8]Van Vliet, op. cit., p. 1224, argues that "The commitment to the effort, in terms of both resources and concern, suggest that the war on poverty has scarcely been joined in Canada."

the economic and social objectives of the country as a whole. The assumption underlying this discussion is that the growth rate of income recorded at the national level is itself related to the nature of the interregional distribution. The exact nature of this relationship is a subject of controversy in Canada. The differences in viewpoint among economists and policy decision-makers appears to hinge heavily upon their appraisal of the degree of effectiveness in the organization and functioning of market forces. Not enough evidence is yet available to clearly determine whether or not the serious interregional disparities of income in Canada are significantly related to imperfections in operating market forces.[9]

The third major difficulty has to do with the present conflict of jurisdiction between levels of government in Canada. This last issue is briefly elaborated in the following paragraphs.

According to W.M. Nicholls, "Research in the national interest is a responsibility of the federal government" in Canada.[10] However, any casual observer of the policital evolution of Canada over the last decade might admit that not everybody agrees over what does or should

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[9]Further research on this issue is needed. Some people believe that operating market forces have not been so effective as to produce a significant convergence in the degree of interregional income differences in Canada. Factual evidence confirming this belief is, however, at most cursory. See S.E. Chernick, Interregional Disparities in Income (Queen's Printer, Ottawa, Canada), Staff Study No. 14, prepared for the Economic Council of Canada, August, 1966, p. 66.

[10]William M. Nicholls, Views on Rural Development in Canada (Queen's Printer, Ottawa, Canada), Special Study No. 1, prepared for the Canadian Council on Rural Development, 1967, p. 125.

constitute the national interest. The very challenge of the concept of national interest in Canada has been detrimental to the status of planning at all levels of government. The recent explosion of advisory groups (most of which are called Councils) serving specific levels of government reflects a need for coordination of economic and social policies in Canada.

The regional development programs which have already been undertaken in Canada cannot be fitted within a national or even a provincial planning framework. The question whether Canada needs a more formal economic planning structure is beyond the scope of this research. Let it be sufficient to point out that the issue of rural poverty in Canada has been instrumental in giving rise to regional development programs.

The Need for Using Project Appraisal Criteria in Canada

The question whether income redistribution to the benefit of a region such as Eastern Quebec should constitute an important objective in Canada cannot be answered by any scientific method. This is because the answer involves a series of value judgments with moral and ethical ramifications. However, the recognition of an important social objective as a policy goal must not preclude the simultaneous recognition of the economic costs and benefits. For instance, any government agency aware that a given set of strategies might contribute more than another set of programs to increase the well-being of dairy farmers in Eastern Quebec.

for a given cost, could be rightfully blamed if it proceeded to choose the latter set of strategies.

The importance of sound economics has been frequently emphasized in public statements by leading representatives of various government agencies in Canada. Yet evidence indicates that the valuable tool of benefit-cost accounting has played a very limited role in government investments until quite recently. This evidence was presented by various authors whose conclusions sustain the following comments by Buckley and Tihanyi:

> ARDA at least made some beginning in working out the methods of more rigorously applied benefit-cost principles.....Yet, in every day ARDA operations, statements of benefits in the most rudimentary terms are apparently acceptable as a basis for evaluating the merits of project sponsored from ARDA funds.

There are several reasons for believing that benefit-cost accounting studies are necessary for sound economic planning and that such studies need to be conducted at the policy formulation stage. The first general reason is that the benefit-cost analysis framework forces the planners to think in terms of alternative projects competing for scarce resources and to take a hard look at the possible outcomes of alternative strategies. The second general reason is that screening projects at the implementation stage may be too late in those cases where the research planning effort has created a momentun for new expectations regarding government policies. Much public controversy may be avoided by screening projects at the policy formulation stage itself.

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[11]Helen Buckley and Eva Tihanyi, op. cit., p. 21

Methods for Valuing Alternative Development Projects

Two methods of benefit-cost analysis are commonly used to appraise development projects. The first method which is often referred to as financial analysis examines the private profitability of a given project. Annual benefits, estimated on the basis of monetary revenues and costs accruing to the private entrepreneurs, are related to the amount of capital invested. The second method, usually called economic benefit-cost analysis, has been defined in the following terms:

> Cost-benefit analysis is a practical way of assessing the desirability of projects, where it is important to take a long view (in the sense of looking at repercussions in the further, as well as the nearer, future) and a wide view (in the sense of allowing for side-effects of many kinds on many persons, industries, and regions, etc.) i.e., it implies the enumeration and evaluation of all relevant costs and benefits.[12]

There are three major conceptual differences between the private profitability criterion of financial analysis and the real profitability criterion of economic cost-benefit analysis. These differences are the following:

1. Economic analysis recognizes that the contribution of a project or a group of projects to the growth of the economy is a indirect as well as direct. The direct effects consist of the immediate contributions to production. The indirect effects are those generated by the project or group of projects in all other sectors linked to the project.

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[12]H.R. Prest, and R. Turvey, "Cost-Benefit Analysis: A Survey," The Economic Journal, vol. LXXV, no. 300, December, 1965, p. 683.

2. Economic analysis is not conceptually restricted to the use of actual prices as measures of economic value. Prices adjusted to reflect true opportunity costs to the economy are used when one, two or all three following circumstances prevail:
   a) some resources of the economy are not fully utilized;
   b) production under decreasing cost functions--which can be attributed to indivisibilities either in input or output industries--characterized one or some of the sectors affected by the project; and/or
   c) market imperfections of different kinds exit in the economy.
3. Economic analysis relates benefits not exclusively to the private capital invested but rather to the sum total of annual costs which include both capital and project operation costs over time.

Financial Analysis as a Step in Benefit-Cost Accounting

Since private entrepreneurs normally respond to the monetary returns accruing to them rather than to the economic returns--measured in terms of opportunity costs-accruing to the total economy, it must be emphasized that the economic benefit-cost analysis is not a substitute for financial analysis when the use of shadow prices is justified.[13]

[13]This argument may be clarified by an example. Suppose that a dairy development project proposed in Eastern Quebec was shown to have an economic benefit-cost ratio significantly higher than one but that hired labor was appropriately valued at zero cost. The important question is the following: Does the benefit-cost ratio imply that the dairy farmers will get enough benefits from the project to make a positive

The logic of this argument suggests that planners must be concerned with both the financial and the economic criteria for project appraisal if there are valid reasons to believe that the use of shadow prices is needed for computing the economic criterion.

The analytical part of this study is restricted to estimating the relative merit of alternative development strategies for increasing the well-being of dairy farmers in the regional economy of Eastern Quebec. The financial analysis criterion is therefore used. There are valid reasons to believe, however, that the current market price for some important factors of production might differ from their real opportunity costs in alternative uses in the regional agriculture. Evidence on these possible differences is presented in the following chapters.

Agricultural Planning in a Canadian Perspective

Planning is a concerted and coordinated development effort. Whether or not planning for agricultural development can be viewed as a major subset of general planning depends upon the relative importance of agriculture in the total problem situation. It might also depend in practice, upon (1) the way in which the public institutions servicing agriculture (including the Ministry of Agriculture) define their constituency and (2) the willingness of these institutions to participate into a concerted effort at either the national or the regional level.

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response to it? The answer is "not necessarily" because the dairy farmers are preoccupied not by the real value of the hired worker in alternative use but rather by the wage rate that they must pay in order to hire labor services. Rationality on the part of the dairy farmer must therefore be measured in terms of his financial costs and returns.

The early regional development efforts undertaken in Canada were directed primarily to land-use conversion and resource-oriented forms of agricultural development. There was a tendency on the part of the researchers who participated in these studies to pay little attention to the growing interdependence between agriculture and the nonfarm sectors and to disregard the relative importance of nonfarming activities in rural areas. However, a significant shift in emphasis began to take place in the early 1960's partly as a result of a revision in the ARDA legislation. It was thought that government funds allocated to planning research would probably provide a substantially more significant impact on disadvantaged rural areas if research were carried more strongly to encompass structural readjustments of agriculture and the broader development of nonagricultural phases of rural economy.

Agricultural economists were particularly affected by this change in program focus. Those who participated in the early efforts mostly as farm management specialists are now required not only to contribute to an understanding of resource adjustments at the farm level but also to suggest means for strengthening the interdependence between agricultural and nonagricultural sectors in depressed rural areas.

The essential newness and as yet limited extension of the above emphasis precludes definitive assessment of the future importance of agricultural planning in Canada. However, there are some reasons for believing (1) that there will probably be a substantial increase in the demand for agricultural planners in Canada, and (2) that agricultural economists will be asked to perform as members of planning teams concerned with a broad array of problems, including the potential contribution of

the agricultural industry to the future development of depressed rural areas.

The regional approach to development planning that has begun to emerge in Canada during the last decade can be theoretically connected with what V. Ruttan has called "the industrial impact hypothesis."[14] The industrial impact hypothesis postulates that economic development tends to occur more rapidly in specific locational matrices which are primarily industrial-urban in composition and that certain agricultural areas of a country appear to benefit more from their favorable location in relation to such centers than other agricultural areas located at the periphery of these centers. Discussing the theoretical as well as the practical implications of this hypothesis for regional planning in Canada is beyond the scope of this study. It must be emphasized however that an agricultural planning approach relying heavily upon that hypothesis might lead to disregarding an important factor, namely the ability of a region to export agricultural commodities for which it has comparative advantage. It is not an overstatement to suggest that agricultural economists with sound expertise in agricultural market

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[14]Vernon Ruttan, "Growth Stage Theories and Agricultural Development Policy," The Australian Journal of Agricultural Economics, vol.IX, no. 1, 1965, p. 23. This general hypothesis has many proponents. In North America its major proponent has been T.W. Schultz who expressed it in the form of three tentative statements concerning the ways in which economic development appears to propagate itself over a country's geographical space. See T.W. Schultz, The Economic Organization of Agriculture (New York, Toronto, London, McGraw-Hill Book Company, Inc.), 1953, p. 147. Other proponents' views are summarized in Bela Balassa, The Theory of Economic Integration (Homewood: Richard D. Irwin, Inc., 1961), pp. 193-98.

analysis might have much to contribute to regional planning in Canada. Their absence might otherwise lead to a serious aggravation of the agricultural surplus problems that have plagued Canadian agriculture for the last decade.

Economic planning is essentially a team effort. The nature of the regional income disparity problems currently existing in Canada indicates that the demand for agricultural economists with some expertise in planning might substantially increase in this country in the foreseeable future. The nature of the planning approach which has been brought to bear on these problems in turn indicates that agricultural economists will be expected to work in close cooperation with specialists in other disciplines.

Summary

The inroads so far made into the complex problem of rural poverty in Canada represent a bare beginning. Canada has just begun an approach to the problem of income distribution within its lagging rural areas after many years of concentration on the income distribution problem between agriculture and other sectors of the economy. The program activities undertaken so far reflect a serious lack of a basic theory of area and regional economy as viewed within the national perspective. Their effectiveness has been partly dissipated by failure to appropriately evaluate the payoff accruing to alternative uses of public funds for alleviating rural poverty.

This points out the need for concerted and coordinated efforts where stringent project appraisal criteria are applied for screening

alternative development strategies. The relative importance of agriculture in the poverty areas of Canada suggests that the expertise of agricultural economists might be in greater demand in the foreseeable future. Their expected contributions may need to shift somewhat from farm management research to macro supply and demand analysis. However, the expertise of farm management specialists will continue to be needed for finding effective ways and means of implementing agricultural development strategies, particularly with regard to the incentives which farmers need in order to change their farming methods and production patterns in desirable directions.[15]

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[15]The ways in which farm management specialists might substantially contribute to planning for agricultural development are explored in detail in Rainer Schickele, Farm Management Research for Planning Agricultural Development (New York: Agricultural Development Council, ADC Reprint, December, 1966).

CHAPTER III

THE GENERAL PLANNING PROBLEMS AND OBJECTIVES IN EASTERN QUEBEC

This chapter gives an overall view of the recent changes that were wrought into the social and economic organization of Eastern Quebec. Special emphasis is laid upon the economic situation of the agricultural sector. This information is presented as a background for understanding the general objectives that were set forth in the regional development plan.

Definition of the Region

To study the social and economic problems currently faced by the population of Eastern Quebec, let us first circumscribe the region and examine its recent economic and social evolution. The Eastern Quebec region comprises the following nine counties: Rivière-du-Loup, Témiscouata, Rimouski, Matane, Matapédia, Bonaventure, Gaspé-North, Gaspé-South and Iles-de-la-Madeleine. The area, with the exception of Iles-de-la-Madeleine county, is bounded on the south by the province of New Brunswick and on the North by the St.Lawrence River (Figure 1). Iles-de-la-Madeleine, located 120 miles away from the mainland eastern boundary of the territory, is recognized to share very little economic complementarity with the mainland area of Eastern Quebec. Moreover, this county has been treated as separate geographical entity in the

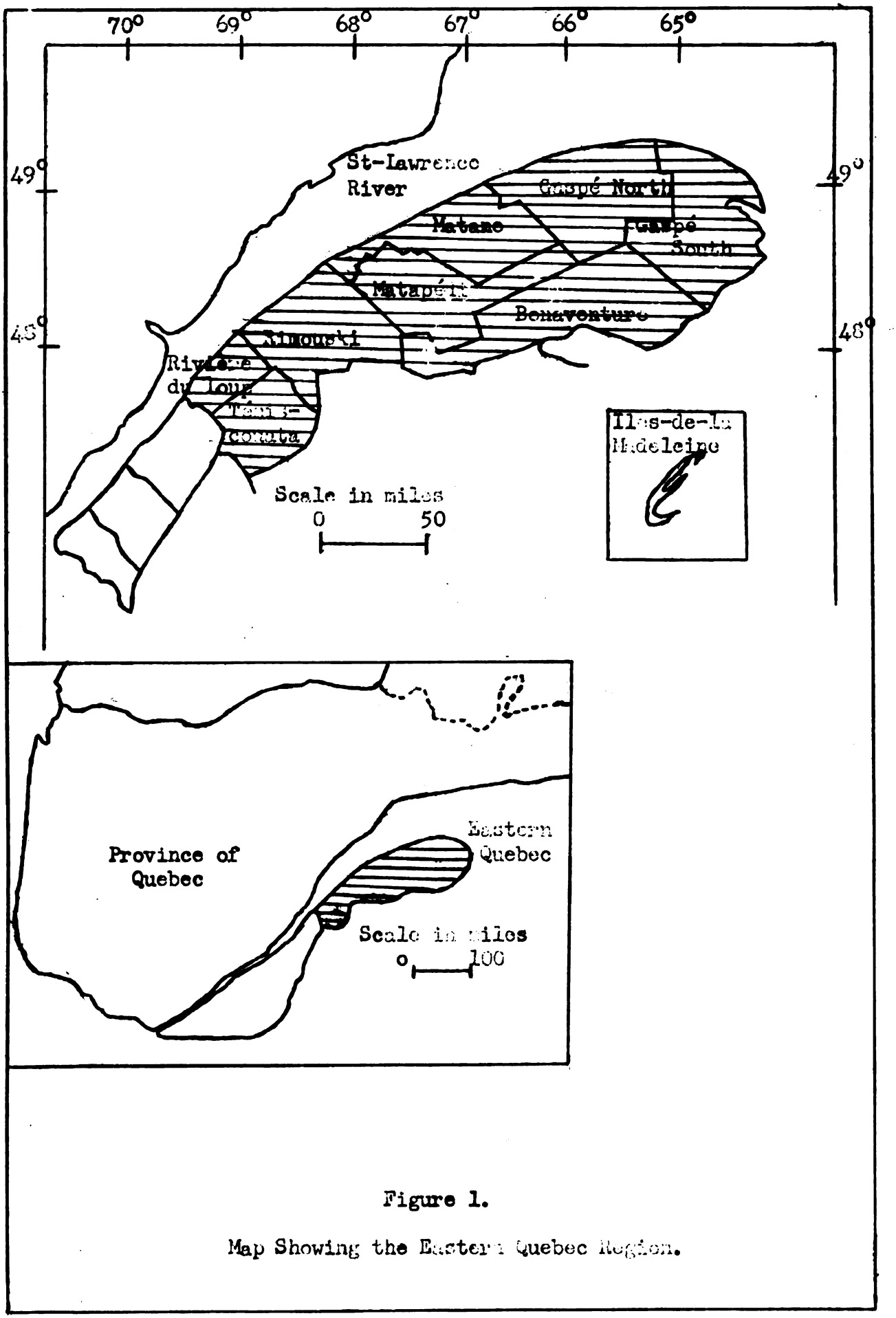

Figure 1.

Map Showing the Eastern Quebec Region.

development plan. Therefore, for the purposes of this study the Eastern Quebec region excludes Iles-de-la-Madeleine county.

The Human Resources

The population of Eastern Quebec increased at a decreasing rate from 1901 until about 1961, when it started to decrease in absolute terms (Table 2). An important exception to this trend occured between 1931 and 1941, when the population of the area increased by 23 per cent. Although no precise estimates can be obtained, cursory evidence indicates that this exceptional diversion from the long-run trend can be partly attributed to the so-called "retour à la terre"(back-to-the-farm) movement which took place in Quebec during the depression period and its aftermath. An interesting study has shown that the characteristics of the farms located in the rural towns incorporated before 1931 differed substantially from that of the farms established in towns incorporated after 1931.[1] The first farm settlers were apparently apt at selecting the most ecologically suitable soils while the wave of would-be farmers of the 1930's apparently had to settle on types of soils generally less suitable for agriculture.

A peculiar characteristic of the region is the relatively high proportion of the population classified as rural non-farm. The rural farm population decreased by almost 50 per cent between 1951 and 1966

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[1]Yves Dubé and Jean-Marie Martin, Problèmes de l'Agriculture dans la Région du Bas Saint-Laurent (published and edited by the Département des Sciences Sociales de L'Université Laval, Quebec City, Canada), Le Conseil d'Orientation Economique du Bas Saint-Laurent, Québec, 1963, pp. 81-106.

while the rural non-farm population did not start to decrease until around 1961 (Table 2). Part of this phenomenon can be attributed to the change of definition of a census farm between 1951 and 1961.[2] However, adding up rural farm and rural non-farm population eliminated this conceptual inconsistency. The joint estimate indicates that the absolute importance of these two groups has been slowly eroded but their relative proportion of the total population was still 62.7 per cent in 1966.

The Natural Resources

The region is typically rural. The activities of the people in the area were almost exclusively centered on the use and transformation of natural resources until around 1900. They still are, to a very significant extent. These resources have been described in the following terms:

> An unexplored underground, marginal farm lands, a limited forest, a limited stock of cheap fish species and a touristic potential which, up to now, has not been put into advantages. The situation is aggravated by the fact that this real but marginal reservoir of natural resources does not support an adequate industrial sector. At the present time, there are only a few important industries in the territory, and out of five hundred and sixty-one industries, four hundred employ less than fifteen people each.[3]

For the purposes of this study attention is concentrated on the resources of the agricultural sector. Various technical studies which

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[2]See footnote "a" of Table 2, for the definitions of urban, rural non-farm and rural farm population.

[3]François Poulin, "The Planning of Regional Development: Eastern Quebec," Canadian Journal of Agricultural Economics, vol. XIV, no. 1, 1966, pp. 7-8.

TABLE 2. Population of Eastern Quebec, 1901 to 1966, and Distribution of the Regional Population in Urban, Rural-Farm and Rural Non-Farm, 1951 to 1966.[a]

Year	Total Population		Urban Population[b]		Rural-Farm Population[b]		Rural Non-Farm Population[b]	
	Number ('000)	Rate of Change (per cent)	Number ('000)	Rate of Change (per cent)	Number ('000)	Rate of Change (per cent)	Number ('000)	Rate of Change (per cent)
1901	118		N.A.		N.A.		N.A.	
1911	144	+21.8	N.A.		N.A.		N.A.	
1921	170	+18.1	N.A.		N.A.		N.A.	
1931	197	+15.4	N.A.		N.A.		N.A.	
1941	242	+23.1	N.A.		N.A.		N.A.	
1951	277	+14.2	61		133		83	
1961	310	+12.1	107	+75.4	82	-38.3	121	+46.3
1966	298	- 3.8	111	+ 4.4	68	-16.4	119	- 2.5

Source: Census of Canada, Vol. 1 - Population (General Characteristics), Catalogue No. 92-608, Dominion Bureau of Statistics, Ottawa, Canada, 1901 to 1966.

Symbol: N.A. not available

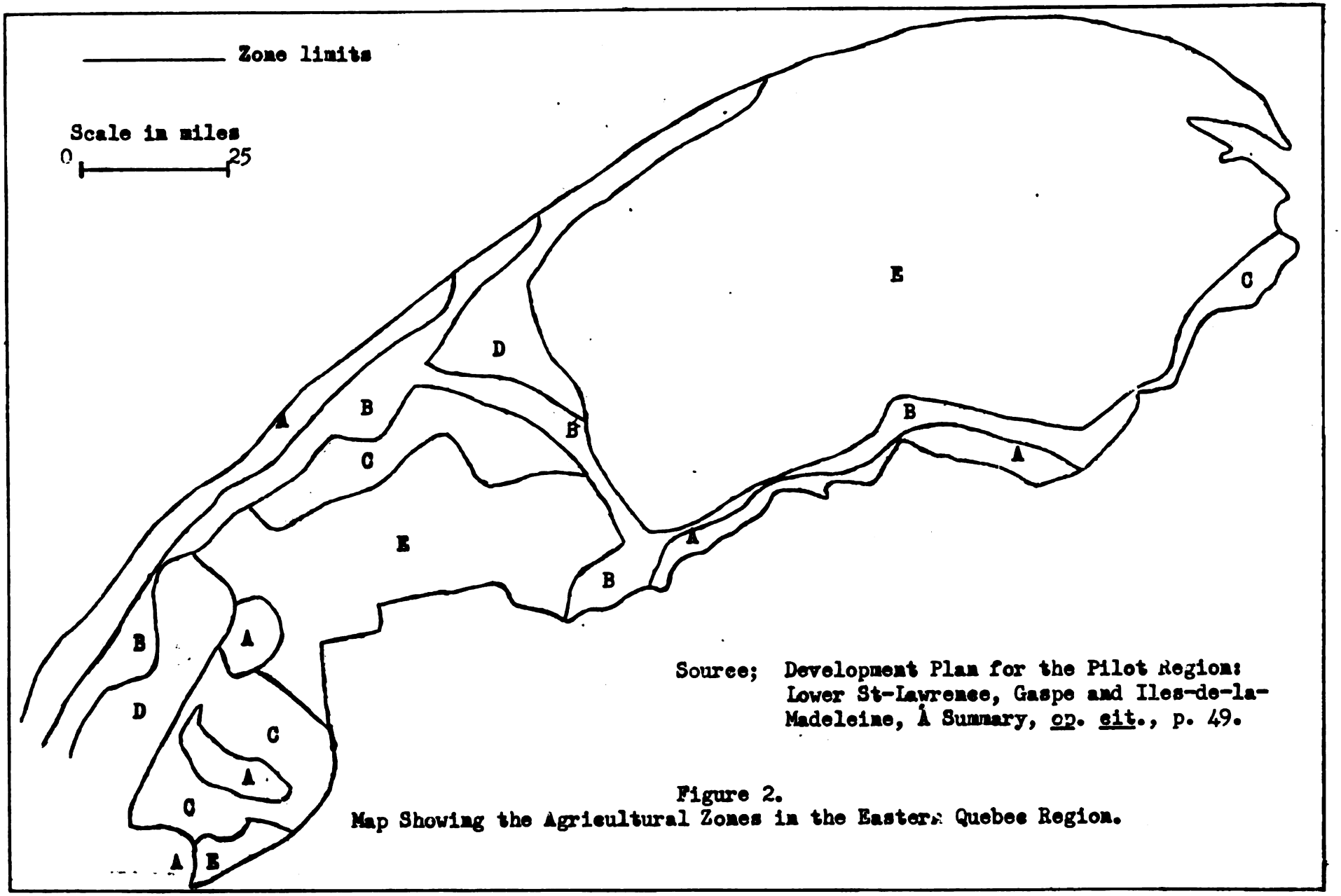
[a]Urban; includes the population living in cities, towns and villages of 1,000 people or more, whether incorporated or not. Farm and non-farm: In 1951, the "farm" population was defined as comprising all persons living on a holding on which agricultural operations are carried out and which comprised (i) three acres more in size, or (ii) from one to three acres in size with agricultural production in 1950 amounting to $250 or more. In 1961, this definition was revised and a farm was defined for census purposes as an agricultural holding of one or more acres with sales of agricultural products of $50 or more in the previous year. In both cases, rural non-farm population equals total population minus urban population minus rural farm population.

[b]Data prior to 1951 are not consistent because of major changes in definitions for census purposes.

were made in the agricultural areas of the region appear to support the following generalizations. The region's cool climate and abundant water supply make it well-suited for growing grass. Grains and particularly oats appear to grow equally well. Because of the abundance of weeds cereals are mostly grown as shelter and forage crops. Cereals grown for grain, however, are mostly limited to coastal areas where the sea moderates the climate. The humidity which tends to favour growing of forage crops also poses a serious problem for their storage. The ecological conditions of the region make it difficult to dry hay in the field while maintaining good quality in storage. The climate of the region is also suited to produce a few vegetable and fruit crops, especially potatoes.

The region can be meaningfully divided into five agricultural zones where the climate, the type of soils and the topography are unequally favorable to the development of a viable farming industry (Figure 2). The physical characteristics of these zones can be described as follows:

1. Zone A. Comprising less than 25 per cent of the settled area of the region, this zone is considered the most ecologically favourable to the development of the farming industry. It is suitable for growing cereals and for harvesting two crops of hay per year. Out of the 11,314 farms recorded in the region in 1961, 3,796 were located in this zone.
2. Zone B. This zone has proportionately less cleared arable land than zone A. Its arable soils are also of inferior



Source; Development Plan for the Pilot Region: Lower St-Lawrence, Gaspe and Iles-de-la-Madeleine, A Summary, op. cit., p. 49.

Figure 2.
Map Showing the Agricultural Zones in the Eastern Quebec Region.

quality. The climate is more rigorous and cereal growing is more hazardous in zone B than in zone A. Some 3,193 farms were located in that zone in 1961.

3. Zone C. This zone has only 16 per cent of the region's cleared arable land but its soils are particularly well-suited for agriculture. However, the climate is more rigorous than zone B. Cereals cannot be grown except as a nurse crop to be harvested as fodder and only one cut of hay per year is possible. Some 2,088 farms were recorded for this zone 1961.
4. Zone D. This is the most disadvantaged of the region's agricultural zones. Its cleared arable land is stony and poorly drained. The climate is unsuitable for cereals. Some 1,185 farms were located in this zone in 1961.
5. Zone E. Despite the fact that it is considered ecologically unsuitable for any agricultural crop, this zone had 1,052 farms in 1961. These farms were mostly subsistence and part-time farming operations.[4]

The technical difficulties associated with farming activities in Eastern Quebec appear to increase significantly as one goes from zone A to zone E. On the one hand, the rate of disappearance of farm operations has recently been more rapid in zones C, D and E than in zones A and B (Table 3). On the other hand, commercial farms are now substantially

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[4]Factual information on these physical characteristics of the region was drawn from "Development Plan for the Pilot Region: Lower St.Lawrence, Gaspé and Iles-de-la-Madeleine, A. Summary," op. cit., pp. 46-50.

more numerous in zones A and B than in the other zones (Table 4).[5] As a matter of fact, about one farm operation out of two was a commercial farm in zone A, one out of three in zone B, one out of four in zone C and only one out of six in zones D and E, in 1966.

Major Resource Problems in Agriculture

Eastern Quebec is considered as one of the most economically depressed areas of Canada. While the use of average measures has its limitations, some comparisons between the Province of Quebec as a whole and the region of Eastern Quebec might illustrate the nature and extent of the problem situation which was faced by the planners. For example:

1. Personnel disposable annual income per capita has been roughly estimated at $ 606 in Bonaventure, $ 643 in Gaspé (Gaspé-East and West), $ 647 in Matane and Matapédia, $ 693 in Rivière-du-Loup and Témiscouata and $ 800 in Rimouski, as compared to $ 1217 for the Province as a whole in 1961. The comparable figure for the populous region of Montreal was $ 1444 per capita in the same year.[6]
2. Transfer payments accounted for $ 58 million (or 27 per cent) of a total disposable income of approximately $ 220 million

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[5]For census purposes, commercial farms are defined as agricultural holdings of one or more acres with a value of agricultural products, in the 12 months prior to the census, of $ 2,500 or more (excluding institutional farms).

[6]Gérard Vibien, Répartition Régionale du Revenu Personnel au Québec, 1961, Plannification du Développement Régional, Serie II Rapport d'Analyse, Cahier II/3, Published by the Conseil d'Orientation Economique du Québec, Quebec, November, 1967, p. 122.

TABLE 3. Number of Farms Per Zone, and Rate of Disappearance of Farms, 1961 to 1966.

Zones	Number of Farms		$\frac{1966-1961}{1961} \times 100$
	1961	1966	
			(per cent)
A	3,796	3,122	-17.8
B	3,193	2,540	-20.5
C	2,088	1,530	-26.7
D and E	2,237	1,714	-23.4
Total	11,314	8,906	-21.3

Source: 1966 Census of Canada: Agriculture, Quebec, Catalogue No. 96-606, Dominion Bureau of Statistics, Ottawa, Canada, February, 1968.

[a]Farm operations were allocated by zones according to the list of municipalities specified in "Plan de Développement," Cahier 3, op. cit. pp. 64-71.

TABLE 4. Total Number of Farms and Number of Commercial Farms Per Zone, 1966.

Zones	Number of Farms 1966		$\frac{\text{Commercial}}{\text{Total}} \times 100$
	Total	Commercial	
			(per cent)
A	3,122	1,435	46.0
B	2,540	997	39.3
C	1,530	391	25.6
D and E	1,714	285	16.6
Total	8,906	3,108	34.9

Source: Same as Table 3.

[a]Same remark as in Table 3

recorded for Eastern Quebec in 1961.[7] The comparable figure for the Province of Quebec as a whole was 13 per cent in 1961. It must also be pointed out that government financial aid granted to agriculture in the region represented about 40 per cent of gross income from sales of farm products.[8]

3. Approximately 38 per cent of the labour force was engaged in primary seasonal activities in Eastern Quebec in 1963, compared to 15 per cent for the Province as a whole. Moreover, seasonal unemployment was considerable in the former area. It has been estimated that approximately 35 per cent of the wage earners in Eastern Quebec were unemployed for more than six months in 1963.[9]

Although more precise data are not available for comparing Eastern Quebec with other areas of Canada on a real income basis, these indicators describe a regional economy which is seriously depressed.[10] A discussion of the major social problems associated with low incomes and high levels of unemployment in the region is beyond the scope of this study.

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[7] Ibid., p. 119.

[8] François Poulin, op. cit., p. 8.

[9] Ibid., p. 7

[10] Even if one makes adjustments for spatial price differences, the income differences tend to remain large between regions of Canada. Evidence on this matter can be found in S. E. Chernick, op. cit., pp. 47-51.

The main issue which is further explored in this study is the following: What is the combination of economic forces which has led to the general economic stagnation presently experienced in Eastern Quebec? A possible answer to this question is suggested in the following pages.

Problems Related to Migration Patterns

Perhaps the lack of natural resources alone does not suffice to explain why poverty is such a serious problem in Eastern Quebec. Low educational levels and disproportionate presence of the least productive population age groups may be important causal factors. Consider for example that:

1. Eastern Quebec attracted population from other areas of the Province of Quebec during the early land settlement period (1850-1900) and also during the depression and its aftermath (1930-1940).
2. The natural rate of increase (birth rate minus death rate) in the regional population was still as high as 15.5 per cent over the period 1951-1956 as compared to a 11.6 per cent for the province of Quebec as a whole over the same period.[11]
3. The level of education of the regional population was estimated to be consistently and substantially less than the provincial average.[12]

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[11]Robert D. Hirsch, Gérard Vibien and Bernard Robert, L'Origine et la Nature des Désiquilibres Régionaux au Québec, Planification du Développement Régional, Série II Rapport d'Analyse, Cahier ii/2, published by the Conseil d'Orientation Economique du Québec, Québec, February, 1968, p. 73.

[12]Ibid., p. 109

4. The net regional outmigration totalled 35,334 people between 1951 and 1961. Most of the people who left the region from 1951 to 1961 were between 15 and 44 years of age.[13]
5. The regional cities and towns have grown very slowly. Indeed the regional population is presently distributed among 200 small localities located mostly along a 500-mile coast-line. The ten most important towns in the region have a total population of about 60,000 people or 20 per cent of the regional population.
6. Selectivity of migration has apparently contributed to leave a regional population which is seriously distorted in its age distribution characteristics as compared to the rest of province of Quebec (Table 5).

It may logically be hypothesized, on the basis of these facts, that two long-run factors have been particularly defavorable to the economic development of the region since 1940. The first factor has to do with the increasing degree of selectivity in migration patterns. The second factor consists of the apparent failure of low wage rates to attract investments in the region. No one of these factors is unique to Eastern Quebec. The combination of these factors, however, appears to have been particularly effective in generating serious social and economic problems in the region since about 1940.

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[13] Ibid., pp. 75 and 80.

TABLE 5. Percentage Distribution of Population by Twenty-Year Age Groups in Eastern Quebec and in all Other Areas of the Province of Quebec, 1966.

Age Groups	Proportion of Total Population in Specified Age Groups	
	Eastern Quebec	All Other Areas of Quebec
	(per cent)	(per cent)
0-19	51.7	43.0
20-39	22.6	28.0
40-59	17.0	19.9
60 and over	8.7	9.1
	100.0	100.0

Source: Compiled from 1966 Census of Canada (Ottawa, Dominion Bureau of Statistics), Catalogue No. 92-610, vol. I (1-10), Population, Age Groups, March, 1968.

Nature and Resource Problems of Agriculture

In the early 1960's, primary agricultural activities--that is activities which can be directly associated with farming--absorbed about 16 per cent of total regional labour force of about 83,000 people.[14] In the meantime, census reports indicated that 65.6 per cent of the population in Eastern Quebec, as defined herein, was nonurban by residence (Table 2). The difference between these estimates indicates that a substantial proportion of the regional population earns a living in rural activities that are not directly related to farming.[15]

[14]F. Poulin, op. cit., p. 1

[15]The number of people who live and work in the rural areas of the region is probably smaller than the number of people classified as nonurban by residence.

The Importance of Dairying in the Region

The production of dairy commodities is the predominant source of income from farming in the region. Milk sold on the market accounted for 46.7 per cent of total farming income derived from the sales of agricultural commodities in 1965 (Table 6). Moreover, the predominance of dairy salvage in terms of the regional beef output leads to the conclusion that total regional marketings of cattle to yards and plants are in the form of heifers, calves and culled cows.[16] In addition the proportion of total annual milk production which is fed to livestock skim milk may be quite significant in Eastern Quebec. However no precise estimate of the quantity of milk used as an input on own farms could be obtained.

TABLE 6. Value of Agricultural Products Sold by Eastern Quebec Farmers, by Groups of Products, 1965.

Groups of Products	Value	Percentage for Specified Groups
	($'000)	(per cent)
Dairy products	10,131	46.7
Pigs	3,579	16.9
Cattle	3,196	14.7
Field crops	1,420	6.5
Forest products	1,283	5.9
Poultry Products	880	4.2
Others	1,191	5.5
All groups	$ 21,688	100.0

Source: 1966 Census of Canada: Agriculture, Quebec, op. cit., Table 23,1 to 23.10.

[16]T.C. Kerr, An Economic Analysis of the Feed Freight Assistance Policy, published by the Agricultural Economics Research Council of Canada, Ottawa, Canada, Publication No. 7, Spetember, 1966, pp. 103-05.

The general structure of regional farming includes the following features:

1. In terms of income generated through the sales of agricultural commodities, the dairy enterprise might, with very few restrictions, be currently considered the mainstay of farming in the region.
2. Dairy enterprises can be found on various types of farms.[17] The farms on which they are found have either one or a combination of the following enterprises;
   a) a dairy enterprise;
   b) a combination of dairy-related crops;
   c) a swine enterprise;
   d) a forestry-related enterprise;[18]
   e) a chicken enterprise;
   f) a potato enterprise; and
   g) other minor enterprises.

No data are available for determining how many farms have a given combination of these enterprises. However, census data tend to indicate that combinations a) and b) usually in conjunction with c) and/or f) are most frequently found.

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[17]There were 7,468 farm operators (out of a total of 8,906 census farm operators) who reported cows potentially in lactation, in 1965.

[18]The forest occupies 14,000 of the 16,000 square miles of Eastern Quebec. A minor fraction of this forest area extends on the border of current farm areas. However forest-related enterprises appear to decrease in importance as a source of farm income in the region.

3. The few farms which do not have dairy enterprises tend to have smaller annual gross sales of agricultural products. Only one census farm out of four did not report any sales of dairy products in Eastern Quebec in 1965. Moreover, 93.9 per cent --or 2,162 out of 2,302 census farms-- of those farms sold less than $2,500 of agricultural products in 1965 (Table 7).

TABLE 7. All Census Farms and Census Farms not Reporting Sale of Dairy Products, Eastern Quebec, 1965.

Class of Sales	All Census Farms	Census Farms Not Reporting Sales of Dairy Products
(value of sales)	(number)	(number)
$2,500 and more	3,108	140
50-2499	3,782	2,162
TOTAL	8,890	2,302

Source: 1966 Census of Canada: Agriculture, Quebec, Catalogues No. 96-636 and 96-606.

Evidence on Low Returns to Factors of Production in Regional Agriculture

The returns accruing to the factors of production committed to farming are low. Yet nobody has been able to accurately estimate regional net farm income.[19] This is understandable since consistent data on farm costs are not yet systematically collected in the region. However, crude approximations made in this study indicate that very few farmers

[19]By net farm income we mean the residual income with which a farm operator is left to remunerate his own labor, his capital and managerial ability.

might earn their living from farming alone in Eastern Quebec (Table 8).

Farms might be appropriately classified into the following categories:

1. Farms with the largest growth potentials. This category might include those farms which reported sales of agricultural products of more than $ 10,000. Table 8 indicates that there were 174 such farms in Eastern Quebec in 1965. It is tentatively suggested that these farms might possess some combinations of the following characteristics:
   a) operator's superior managerial ability;
   b) favorable location vis-à-vis the regional urban markets;
   c) enough capital and borrowing capacity to finance the acquisition of additional resources;
   d) operator devoting most of his work time to the farming operation;
   e) relatively high productivity.
2. Farms with restricted growth potentials. This category might comprise those farms which reported sales of agricultural products of more than $ 5,000 and less than $ 10,000. Some 945 farms came under this category in 1965. The major barrier faced by these farm operators might be that of getting hold of additional funds to finance further growth. Furthermore, the probability that these farmers will continue farming in foreseeable future might be relatively high.
3. Farms without current growth potentials. This category consists of those farms which reported between $ 2,500 and $5,000

TABLE 8. Number of Farms by Classes of Annual Net Farm Income, Eastern Quebec, 1965.

Class of Gross Farm Income	"Gross Income" Used for Class (1)	Hypothetical Net Farm Income[a] (2)	Other Net Income Accruing To Farmers[b] (3)	Total[c] (2+3)	Number of Farms in Each Class
($)	($)	($)	($)	($)	(number)
35,000-and more	35,000	10,500	1,000	11,500	6
25,000-34,999	30,000	9,000	1,000	10,000	7
15,000-24,999	20,000	6,000	1,000	7,000	39
10,000-14,999	12,500	3,750	1,000	4,750	122
7,500- 9,999	8,750	2,625	1,000	3,625	220
5,000- 7,499	6,250	1,875	1,000	2,875	725
3,750- 4,999	4,375	1,312	1,000	2,312	740
2,500- 3,749	3,125	937	1,000	1,937	1,249
1,200- 2,499	1,850	555	1,000	1,555	2,013
250- 1,199	725	217	1,000	1,217	2,480
50- 249	150	45	1,000	1,045	1,289
					8,890

Source: 1966 Census of Canada: Agriculture, Quebec, Catalogue No. 96-606, Dominion Bureau of Statistics Ottawa, Canada, June 1968.

[a]Estimated at 30 per cent of "mean gross income" used for each class.

[b]Net value of home-produced and home-consumed food and rental value of the house.

[c]On the one hand, the multiplication by 30 per cent for all classes to compute "hypothetical farm net income" tends to introduce a bias in favor of smaller income farms. On the other hand, adding $1,000 of "other net income accruing to farmers" to each class tends to introduce a bias in favor of larger income farms. The extent to which these biases are compensating each other cannot be substantiated due to a lack of appropriate data.

sales of agricultural products. Some 1,989 farms were in this category in 1965. The probability that these farmers will continue farming either as a full-time or a part-time occupation will depend heavily upon the success of the government policies in inducing a greater regional demand for labor outside of farming. Most of these farmers are likely to have sporadically entered the off-farm labor market in the past. Their reluctance to give up farming might be related to the fact that the nonagricultural activities offer very few stable job opportunities in the region. Those farm operators who want to continue farming will need considerable help in setting up larger and more productive farming operations.

4. Farms without future growth potentials. This category includes all those farms which reported less than $ 2,500 sales of agricultural products (5,782 farms in 1965). Few of these farmers are likely to consider that farming is their main occupation. Furthermore, the disappearance of most of these farms can be expected in a foreseeable future. Farm operators in this category who will continue farming are probably people who assign a high value to their rural type of living.

The fact that 7,771 farms or 87 per cent of all the farms in the region are in the last two categories suggests that low level of profitability is a major problem faced by a majority of the farm operators in Eastern Quebec. The question which needs to be explored at this juncture is the following: What are the main causes of such incomes in regional farming? A possible answer to this question is presented in the following section.

The Causes of the Low Income Problem in Regional Agriculture

An addition to the limited supply of highly productive resources which will be discussed later the regional farming industry shows three characteristics which combine to "explain" the chronically low returns accruing to some factors of production currently committed to farming. These are (1) lack of growth of effective demand, (2) limited employment opportunities outside farming, and (3) slow rate of adoption of modern technology.

Lack of Growth of Effective Demand

Evidence indicates that three factors seriously militate against the farming industry of Eastern Quebec in the long-run. These factors are the following:

1. Its farming industry is highly based upon dairying.
2. Its dairy processing industry is almost exclusively specialized in butter production.[20]
3. The size of the regional population has recently started to decrease (Table 2).

The first two factors imply that the regional farming industry was particularly vulnerable to the consumption trend which has adversely affected the Canadian dairy industry during the last decade. This adverse trend has been documented by W. Mackenzie who argues the following:

> One of the main problems of the dairy industry (in Canada) is that per capita consumption of dairy products is falling about as fast as population is growing, leaving little room for total expansion of production. Ten years ago, in 1956, the consumption

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[20] Evidence on this characteristic will be presented in the following chapter.

> per capita of dairy products was 1,029 lbs. per annum. By 1966, the per capita consumption had fallen to 885 lbs. The main factors contributing to the fall are the declining consumption of fluid milk and cream per capita and the falling consumption of butter.... There is every reason to suppose that the decline is likely to continue.[21]

In addition, the recent decrease in regional population directly resulted in an adverse shift in the local demand function for milk products as well as for other agricultural commodities which are produced and mainly consumed in the region. The other agricultural commodities of significant importance in the region are pigs, potatoes, chickens, eggs and cattle most of which were cows (Table 6).

Limited Employment Opportunities Outside of Farming

The general state of poverty which characterizes the regional farming industry indicates that, in order to remain competitive, a large proportion of the farmers in Eastern Quebec have been willing to accept low remuneration for their own labor. This situation may be ascribed to a host of factors contributing to depress the value of their work outside of farming. Age, low level of education, high costs of migration, psychological attachment to the region and stagnant regional demand for nonagricultural workers are some of the factors which contribute to the existence of agricultural labor with low alternative opportunities.

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[21]William Mackenzie, The Canadian Dairy Industry, Rural Development Branch, Canada Department of Forestry and Rural Development, ARDA Project No. 15033, August, 1967, p. 1

It is interesting to note that the population of the region started to move out at an unprecedented rate between 1961 and 1966 (Table 2). Evidence indicates that this outflow of population was partly generated by numerous employment opportunities which became available in the North Shore area of Quebec during the same period.[22] It may be hypothesized that these employment opportunities were particularly attractive to a large segment of the Eastern Quebec population because the disadvantages due to low levels of education and costs of migration were minimal in this particular instance.

Slow Rate of Adoption of Modern Technology

The introduction of modern agricultural technology has lagged in Eastern Quebec as compared to other major farming areas of the Province of Quebec.[23] This lag can be partly explained by (1) the lack of growth of effective demand for the agricultural commodities which are produced in the region, (2) the relatively low opportunity cost of agricultural labor and land in the region, (3) the nature of that technology which is either labor-saving (such as modern milking parlors) or land-saving (such as fertilizers) and (4) the inability of farm operations in Eastern Quebec to generate funds which can be reinvested in farming.

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[22]The North Shore area of Quebec is bounded on the south by the Eastern Quebec region. The economic development of this area was mainly generated by the discovery of its rich iron ore deposits during the 1950's.

[23]This statement will be documented in the following chapter.

This study submits that the slow rate of adoption of modern practices by the regional farmers has much to do with the current levels of input and output currently faced by the people. This proposition will be substantiated later in the study.

The Combined Effects

The combined effects of limited agricultural resources, location which is not particularly favorable with regard to the large national urban markets, slow growth in effective demand for regional agricultural commodities, limited employment opportunities outside of farming and slow rate of adoption of modern technology resulted in an agricultural economy which apparently needs new incentives to further contribute to the economic development of the region. The interaction of these characteristics suggests that economic events outside of agriculture have had a considerable influence upon the extent and duration of the low-income problem in regional agriculture.

Much of the controversy over the appropriate economic policy for regional agriculture revolves around which of these characteristics can be modified by public policy so as to provide new incentives for development.

Planning Alternatives Considered by the Bureau d'Aménagement de l'Est du Québec

The nature of the problems which were encountered by the planners in Eastern Quebec led them to consider three alternative economic development strategies for the region. The first strategy consists

exclusively of economic incentives to encourage a further migration from the region to the major urban centers of the province. The second alternative revolves around measures which would induce an increase in the productivity of agriculture, forestry, fisheries, mining and tourism. Both alternatives were rejected because it was felt that they would result in

> considerable loss and under-use of the existing social and structural facilities, a major decline in the tertiary sector, and an extremely costly, if not impossible, task of providing the local population with urban services.[24]

The third option which is considered (and retained) is more ambitious. In more detail this option amounts to the following:

1. Increase the productivity of the five sectors which currently dominate the economic structure of the region, namely agriculture, forestry, fisheries, mining and tourism, while recognizing that this objective will very likely be accompanied by a release of human resources from agriculture, fisheries and forestry.
2. Facilitate the transfer of human resources, through retraining programs, to other sectors of economic activity located either inside or outside the region.
3. Stimulate more rapid growth of the few small urban centers of the region by attracting new industrial activities and new services, thereby increasing the probability that the human resources which are being retrained as well as the local newcomers in the labor market will stay in the region.
4. Take advantage of the fact that the subzones which are ecologically most suitable for agriculture (zones A and B) are

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[24]Development Plan for the Pilot Region, op. cit., p. 6

located more favorably than others (zones C, D and E) in relation to the few urban centers of the region.

5. Promote development projects which are economically profitable while taking fully into account the secondary benefits which might be generated through a reinforcement of the economic ties between rural areas and urban centers.

In attempting to alleviate some of the social and economic problems of the region by promoting these objectives, a number of policies were advocated for the agricultural sector by the regional planners. These policies can be classified under three main categories:

1. Policies for inducing increases in the productivity of farms owned by people who choose to continue farming: Since this study is directly concerned with the set of programs for the dairy farming industry, it is convenient to discuss their content at a later stage of this study.
2. Policies directed at facilitating the transfer of human resources from agriculture to the nonagricultural sectors: On the one hand, older farmers would be encouraged, through pensions, to leave farming when this is likely to favour the enlargement of neighbouring farms, the establishment of younger men in farming or the formation of community pastures. On the other hand, training and labor mobility programs are proposed for younger farmers who choose to leave farming for another trade.
3. Policies aimed at developing and/or strengthening the agricultural marketing institutions of the region, and at increasing the productivity of the agricultural processing industry: The

content of these programs is not explored in this study.[25]

It appears fair to argue that the approach adopted by the planners of Eastern Quebec gives substantial attention to the agricultural sector. This is reflected by the proportion of funds which have been allocated for improving the performance of this sector in the region (Table 9). In addition to the 8 per cent allocated directly to agriculture, the program area called "Social Development and Manpower Improvement" also involves a substantial amount of funds which will be used for implementing farmers's retirement and retraining projects. However, the proportion of funds which will be committed to these projects could not be estimated in this study because of lack of data.

TABLE 9. Summary of Cost Allocation of Development Projects by Program Area.

Program Area	Cost of Projects	Percentage of Costs per Program Area
	($000)	(per cent)
Agriculture	19,850	7.7
Forestry	17,630	6.8
Fisheries	22,760	8.8
Recreation and Tourism	22,100	8.5
Social Development & Manpower Improvement	114,100	44.1
Urbanization	21,850	8.4
Regional Transportation	31,100	12.0
Research	4,400	1.8
Administration	5,000	1.9
TOTAL	258,790	100.0

Source: Lower St.Lawrence, Gaspé and Iles-de-la-Madeleine Area of Quebec, Federal-Provincial Rural Development Agreement, op. cit., pp. 58-60.

[25]Further information concerning the content of the regional plan can be found in the following sources. François Poulin, op. cit.,pp. 1-14. Also François Poulin, "Constraints and Objectives of Regional Planning in Quebec." Journal of Farm Economics, vol. XLIX, no. 5, December, 1967, pp. 1271-76. Also Bureau d'Aménagement de l'Est du Québec (BAEQ), Development Plan for the Pilot Region, op. cit.

Summary

Evidence presented in this chapter indicates that the incidence of low incomes is high among all population groups in Eastern Quebec. Recent patterns of migration within the region also indicate that the incidence of low incomes in the region might be highest for those groups that are most dependent upon agriculture.

Poverty in regional agriculture appears to result from a number of interacting factors. Most low-income farms combine few investments in modern technology and low productive natural and human resources. Selective migration has been particularly unfavorable to the region, leaving a population somewhat distorted in age distribution. In addition, high birth rates combined with low incomes have created a serious lack of resources to invest in education.[26]

There are several reasons for believing that the emergence and continued existence of low incomes in regional agriculture is closely related to a severe lack of urban-industrial expansion. This dimension of the total regional planning problem appears to be particularly significant in Eastern Quebec mainly because the income elasticity for the agricultural commodities currently exported by the region (especially butter, potatoes and fluid milk) is low. Combining with the recent decrease in total regional population, this factor has apparently left little room for expansion of production in those agricultural commodities

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[26]It is interesting to note that similar characteristics appear to be present in low-income farming areas of the United States. Evidence on this matter can be found in Dale E. Hathaway, Government and Agriculture: Economic Policy in a Democratic Society (New York and London: The MacMillan Company and Collier-MacMillan Ltd., 1963), pp. 167-75.

that presently constitute the largest source of income in regional farming. However, the planning objectives which were retained by the regional planners recognize that there is substantial room for improvement in the technical efficiency of resources committed to agriculture in the region.

CHAPTER IV

PLANNING ISSUES IN THE DAIRY SUBSECTOR OF EASTERN QUEBEC

This chapter analyses the salient features of the dairy subsector in Eastern Quebec.[1] First, it reviews the main problems of this regional activity. Second, relevant aspects of trade theory are assembled for examining the long-run government objectives concerning the continuance of the dairy industry in the region. The assumption of economically rational dairy farmers is also explored. Other issues discussed have to do with past and current governement interventions on the dairy product markets.

Problems of the Dairy Subsector in Eastern Quebec

Within the regional dairy subsector there appear to be particularly significant possibilities for increasing factor productivity. The ensuing discussion examines these possibilities in the dairy processing industry, the dairy farming industry, and the industries supplying dairy inputs.

The Dairy Processing Industry

The regional dairy subsector is almost exclusively based on butter production. In 1963, there were 46 dairy processing plants in the region.

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[1]The dairy subsector is defined to include the dairy farmers, their input suppliers as well as the processors and distributors of dairy products. Characteristics of the distributors of dairy products in Eastern Quebec could not be considered in this study because factual information is not available.

In the same year, some 300 million or 95 per cent of a total of 313 million pounds of milk recorded at these plants were processed into butter.[2]

There are apparently three major factors that have an important adverse effect upon the competitive efficency (least-cost production) of the dairy processing industry in Eastern Quebec. These factors are small plant sizes, lack of product diversification at the processing level and significant underutilization of production capacity during eight months of the year.[3]

Small Size of Dairy Processing Plants

It is generally believed that in some industries efficient production requires relatively large plants. Recent trends in the Canadian dairy processing industry are particularly significant in that regard. The following were some of the major changes that took place in the dairy processing industry between 1961 and 1966 in Canada (Table 10).[4] On the one hand, the number of dairy processing plants decreased very significantly from 1,710 to 1,308. On the other hand, the number of large plants, reporting sales of $1 million or more, increased significantly from 180 to 240, and the proportion of total sales of the Canadian dairy processing industry accounted for by these large plants went from 59.5 per cent in 1961 to 70.2 per cent in 1966.

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[2]Bureau d'Aménagement de l'Est du Québec, Esquisse du Plan, l'Agriculture, op. cit., p. 183.

[3]Ibid., p. 185.

[4]The dairy processing industry includes butter and cheese plants, pasteurizing plants, condenseries and ice cream manufacturers.

TABLE 10. Changes in the Number of Dairy Processing Plants and Changes in the Proportion of Total Sales Accounted for by Plants in each Size Group, Canada, 1961 and 1966.

Size Group Based on Value of Sales per year ($'000)	Number of Plants in Operation			Value of Sales and Proportion of Total			
				1961		1966	
	1961 (number)	1966 (number)	Rate of Change in Group (per cent)	Value ($'000,000)	Proportion (per cent)	Value ($'000,000)	Proportion (per cent)
Under 10,	6	9	+50.0	0	0.0	0	0.0
10 to 24.9	46	27	-41.3	1	0.1	1	0.1
25 to 49.9	147	65	-55.8	5	0.6	3	0.3
50 to 99.9	311	160	-48.6	23	2.7	15	1.5
100 to 199.9	435	266	-38.9	63	7.5	42	4.2
200 to 499.9	415	364	-12.3	131	15.5	121	12.2
500 to 999.9	170	177	+ 4.1	119	14.1	114	11.5
1,000 to 4,999.9	158	199	+25.9	328	38.8	414	41.8
5,000 and over	22	41	+86.4	175	20.7	281	28.4
Total	1,710	1,308	-23.5	845	100.0	990	100.0

Source: Dairy Factories, 1962 and 1966, Annual Census of Manufactures, (Ottawa, Canada, Dominion Bureau of Statistics), Manufacturing and Primary Industries Division, Catalogue No. 32-209, Annual, June 1968.

Assuming that butter and cheese plants have shared in this trend, it appears that economies of size may be one to the major variables accounting for this rapid structural evolution.[5] As a matter of fact, aggregate data indicate that the larger the butter and cheese plants in Canada, the smaller their variable costs per dollar or sales (Table 11).[6]

A technical study of the Eastern Quebec butter industry shows that the regional plants have failed to keep up with the national trend. The largest butter plant in the region processed 33 million pounds of milk while the other reported less than 15 million pounds of milk in 1963. It has been estimated that, given the input and output prices in the region and the current level of technology available, a specialized butter plant must process between 50 and 60 million pounds of milk a year in order to produce at least costs, whereas a diversified

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[5]Reporting of data on plants processing only butter and cheese has been discontinued in 1963. Apparently this modification in the reporting of data on Canadian dairy processing industries can be attributed to increase in product diversification within the industry.

[6]No data on fixed costs were available at the national level. Regional studies which have been made indicate, however, that administration is one of the high cost items in butter manufacturing. In general administration expenses decline as the volume of butter increases. See Ferdinand Ouellet, La Consolidation des Usines Laitières dans la Région du Bas St-Laurent-Gaspésie, published and edited by Bureau d'Aménagement de l'Est du Québec (BAEQ), 1964, and W.B. Rogers and H. S. Baker, "An Economic Analysis of the Alberta Butter Industry," Canadian Journal of Agricultural Economics, vol. XVI, no. 1, February, 1968, pp. 40-44.

dairy processing plant must process between 100 and 150 million pounds of milk a year in order to make the most efficient use of its resources.[7]

TABLE 11. Costs per Dollar Value of Shipments of Goods of Butter and Cheese Plants by Size Group of Plants in Canada, 1962.[a]

	Costs per Dollar of Sales	Absolute Difference Between Consecutive Size Groups
$ 10,000 to 24,999	$0.9760	
25,000 to 49,999	0.9465	-0.0295
50,000 to 99,999	0.9491	+0.0026
100,000 to 199,999	0.9384	-0.0107
200,000 to 499,999	0.9374	-0.0010
500,000 to 999,999	0.9354	-0.0020
1,000,000 to 4,999,999	0.9326	-0.0118
5,000,000 and over	0.8855	-0.0381
TOTAL	0.9261	

Source: Dairy Factories, 1962 (Ottawa, Canada, Dominion Bureau of Statistics), Industry Division, Catalogue No. 32-209, June, 1965, p. 7

[a]These include salaries and wages, cost of fuel and electricity and cost of materials and supplies used.

Lack of Product Diversification

The second major element of the low income problem in the regional dairy subsector is the lack of product diversification at the processing

[7]Bureau d'Aménagement de l'Est du Québec, Esquisse du Plan, l'Agriculture, op. cit., pp. 181-85.

level. Because of the importance of dairy processing in the provincial food manufacturing industry, it is interesting to take a broad view of this problem.

The total production of milk in the Province of Quebec increased from 5,713 million pounds in 1956 to 6,733 million pounds in 1968 (Table 12). During the same period, the quantity of milk absorbed by the fluid milk market decreased from 1,613 to 1,359 million pounds while the quantity used by the manufacturing milk industry increased from 3,553 to 4,981 million pounds. The most significant change which took place during this period was the emergence of cheddar cheese production. The proportion of manufacturing milk utilized for the production of cheddar cheese increased from approximately 7 per cent in 1956 to 16 per cent in 1968.

Shifts in supply and demand functions have apparently been particularly favorable to dairy farmers producing for the fluid and the cheddar cheese markets. Farm prices increased, on the average, from 2.70 to 3.30 per cwt. of milk for cheese and from 4.50 to 5.79 for fluid milk between 1961 and 1966 for the Province of Quebec as a whole (Table 12). It appears, however, that price increases in the fluid market resulted from increasingly effective supply restrictions. Under these conditions, it seems reasonable to hypothesize that the farmers who sell a large proportion of their production to butter plants had to bear most of the hardships which resulted from the substantial increases in total milk supply, expecially after 1967. Farm prices per pound of butterfat decreased from ¢74.9 in 1964 to ¢65.3 in 1968.

TABLE 12. Production and Price of Milk According to Utilization, Quebec, 1956 to 1968.

Year	Total Production	Fluid Milk	Manufacturing Milk Equivalent			Other[a]	Average Farm Value		
			Butter	Cheddar Cheese	Other		Creamery Butterfat	Milk for Cheese	Fluid Milk
	--	million lbs				--	(¢ per lb.)	($/cwt.)	($/cwt.)
1956	5,713	1,613	2,863	242	448	547	NA	NA	NA
1957	5,767	1,558	2,858	310	503	538	NA	NA	NA
1958	5,941	1,552	3,125	262	468	534	NA	NA	NA
1959	5,792	1,479	2,975	372	438	528	NA	NA	NA
1960	5,880	1,455	2,895	420	569	541	NA	NA	NA
1961	6,191	1,431	3,260	505	497	498	69.9	2.70	4.50
1962	6,231	1,416	3,382	497	425	511	70.9	2.74	4.49
1963	6,236	1,425	3,239	639	425	508	71.5	2.76	4.51
1964	6,113	1,456	3,123	660	414	460	74.7	2.81	4.65
1965	6,065	1,455	3,080	675	420	435	74.5	3.19	4.82
1966	6,417	1,464	3,304	766	484	399	63.6	3.24	5.14
1967	6,584	1,427	3,491	707	556	403	64 8	3 35	5.70
1968	7,633	1,359	3,609	785	587	393	65.3	3.30	5.79

Symbol: NA not available

[a]Includes mostly home use for various purposes

Sources: Dairy Statistics, 1964 and 1968, (Ottawa, Canada, Dominion Bureau of Statistics), Agricultural Division, Catalogue No. 23-201, Annual, June 1969, and Dairy Statistics 1966, (Quebec, Bureau of Statistics), Agricultural Section, Department of Industry and Commerce, April 1967.

The adverse effects of these provincial trends are particularly significant with regard to the agricultural economy of Eastern Quebec. In 1963, 335 million pounds of milk were marketed in the region. Out of this total, 310 and 21 million pounds were respectively purchased by butter plants and by the fluid milk market.[8] It thus follows that approximately 5 per cent of all the milk produced in the province of Quebec in 1963 came from Eastern Quebec whereas the region accounted for 9 per cent of total provincial use for butter production.[9] It appears safe to conclude, on the basis of these facts, that lack of product diversification is one of the major elements accounting for the low income problem in the regional dairy subsector.

Underutilization of Productive Capacity

The third major problem of the dairy processing industry in Eastern Quebec appears to be a significant underutilization of the productive capacity of dairy processing plants during the fall and winter seasons. This problem is, to a very large extent, common to most dairy processing plants in both the Province of Quebec and Ontario but appears to be less acute in Ontario than in Quebec (Table 13). Furthermore, a comparison of the seasonality of milk procurements of butter factories among regions of Quebec indicates that the monthly index of butter production in Eastern Quebec (region 1) follows a seasonal trend common to almost all regions of Quebec (Table 14). The only major exception is

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[8]Ibid., p. 176

[9]Unfortunately, no other reliable sources of information were available to describe price and production trends in the region itself.

TABLE 13. Milk Equivalents of Factory Products by Month, Quebec and Ontario, 1968.

Monthly Periods	Quebec[a] Quantity	Quebec[a] Monthly Index June = 100	Ontario[a] Quantity	Ontario[a] Monthly Index June = 100
	(million lbs)		(million lbs)	
January	161	23 0	225	45.9
February	133	19.0	205	41.9
March	185	26.5	251	51.2
April	377	54.0	338	69.0
May	534	76.5	422	86.1
June	699	100.0	490	100.0
July	671	96.0	451	92.1
August	633	90.6	424	86.6
September	535	76.6	389	79.4
October	485	69.4	364	74.3
November	315	45.0	272	55.4
December	251	35 9	246	50.2
Year	4,981		4,094	

Source: The Dairy Review, January, 1969 (Dominion Bureau of Statistics, Ottawa, Canada,) Catalogue No. 23-001, Supplement to the Dairy Review, January, 1969, p. 5.

[a]The total quantity of milk processed in these two provinces added up to 78.3 per cent of all milk processed in Canada in 1968.

the Montreal region, where the monthly fluctuations in butter production are not as large as in the other regions of Quebec.

Since the cost of milk procurement is one of the major components of the butter factories' total costs, two hypothetical explanations may be postulated in order to explain the seasonality of butter production in the region. They are the following: (1) periods of cow freshening coincide on almost every dairy farm of the region; and/or (2) the dairy farmers of the region rely rather heavily upon pasture as an input to their

TABLE 14. Creamery Butter Production per Region of Quebec, Monthly Index, 1966, June = 100.[a]

	Region 1	Region 2	Region 3	Region 4	Region 5	Regions 6 and 7	Region 8	Region 9
January	11.1	9.7	12.1	13.2	7.3	25.1	7.5	11.9
February	7.0	7.5	8.6	10.0	9.5	27.1	7.5	10.7
March	11.1	13.7	15.8	16.9	20.0	31.1	21.1	25.5
April	36.7	41.1	41.3	49.5	46.3	56.1	39.3	52.0
May	61.6	55.9	64.9	72.9	66.9	68.6	64.7	70.0
June	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
July	96.8	110.0	97.9	91.3	87.4	82.7	77.4	98.6
August	95.4	98.5	94.0	89.8	78.3	80.9	74.5	92.0
September	83.0	85.7	86.1	73.6	72.6	79.6	67.1	75.7
October	61.7	55.2	70.3	58.5	51.0	61.3	52.3	51.4
November	37.2	34.9	44.4	41.8	27.0	40.6	31.6	27.0
December	22.2	20.8	29.7	23.9	20.7	33.4	21.1	17.8
Total year Production ('000 lbs.)	21,120	3,464	25,916	13,975	36,243	28,644	3,690	7,765
Percentage of Province	15.0	2.5	18.4	9.9	25.7	20.2	2.8	5.5

Source: Dairy Statistics 1966, Quebec Bureau of Statistics, Agricultural Section, Department of Industry and Commerce, April 1967, p. 8.

[a]Region 1: Gaspé-Lower St.Lawrence
Region 2: Saguenay-Lac St-Jean
Region 3: Québec
Region 4: Trois-Rivières
Region 5: Cantons de l'Est
Region 6 and 7: Montreal and Montreal Metropolitan
Region 8 : Outaouais
Region 9 : Abitibi-Témiscamingue

See page 11 of the source for the names of the counties included in each region.

dairy enterprise.[10] This brings the study into the discussion of the problems of both the dairy farmers and the firms supplying inputs to these farms.

Farms Producing Milk in Eastern Quebec

Not only is it difficult to define a dairy farm or a dairy farm operator, but it also turns out to be at least as difficult to identify the persons who provide the labor services that produce dairy products in the region. In 1966, 84 per cent of the 8,906 census farms recorded in Eastern Quebec reported milking cows but only 74 per cent of all farms reported sales of milk (Table 15).[11] Thus there were 1,880 farmers in the region who reported milking cows but did not report any sales of milk. It must be pointed out that 1,852 out of these 1,880 farmers were operating non-commercial farms in 1966.

An alternative way of categorizing the statistical universe is to compare commercial to non-commercial farms. In 1966, some 2,996 out of 3,108 commercial farms reported milking cows; 2,968 out of these 2,996 farms reported sales. Moreover, 1,949 out of the 2,968 commercial farmers participating into the milk market reported milk as being the major enterprise of their agricultural operation (Table 16). Moreover,

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[10]It must be pointed out at this juncture that milk pricing schemes are also an important factor affecting freshening practices followed by dairy farmers. This factor will be discussed in section four.

[11]The 1966 Canadian agricultural census defines a farm as an agricultural holding of one acre or more with sales of agricultural products during the 12 months prior to the census date (June 1, 1966) of $50 or more. An operation to which this definition applies is in turn defined either as non-commercial if it reports sales adding to more than $50 but less than $2,500 or as commercial if it reports sales of $2,500 or more.

TABLE 15. All Census Farms, Census Farms Reporting Milking Cows and Census Farms Reporting Sales of Dairy Products, Number by County in Eastern Quebec, 1966.

County	Number of census farms				
	Total	Reporting milking cows		Reporting sales of dairy products	
		Number	% of total by county	Number	% of total by county
			(per cent)		(per cent)
Bonaventure	1,299	1,063	81.8	862	66.4
Gaspé-East	423	261	61.7	170	40.2
Gaspé-West	236	158	66.9	65	27.5
Matane	852	693	81.3	572	67.1
Matapédia	1,443	1,190	82.5	1,060	73.5
Rimouski	1,886	1,672	88.7	1,567	83.1
Rivière-du-Loup	1,616	1,479	91.5	1,429	88.4
Témiscouata	1,151	952	82.7	863	75.0
Total	8,906	7,468	83.9	6,588	74.0

Source: 1966 Census of Canada: Agriculture, Quebec, Catalogue No. 96-606.

TABLE 16. Census Commercial Farms, Commercial Farms Reporting Milking Cows and Sales of Dairy Products and Commercial Farms Classified as Dairy Farms, Number by County in Eastern Quebec, 1966.[a]

County	Number of commercial farms			
	Total	Reporting milking cows	Reporting sales of dairy products	Classified as dairy farms
Bonaventure	203	189	182	92
Gaspé-East	26	21	19	17
Gaspé-West	20	16	13	7
Matane	283	272	260	181
Matapédia	527	504	508	377
Rimouski	820	794	784	554
Rivière-du-Loup	956	933	935	530
Témiscouata	273	267	267	191
Total	3,108	2,996	2,968	1,949

Source: 1966 Census of Canada, Agriculture, Special Bulletin, Data for Commercial Farms by County, Quebec, Catalogue No. 96-636, (Ottawa, Canada, Dominion Bureau of Statistics), June 1968.

[a]Commercial farms are classified as dairy farms if (1) 51.0 per cent or more of total sales of agricultural products is obtained from dairy products: or (2) 40.0 to 50.9 per cent of total sales was obtained from dairy products, provided that the sale of dairy products together with the sale of cattles and calves amounted to 51.0 per cent or more of total sale of agricultural products.

the 2,968 commercial farms which reported sales of milk accounted for 74.7 per cent of all sales of dairy products having originated in the region in 1968 (Table 17). For the purposes of this study, a dairy farm is therefore defined as a commercial farm reporting sales of dairy products during the 12-month period prior to the 1966 census date.

The choice of this definition can be justified on the basis of the following facts:

1. The number of non-commercial farms has decreased on an average of 36 per cent between 1961 and 1966 in Eastern Quebec (Table 18). Presumably, most of the farm operations which disappeared were non-commercial units.

TABLE 17, Sales of Dairy Products Reported by all Farms and by Commercial Farms and Proportion of Total Accounted for by Commercial Farms, by County of Eastern Quebec, 1966.

County	Sales of all Farms	Sales of Commercial Farms	Share of Commercial Farms in Total Sales by County
	($'000)	($'000)	(%)
Bonaventure	672	352	52.3
Gaspé-East	248	205	82.9
Gaspé-West	74	45	61.1
Matane	1,084	832	76.8
Matapédia	1,707	1,290	75.6
Rimouski	2,701	2,055	76.1
Rivière-du-Loup	2,610	2,191	84.0
Témiscouata	1,035	592	57.3
TOTAL	10,131	7,562	74.7

Source: 1966 Census of Canada: Agriculture, Quebec, Catalogue No. 96-606.

TABLE 18. Changes in the Number of Commercial and Non-Commercial Farms by County in Eastern Quebec, 1961 and 1966.

County	Total number of farms			Commercial farms			Non-Commercial Farms		
	1961	1966	Rate of change	1961	1966	Rate of change	1961	1966	Rate of change
	-- number ---		(%)	-- number ---		(%)	-- number ---		(%)
Bonaventure	1,909	1,299	-32.0	154	203	+31.8	1,755	1,096	-37.5
Gaspé-East	670	423	-36.9	24	26	+ 8.3	646	397	-38.5
Gaspé-West	392	236	-39.8	34	20	-41.2	358	216	-39.7
Matane	1,118	852	-23.8	217	283	+30.4	901	569	-36.8
Matapédia	1,807	1,443	-20.1	379	527	+39.1	1,428	916	-35.9
Rimouski	2,224	1,886	-15.2	651	820	+26.0	1,573	1,066	-32.2
Rivière-du-Loup	1,879	1,616	-14.0	847	956	+12.9	1,032	660	-36.0
Témiscouata	1,563	1,151	-26.4	235	273	+16.2	1,328	878	-33.9
Total	11,562	8,906	-23.0	2,541	3,108	+18.2	9,021	5,798	-35.7

Source: 1966 Census of Canada, Agriculture, Number and Area of Census - Farms and Commercial Farms for Counties and Census Subdivisions, 1966, Special Bulletin, Catalogue No.96-632, September 1966.

2. It is necessary to distinguish between farming as a major source of income for the operator and farming as a side occupation performed in order to supplement salaries and/or wages earned outside the farm. Such a distinction appears particularly relevant in Eastern Quebec. While the proportion of operators of both commercial and non-commercial farms who held off farm jobs was almost equal in 1966, the former spent proportionally much less time off the farm than the latter (Table 19).
3. The definition used in this study automatically excludes almost all farms which produce milk only for home use.

Given these facts, the definition of a dairy farm adopted in the study seems workable, convenient and conceptually valid.

TABLE 19. All Census Farm Operators, Commercial and Non-Commercial Farm Operators Reporting Off-Farm Work by Groups of Days Worked Off the Farm, Eastern Quebec, 1966.

Number of Days Off the Farm	Number of Farmers Reporting Days Worked Off the Farm			Class in Proportion to Total		
	Total	Commercial	Non-Commercial	Total	Commercial	Non-Commercial
	(number)			(per cent)		
1-72 days	3,008	1,506	1,502	51.4	73.0	39.6
73-156 days	1,666	436	1,230	28.5	21.1	32.5
157-365 days	1,179	122	1,057	20.1	5.9	27.0
TOTAL	5,853	2,064	3,789	100.0	100.0	100.0

Source: 1966 Census of Canada: Agriculture, Quebec, Catalogue No. 96-606.

Characteristics of Commercial Dairy Farms and Their Operators

Six characteristics of the regional dairy farming industry appear to be factors leading to the current depressed nature of the industry. These characteristics are size of dairy herds, seasonality of milk production on the farms, techniques of dairy farming, low production of cows, low level of education and high incidence of old age among the regional dairymen.

Size of Dairy Herds

The average dairy herd size on the commercial dairy farms of the region was about 18 cows in 1966 (Table 20.) Averages for counties indicate, however, that dairy herds are relatively larger in Matane, Matapédia, Rimouski, Rivière-du-Loup and Témiscouata counties than in Bonaventure, Gaspé-East and Gaspé-West counties. Unfortunately, a lack of consistent data prevents estimation of the changes in the sizes of the regional herds over time.

For the Province of Quebec as a whole, the total number of farms reporting fewer than 18 milk cows decreased by approximately 55 per cent between 1956 to 1966. Meanwhile, the number of dairy farms with 18 to 32 milk cows increased by almost 57 per cent. The strongest percentage increases occurred among the herds of large size. However, the very large dairy herds, those with 63 or more cows, remained relatively few in number (Table 21). It is particularly interesting to note that the changes in each size distribution appear to have taken place more

TABLE 20. Number of Cows and Heifers, Two Years or Over, Milking or to be Milked, Per Commercial Dairy Farms, by County of Eastern Quebec, 1966.

County	Average Number of Cows Per Farm
Bonaventure	13.5
Gaspé-East	14.0
Gaspé-West	13.4
Matane	18.2
Matapédia	19.3
Rimouski	18.0
Rivière-du-Loup	18.4
Témiscouata	18.3
Eastern Quebec[a]	18.1

Source: 1966 Census of Canada: Agriculture, Catalogue No. 96-636.

[a]Weighted average.

TABLE 21. Changes in Sizes of Dairy Farms, Quebec 1956-1966.

Number of Milk cows	Farms reporting specified number of milk cows			Percentage Change	
	1956	1960	1966	1956 to 1961 (%)	1961 to 1966 (%)
1 to 7	38,926	23,846	13,284	-38.7	-44.3
8 to 17	47,632	39,107	25,852	-17.9	-33.9
18 to 32	13,104	15,285	18,287	+16.6	+19.6
33 to 62	1,375	2,152	4,333	+56.5	+101.3
63 or more	58	97	220	+40.2	+126.8
Total	101,105	80,509	62,020		

Source: 1966 Census of Canada: Agriculture, Catalogue No. 96-606.

rapidly between 1961 and 1966 than between 1956 and 1961. These changes raise a question concerning economies of size in dairying.[12]

Economies of Size Dairying

Interesting studies in the United States show that there are significant economies of size in dairying.[13] It seems impossible, however, to generalize on the basis of these studies alone. The main difficulties arise from the following facts:

1) the inputs which are assumed fixed in the intermediate length of run-barn size, housing and milking arrangements--differ from study to study;
2) the quality of the cows is seldom homogeneous; and
3) the quality of management from farms to farms differs substantially.

Keeping in mind the limitations mentioned above, it appears that two generalizations can be made, on the basis of these studies, which might be applicable to Eastern Quebec dairy farming. They are the following:

1. The introduction of modern dairy technology, which includes such facilities as pipeline milkers, herringbone milking parlors and loose housing loafing barns, appears to be

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[12]In this study, economies of size are defined as "the reductions in total costs per unit of production resulting from changes in the quantity of resources employed by the firm or in the firm's output." This definition is borrowed from J. Patrick Madden, Economies of Size In Farming, Theory, Analytical Procedures, and a Review of Selected Studies, U.S. Department of Agriculture, Economic Research Service, Agricultural Economic Report No. 107, February 1967, p. 1.

[13]No systematic study of economies of size in dairy farming has yet been published in Canada. The most interesting ones which have been published in the United States are reviewed in J.P. Madden, op. cit., pp. 34-70.

profitable on farms that have at least 40 cows with relatively high production capacity. This conclusion seems consistent with the significant changes in the size distribution of Quebec dairy farms between 1951 and 1966 (Table 21). However, the average size of herds on Eastern Quebec commercial dairy farms in 1966 indicates that very few farms might currently have herds large enough (Table 20) to efficiently operate with advanced dairy technology.[14]

2. A number of offsetting relationships appear to explain persistence of small dairy farms. On the one hand, smaller farms are generally less efficient than the larger ones. Despite their relative inefficiency, however, they tend to persist because they do add something to the net income of the operator and very often contribute to reducing living costs of the operator's family. The fact that the operators of small dairy farms sell their labor services outside the farm for longer periods than the operators of larger farms in the region is consistent with this explanation. As a matter of fact, 60 per cent of the regional non-commercial farms operators reporting off-farm income worked off the farm for 73 days or more in 1966 whereas the comparable figure for the commercial farm operators was 27 per cent (Table 19).

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[14]This statement is supported by the findings of W. James White "The Adoption of Modern Dairy Practices," Canadian Journal of Agricultural Economics, vol. XVI, no. 1, 1968, pp. 29-39. White's study deals with Canddian dairy farms producing manufacturing milk and cream. He concludes that "the majority of Canadian dairy farmers who produce manufacturing milk or cream are not utilizing modern management practices and techniques."

Under such circumstances, the rate of disappearance of small dairy farms in Eastern Quebec might have considerably been slowed down by the lack of stable job opportunities outside of agriculture. Moreover, the demand for seasonal workers during the slack period of dairy farming might have contributed to prolonging the existence of small farms in the region.

Seasonality of Milk Production on the Farms

The foregoing discussion suggested that the very high degree of seasonality of butter plant's operations in the region might be partly explained by the following situations: (1) periods of cow freshening coincide on almost every dairy farm of the region, and (2) regional dairy farmers rely rather heavily upon pasture as an input to the dairy enterprise.

There are no firm empirical data to either confirm or deny those characteristics but the seasonality of butter plant operations bears this out. The only information available consists of cursory evidence found in one of the published planning documents. It states that "almost all calvings on the dairy farms in Eastern Quebec happen during the spring season so that the period of lactation of cows is concentrated in the summer season".[15]

The whole system of milk production in Eastern Quebec appears to depend largely on utilization of summer grazing and on cheap (forage) winter rations. But there is a serious need for further research on the

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[15]Bureau d'Aménagement de l'Est du Québec, Esquisse du Plan, op. cit., p. 188.

interacting forces which perpetuate this situation. The main factors that apparently need to be considered are; costs and returns for varying seasonal freshening and production, milk price variations by month, level and composition of seasonal feeding rations and the relative importance of milk utilized as fluid in the region and the possibilities and costs of preserving more forage for winter feeding. Since empirical data on most of these factors are not available, the belief that regional farmers would substantially benefit from more even production over the year cannot be adequately substantiated.

Technology of Regional Dairy Farming

The third salient feature of regional dairy farming is its low level of technology as compared to the modern dairy technology which is now available in countries with advanced dairying. It is appropriate, at the outset, to distinguish between dairy crop technology and the technology of the dairy enterprise itself.

Dairy Crop Technology: Two features stand out as far as dairying crop technology is concerned. First, ensilage of forage crops is not a common practice on dairy farms of the region (Table 22). Secondly, harvesting of hay (baled and loose) and oats for grain--the two most important dairy-related crop enterprises in the region--is carried out with the same type equipment on almost all the dairy farms of the region. The question whether it would be profitable for these farmers to shift gradually from barn storage to ensilage practices has been raised by the planners in the following terms:

The humidity which favors growing of forage crops also poses a problem for their storage. It is difficult to dry hay in the field and maintain good quality in storage. Ensiling of storage crops is the theoretical solution, but in practice, because investments have been made in buildings and machinery with barn storage especially in mind, silage is recommended only in cases where reinvestment is needed to replace building and machinery that are no longer suitable for the storage of hay. Artificial cool-air drying could be introduced in other cases. Investment in ensilage equipment is more urgent where two harvests of forage are possible and field-drying of hay in the autumn is difficult.[16]

TABLE 22. Percentage of Respondents with 10 Milking Cows or More Reporting Specified Types of Equipment in Eastern Quebec, July, 1969.[a]

Items	Proportion of Farms Surveyed Reporting Specified Items
	(per cent)
A. Dairy Crop Technology	
- tractors	95
- tractor-plows	93
- threshing machines	72
- planters	87
- binders	86
- silos	1
- mechanical cool-air dryers	0
B. Dairy Enterprise Technology	
- barn type:	
- stanchion barns	100
- loose housing barns	0
- cream separators	90
- milking machines	90

Source: Eastern Quebec Dairy Farms Survey, 1969.

[a]See Appendix A, for methodological considerations on the design of the survey. This table includes information reported by 76 respondents. The respondents may have other items (balers, hay conditioning equipment, gutter cleaners, milk coolers, bulk tanks and others) not covered by the questionnaire.

[16]Development Plan for the Pilot Region: A Summary, op. cit., p.46.

Ensilage or artificial cool-air drying may be sound technical solutions for the storage problem faced by these dairy farms. Unfortunately, no well-documented study on the profitability of alternative technologies for harvesting and storage of forage crops has yet been undertaken in the region. It may be suggested, however, that these farmers have not shifted to ensilage or cool-air drying (Table 22) because they are convinced that it would not be profitable to do so given the present size of their herds and investment which is already tied up in barn storage facilities.

Dairy Technology: As far as the dairy enterprise-technology is concerned, a general pattern emerges. First, common stanchion barns are found on almost all of the regional dairy farms. Second, the transformation of raw milk on the farm by the use of cream separators is a widespread technique in the region (Table 22). Apparently, regional dairy farmers believe that this practice is the most profitable for them, given the nature of the dairy processing industry operating in the region. Butterfat is presently sold to butter factories whereas the bulk of skim milk is fed to calves and hogs raised on dairy farms. The peculiarity might partly explain why multiple enterprises are such a common feature of dairy farms in the region. This in turn suggests that maintaining multipurpose barns may be one important cost that these farmers have to pay in order to achieve a certain degree of flexibility.

A gradual shift from a regional dairy-processing industry exclusively oriented on butter to one which would buy whole milk from the farmers might generate significant changes in dairy-farm technology.

The relative technological backwardness of housing and milking arrangements on dairy farms cannot, however, be totally explained by the nature of the links between dairy farming and dairy processing in the region because size of the dairy herd is also an important factor determining the profitability of the latest innovations in dairy housing and milking arrangements.

Low Production Capacity of Dairy Cows

The fourth salient feature of regional dairy farming has to do with the production capacity of cows. The difference in the production capacity of two dairy cows can be partly explained by a group of factors which are amenable to analysis under experimental conditions. Appendix B presents a partial enumeration of such factors. To estimate the amount by which the production capacity of dairy cows differ from region to region of a country, however, has so far proved a rather intractable problem. Breeds, period of lactation, management practices commonly followed, climate, length of period on pasture, feeding levels and feed ration composition along with prices of inputs, to name but a few, are known to differ significantly from one region to another. Because of these variations it is almost impossible to disentangle inheritance factors from the host of other variables which are known to affect the yields of dairy cows.

An effort was made during the field survey to collect some evidence on the capacity of cows in regional dairy herds. Unfortunately, this evidence does not permit to go much beyond the descriptive stage.

Conclusions which may be drawn from it are the following:

1. Herds of mixed breeds are by far the most popular among regional dairymen (Table 23). The fact that the Ayrshire-Holstein mixed breed is so highly favoured by the region's dairy farmers cannot be easily explained. It is generally recognized that one of the strong points of Ayrshires is their excellent grazing qualities and that this breed ranks

TABLE 23. Breeds of Dairy Cows Reported by Dairy Farm Operators with 10 Cows or More in Eastern Quebec, July, 1969.[a]

Breed	Number of Farms Reporting Specified Breed
Mixed-Breed[b]	69
Ayrshire	5
Guernsey	0
Holstein	2
Canadian	2
Jersey	0
TOTAL	78

Source: Eastern Quebec Dairy Farms Survey, 1969.

[a]See Appendix A for methodological considerations on the design of the survey.

[b]One type of mixed breed is most frequently reported in the region. It resulted from the crossbreeding of either Holstein sires with Ayrshire dams or Ayrshire sires with Holstein dams. The latter is found slightly more frequently than the former.

high in beef production for a dairy breed. As beef producers the Holstein breed, also ranks high for a dairy breed. The Holstein breed, however, ranks lower than the Ayrshire breed

as grazers on hilly or scanty pastures.[17] The question whether regional dairy farmers have been able to develop a mixed breed which combines these traits cannot be answered in this study. The absence of Jerseys in the region indicates, however, that these farmers are ready to forego higher income opportunities on manufacturing milk in order to realize higher income opportunities on the sales of calves and culled cows. Since local farmers receive about $4.20 per 100 pounds of milk (including subsidies) and about $15.00 per hundred pounds of culled cows, the possibility may be foreseen that the trade-off between prospective income opportunities might currently favour the Ayrshire over the Jersey in the region. It is appropriate to recall at this juncture that Jerseys stand very low, even among dairy breeds, as meat producers. The climate of the region may also partly account for the absence of Jerseys.

2. Evidence indicates that the milk yields recorded for regional dairy herds are, on the average, substantially lower than those recorded for the entire province (Appendix B).

Improving the yields of their dairy herds appears to be one of the major preoccupations of dairymen in Eastern Quebec. There is no agreement among them, however, as to how this might most appropriately

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[17]C.H. Eckles, and E.L. Anthony, Dairy Cattle and Milk Production (The MacMillan Company), fifth edition, 1956, pp. 49-51 and 81-83.

be achieved. This issue will be elaborated in the next chapter.

Age of the Farming Population

There is a widespread belief that farming no longer attracts younger elements of the working population in Eastern Quebec. If this were true, it could then be argued that poverty in regional agriculture cannot be exclusively attributed to inadequate capital resources.

Evidence indicates that the proportion of younger farmers (34 years of age or less) to the total number of farmers in the region decreased from 24.5 per cent to 15.1 per cent between 1951 and 1966 while the proportion of older farmers (55 years of age or more) increased from 23.3 per cent to 28.1 per cent during the same period (Table 24). Comparable figures for the provinces of Quebec and Ontario indicate, however, that this phenomenon is not peculiar to Eastern Quebec. As a matter of fact, the magnitude and the direction of this change in both Eastern Quebec and the province of Quebec as whole were much similar but this trend started earlier in Ontario than in Quebec (Table 24).

The increased age of farmers raises a whole spectrum of social and economic issues which are beyond the scope of this study. Let it be sufficient to emphasize that empirical evidence tends to support the belief that regional farming attracts less and less younger elements of the working population despite limited job opportunities in other regional activities.

Low level of Education of the Farming Population

There is also a widespread belief that the level of education of the farming population is in general lower than that of most of the other segments of the total population in Quebec. Moreover, another widely held belief states that there are significant differences in the regional levels of education for any given segment of economic activity in Quebec. These two propositions are not mutually exclusive. As a matter of fact, both propositions could be concurrently substantiated if enough evidence could be brought to confirm that farm operators are relatively less educated than the rest of the working population in Eastern Quebec, and that farm operators in the region are relatively less educated than farm operators in the more developed regions of Quebec.

TABLE 24. Proportion of all Farm Operators of a Given Age Group in Eastern Quebec, 1951 and 1966.

Age Group	Percentage of Farm Operators in Specified Age Group					
	Eastern Quebec		Quebec		Ontario	
	1951	1966	1951	1966	1951	1966
	(per cent)		(per cent)		(per cent)	
34 years or less	24.5	15.1	23.3	15.9	17.3	13.6
35 to 54	52.2	56.8	51.4	54.3	49.5	49.7
55 years or more	23.3	28.1	25.3	29.8	33.2	36.7
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

Sources: 1966 Census of Canada: Agriculture, Quebec (Ottawa, Dominion Bureau od Statistics), Catalogue 96-606; and 1966 Census of Canada: Agriculture, Ontario (Ottawa, Dominion Bureau of Statistics), Catalogue 96-607, June 1968.

A study entitled "Problèmes de l'Agriculture dans la Région du Bas Saint-Laurent" appears to be one of the best documented sources of information on the comparative levels of education of the population in Eastern Quebec.[18] The study indicates that both the farm operators of Eastern Quebec and their offsprings of school age are at or very near the bottom of any inter-regional classification devised on the basis of educational criteria. Moreover, the authors of that study were lead to conclude that all the data which they could gather "clearly indicate that the level of education of a very large majority of the (rural) population was significantly inferior to that of the urban population in Eastern Quebec."[19] The propositions that farm operators are relatively less educated than the rest of the working population in the region, and that farm operators in Eastern Quebec are less educated than their counterparts in the more progressive regions of the Province thus appear to be substantiated.

The Suppliers of Dairy Farming Inputs

This section suggests that the suppliers of inputs to the regional dairy farming industry might have also faced serious difficulties of their own in the region.

Dairy Feed Market

There were 33 plants processing grains in the region in 1963. Not much is known about these feed mills except that they are very small enterprises selling the bulk of their production to the dairy farmers of the region. Looking in turn at the types of crops cultivated

[18] Yves Dubé and Jean-Marie Martin, op. cit., pp. 41-44.

[19] Ibid., p. 44

by commercial farmers in the region indicates that a very large proportion of the crop acreage is devoted to the production of feed crops which are inputs to the dairy enterprises. Hay, improved pasture and oats for grain accounted for 87.1 per cent of total crop acreage in the region in 1966 (Table 25). Very little wheat is grown in the region and the proportion of total crop acreage devoted to corn and rye was less than 0.01 per cent in 1966.

The regional feed mills are faced with a very sporadic demand for feed from the dairy farmers. As long as the dairy farmers will keep on growing most of their feeds at apparently lesser costs than they can buy them, feed mills are very likely to remain purveyors of mixed feeds and/or protein supplements which are not otherwise available on the farms. In the long-run, this situation might be altered by the occurence of either a substantial decrease in the cost of feed processed by the feed mills or a substantial increase in the opportunity cost of labor on the dairy farms, especially with respect to labor used in growing crops fed to dairy livestock.

Transportation of feed grains from the Canadian Prairies has been subsidized under the Feed Freight Assistance Policy since 1941. The objective of the policy has been to achieve some form of regional price equalization on feed grains throughout Canada through a subsidy offsetting costs of transport from the Lakehead to Eastern Canada and from Alberta to British Columbia. However, the influence of the Feed Freight Assistance Policy is marginal in Eastern Quebec. A crude estimate

TABLE 25. Improved Agricultural Land Area Devoted to Major Crops by County of Eastern Quebec, 1966.

County	Total improved agricultural land	Percentage of total devoted to major crops by county						
		Hay	Pasture	Oats for grain	Mixed grains	Oats cut for fodder	All other crops[a]	Total
	('000 acres)	- -			per cent			- -
Bonaventure	76	38.7	32.5	12.1	3.7	5.9	7.1	100.0
Gaspé-East	13	47.0	28.1	5.4	- -[b]	9.6	9.9	100.0
Gaspé-West	15	35.9	32.0	12.9	2.1	9.3	7.8	100.0
Matane	86	34.6	35.1	14.2	2.8	7.4	5.9	100.0
Matapédia	118	46.8	29.5	11.3	5.1	4.5	3.7	100.0
Rimouski	171	43.4	31.0	14.8	4.4	2.9	3.5	100.0
Rivière-du-Loup	168	45.4	26.4	17.0	5.3	1.8	4.1	100.0
Témiscouata	89	46.2	30.0	11.5	4.5	4.2	3.6	100.0
Region[c]	736	43.1	30.2	13.8	4.4	4.1	4.4	100.0

[a]Potatoes is the most important crop in this category.

[b]Indicates that the percentage was less than 0.01 per cent.

[c]Percentage figures for the region are weighted averages.

Source: 1966 Census of Canada, Agriculture, Quebec, (Ottawa, Canada, Dominion Bureau of Statistics), Catalogue No. 96-636, June 1968.

indicates that slightly less than 1 per cent of dairy feed concentrates used by regional dairy farmers came from the Prairies.[20]

The reasons which might explain why so little Prairies feed is used in Eastern Quebec are not entirely clear but it can be argued that price instability is one of them. This was brought into focus by T.C. Kerr, in whose opinion,

> the implications of closed navigation season and the possibility of a shortage of grain developing in Eastern Canadian points during the winter season are still highly significant in terms of feed grain price instability.[21]

It would be hazardous to draw generalizations from so little information. The only conclusion which appears to be supported is that the links between dairy feed suppliers and the regional dairy farming industry apparently need to be improved.

Credit Market

Not only is it difficult to find relevant information concerning the sources of regional dairy feed supply, but it also turns out to be at least as difficult to document the main characteristics of the regional agricultural credit market. It is therefore hoped that the following observations will partly fill the gap.

Two main sources of agricultural credit can be readily identified. The first one is the so-called "Office du Crédit Agricole," a government agency involved in the business of lending money to farmers at a lower

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[20]Compiled from T.C. Kerr, op. cit.,pp. 136-38. It was computed by assuming that regional dairy farmers bought about 5 per cent of all freight-assisted feed grain shipments transported to the Province of Quebec in 1963-1964 and that the 236,744 cows found on regional commercial dairy farms were fed about 1,000 lbs. of grain concentrates per year. Kerr's study indicates that the 5 per cent assumed above can be viewed as a maximum.

[21]T.C. Kerr, op. cit., pp. 75-76.

interest rate than private lenders. The second one is mostly made up of private lending institutions. The quantity of credit supplied to local dairymen from each source could not be estimated.

A study has been made by Dubé and Martin on the basis of the Office du Crédit Agricole files for the years 1946 to 1956. Their major conclusion was that the most progressive farmers of the region borrowed very little from the government agency and that the main reason given by farmers for borrowing from this source was to repay current debts.[22] However, there is no basis for determining whether or not this situation still prevails in the region.

It might be hypothesized that, because of their low levels of income, a great majority of the dairy farmers in Eastern Quebec have been unable to finance the growth of their dairy enterprise through reinvestment of generated net income. Most of these farmers have apparently borrowed at one time or another on either the private and/or the government credit markets.[23] However, the large number of farmers who declared that they wanted to borrow from the government agency in order to repay on-going debts indicates that many regional farmers have not realized the returns that they expected on their agricultural investments.

Suppliers of Dairy Equipment and Fertilizer

Very little is known about the problems of the regional market for dairy equipments and fertilizer. It would appear that a few

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[22]Yves Dubé and Jean-Marie Martin, op. cit., pp. 153-59

[23]Ibid., pp. 157-59.

regional cooperatives might have been able to bid down the prices of these inputs for their members. A well documented study of the problems of the industries supplying inputs to regional agriculture is needed for determining the extent to which the improvement of their performance might contribute to the well-being of the farmers in the region. It appears very unlikely that regional dairy farming will achieve much higher profitability without a more effective support from both the dairy input supply industry and the dairy processing industry.

It appears that a great majority of the regional dairy farmers have persisted in their trade because of government income transfer programs. The main issue which must be raised concerning some regional development planning objectives is whether or not a large proportion of them could thrive while competing with other dairy producing areas of Canada without continual government help.

Long-Run Objectives and Comparative Advantage

The thrust of planning in market economies must be the promotion of economic activities which can hold on their own under free market conditions. One of the main, and usually most difficult, tasks of planners is therefore to predict comparative advantage in the economic activities which they attempt to promote. The ensuing discussion considers the planning issues in the dairy subsector of Eastern Quebec within this perspective.

Distinction Between Fluid and Manufacturing Milk

A major distinction is made at the outset between fluid milk and manufacturing milk. For the dairy industry which supplies fluid

milk, the end product, because of its relatively high transportation costs and perishability, dictates that the fluid milk industry will locate relatively close to markets. The manufacturing milk industry on the other hand does not appear to be as closely tied to markets. Its location depends upon a number of factors, including, a steady and adequate supply of milk and/or cream from dairy farms, the availability of labor, concentration of the industry to the extent that it determine whether or not optimum size processing plants can be achieved in a specific region, adequate transportation services and many other factors.

In the Province of Quebec, Montreal has a fairly large milkshed which appears to extend farther away year after year. Quebec city and the few other smaller urban centers also receive the bulk of their fluid milk supply from their surrounding rural communities. It might reasonably be expected that the dairy farmers of Eastern Quebec will not be able to penetrate these major urban fluid milk markets in the foreseeable future, unless the farmers of these two major milksheds are presented with and take further opportunities of restricting supply in order to bid up the price of fluid milk within these areas. Even under these circumstances, however, greater collective action (which is in the offing) would very unlikely create interregional price discrepancies such that one might consider the possibility of competitively transporting milk from Eastern Quebec to Montreal for instance. Under current conditions the area supplied by fluid milk producers of Eastern Quebec includes the totality of the small urban markets of the region

itself, a growing market on the so-called North Shore of Quebec and marginal entries into some adjacent areas. It is expected that the dairy farmers of Eastern Quebec will be able to supply this fluid milk market at less costs than any other agricultural region of Canada in the foreseeable future. A detailed discussion of the nature and the size of this market is in a later section of this chapter.

For the dairy industry which supplies manufacturing milk, the situation is much more ambiguous. It is appropriate to recall that 95 per cent of all milk produced in the region in 1963 (300 million out of 313 million lbs) was processed into butter. The question which naturally arises at this point is the following: Can the continuance of this industry in the region be explained in terms of the theory of comparative advantage?

Regional Comparative Advantage in Dairying

On the basis of Haberler's formulation of the theory of comparative advantage one might hypothesize that Eastern Quebec devotes a substantial quantity of its resources to produce butter because the cost of producing butter in terms of alternative commodities foregone is currently less in this region than in the other regions of Canada which do not produce this commodity or which devote a decreasing amount of resources to this commodity.[24] It is appropriate to introduce a clarification at this stage. This clarification has to do with the fact that this study compares Eastern Quebec with the rest of Quebec

[24]G. Haberler, The Theory of International Trade (London: Hodge, 1963).

and Canada. It therefore arbitrarily excludes the United States as competitor. The only justification for this exclusion is that butter is a highly protected commodity in Canada. As a result of an embargo set up by the Canadian government, butter is sold in Canada at a price at least twice higher than the current world price. Challenging this policy is beyond the scope of this research. It is therefore accepted as a statement of fact which is likely to prevail in the foreseeable future.

In order to substantiate the comparative advantage of the region in agriculture, we first rely upon the following excerpts of arguments advanced by the planners:

> The final option is based on the belief that the various types of farm production should be regionalized in Quebec, where each would specialize in the type of production in which it has a comparative advantage. Since forage crops can be used equally well for dairy production or beef-cattle raising, a choice must be made between the two. However, if the long-run increases in production within a region are to some extent proportional to the natural advantages of that region, it appears that the Pilot Region (Eastern Quebec) should specialize in dairy rather than beef production. There is a tendency for the raising of beef cattle to be concentrated more and more in the Western Provinces while, in dairying, Quebec and Ontario continue in the lead. Moreover, Quebec has been gaining relatively, while Ontario has declined. Since the objective of the "Bureau d'Aménagement de l'Est du Québec" is to make intensive use of all production factors while ensuring an adequate income, development efforts should be towards the dairy industry. . . . It should be added that the reorganization of agriculture will decrease the number of farmers, and hence will impose the need to create enough jobs in other sectors. The substitution of beef for milk would greatly accentuate this problem. Total conversion of the dairy industry to livestock raising would bring about a further decrease of about 4,000 individuals classified as farmers.[25]

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[25]Development Plan for the Pilot Region, A Summary, op. cit., p. 41, 46 and 47.

Two major preoccupations of the planners are carried by these statements. The first one has to do with the choice of agricultural strategies which would be consistent with the agricultural comparative advantage of the region. The second one has to do with the labor displacement effect of the alternative strategies which could satisfy the requirements of regional comparative advantage. As far as their first preoccupation is concerned, the planners argue that the past trends in agricultural resources allocation by Provinces of Canada indicate that Quebec's share of the national dairy market has been increasing. Evidence shows that this argument is true. Quebec's share of total milk production in Canada went from 33 per cent in 1950 to 36.7 per cent in 1964.[26] However, no data are available to determine whether or not Eastern Quebec's share of the national production has been increasing over time. This study submits that strictly valid conclusions on comparative advantage cannot be reached on the basis of past trends alone. This is especially true with respect to both dairying and cattle feeding where government intervention has been such that the monetary costs of production can no longer be equated with the real costs to the economy.

On the basis of the previous discussion on the nature of the problems in the regional dairy subsector, it appears that regional agriculture has become heavily specialized in butter production because of its relatively low costs of producing butter in terms of alternatives

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[26]T. C. Kerr, op. cit., p. 99.

foregone.[27] It is interesting to note on that respect that total industrial employment in the region decreased from 6,096 in 1949 to 5,739 in 1965.[28] Under these circumstances, it may be argued that the regional dairy processing industry had little difficulty to attract labor services at relatively low wages as well as to buy manufacturing milk at relatively low prices.

By combining the various characteristics of the regional dairy subsector it appears possible to explain the presence and the continuance of butter production in Eastern Quebec in the following manner. Butter production is known to be a highly seasonal economic activity in Canada (Table 13). This structural characteristics of the dairy industry implies that butter factories must be able to attract labor mostly during the summer season. The supply of labor is not likely to come from the dairy farming population since the farmers are also producing at their peak levels during the same period. From the point of view of entrepreneurs, it would appear that an advantageous location consists of a region where both raw materials and labor services can

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[27]Trant argues the following: "In recent years, the number of dairy cows has been increasing in the Province of Quebec, but declining in most others. This has been attributed to the limited alternatives available to Quebec farmers, who have been faced with a short growing season more suitable for forage production than for the fattening of livestock. Consequently, while most Canadian dairy producers would be hurt by free (international) trade, Quebec producers, because of their limited alternatives, would be more likely to remain in dairying than producers in other provinces." In Gerald I. Trant, David L. MacFarlane and Lewis A. Fisher, Trade Liberalization and Canadian Agriculture (University of Toronto Press), published for the Private Planning Association of Canada, 1968, p. 54.

[28]Growth Patterns in Manufacturing Employment by Counties and Census Divisions, 1949-1959/1961-1965 (Ottawa, Canada, Dominion Bureau of Statistics), Catalogue no. 31-503, Occasional, October, 1969, pp. 24-31.

be bought at the lowest price, given that such a location does not involve transportation costs which more than offset the relative advantage in production. This appears to be of special importance for the smaller firms as far as the cost of labor is concerned (Table 26). As a matter of fact, a considerable amount of verbal information spread throughout the technical studies made in the region indicates that the regional butter plants have been paying somewhat lower wage rates and lower prices for their milk than the plants located in other areas of the country with advanced dairy industry. The relatively high level of seasonal unemployment in Eastern Quebec as well as the marked tendency for regional dairy farming to depend largely on utilization of summer grazing are consistent with these findings.

TABLE 26 Hourly Wages in Butter and Cheese Factories by Group Based on Value of Sales, Canada, 1962.

Size Groups ($'000)	Man Hours Paid (1) ('000 hours)	Wages (2) ($'000)	Average Hourly Wages (2/1) ($/hour)
Under 10	6	5	0.83
10 to 24.9	22	23	1.05
25 to 49.9	130	146	1.12
50 to 99.9	481	536	1.11
100 to 199.9	1,382	1,580	1.14
200 to 499.9	2,854	3,439	1.20
500 to 999.9	2,006	2,533	1.26
1,000 to 4,999.9	3,739	5,068	1.36
5,000 and over	1,127	1,807	1.60
TOTAL	11,748	15,137	1.29

Source: Dairy Factories, 1962 (Ottawa, Canada, Dominion Bureau of Statistics), Catalogue No. 32-309, June 1965.

Can Regional Comparative Advantage in Dairying be Maintained?

An important planning issue in the region consists in the fact that current regional comparative advantage in dairying must be attributed to low factor costs rather than to relative physical efficiency in production. If the current comparative advantage of butter plants in the region can be partly explained by lower factor costs due to low opportunity cost of the people supplying these factors, a relevant question which naturally arises is the following: To what extent can this comparative advantage be maintained in the future if the planning effort is successful in its broad attempt to raise the opportunity of the people supplying labor services and milk? The answer is that this comparative advantage is likely to be lost unless a major breakthrough is achieved in raising the technical efficiency of both the butter plants and the dairy farms supplying the raw material to these plants. The dairy development strategies proposed by the planners are genuinely oriented towards this objective. Discussing whether or not this breakthrough may be achieved in the regional dairy processing industry is beyond the scope of this study.

In conclusion it appears that there is a substantial potential for efficiency improvements in the regional dairy subsector and that the planners were probably right in arguing that dairy development strategies oriented towards both the milk processors and the dairy farmers would be more likely to succeed than dairy farming development

projects alone. Dairy Farming was retained by the planners as the sector of agricultural activity which will most likely continue to justify its presence in the region in the foreseeable future.[29]

The belief that dairy farming is likely to become a more profitable activity under the impetus of the development projects is based, however, on the assumption that the dairy farmers will react to these policies according to the planners' expectations. It is our own belief that the dairy farmers of Eastern Quebec will respond to these policies according to their individual interests in the same way that they have rationally responded in the past to the environment and the government policies which directly or indirectly affected the conduct of their business. The belief that economically depressed areas are inhabited by economically non-motivated people has persisted to some extent in Quebec. This belief has crept into the planners' arguments. However, the assumption of economic rationality on the part of the participants in the regional dairy subsector has not been carefully examined.

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[29]Discussion presented in this section reaches an agreement with the planners--and with Trant (see footnote 26)--over the argument that a region like Eastern Quebec has but a limited number of alternatives in agriculture. This study submits, however, that one long-run alternative which deserves some further attention is that of raising cattle in Eastern Quebec. Such research would need to compare two sub-alternatives. The first one would involve raising cattle to maturity in the region. The second alternative would consist in raising starters that would be exported to grain-crop regions where they would be fed to maturity. The former sub-alternative has been given some consideration by the planners of Eastern Quebec but the latter has not.

Economic Rationality in the Regional Dairy Subsector

It has been said again and again that people in poor communities do not care to maximize the returns accruing to the factors of production which they own, including their labor services. The following are excerpts of arguments drawn from the regional planning documents which carry this belief:

> The first reason for the region's lag is marginality caused by difficult bio-physical conditions, distance from important urban markets, and the higher cost of supply that distance imposes. Another reason is that the farm is not always regarded as an economic enterprise that should be profitable . . . Present farm structures are not properly balanced; the production factors of land, labor and capital are not combined to give the best results.[30]

However, it is possible to account for much of the poverty in regional agriculture without assuming that it is partly due to lack of economic motivation.[31] Those who argue lack of economic motivation need to demonstrate resource adjustments strictly under the farmers' control which would increase output significantly with due regard to (1) the current physical and institutional environments within which they have to operate, and (2) the present input and output price levels in the regional dairy subsector. The hypothesis advanced in this study is to the contrary, namely the poverty in the regional dairy subsector must be attributed to the inadequate resources (including human resources) from which these farm owners seek to obtain as much

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[30]Development Plan for the Pilot Region, A Summary, op. cit., pp. 42 and 44.

[31]The word "assumption" is purposedly used in this statement because nobody has yet proved that these people lack economic motivation.

income as they can. The approach of the following discussion is to apply the concepts of production economics to show that low resources productivity in the regional dairy subsector is not necessarily due to lack of economic motivation. The discussion is restricted to the butter plants and the dairy farms, the two major users of production factors in the regional dairy subsector.

The Butter Factories

An example illustrates the complexity of cost conditions in butter processing which can explain why small high unit cost plants might have persisted in Eastern Quebec. Butter production was shown to be a highly seasonal activity in the region. As a matter of fact, regional data showed that the peak-production (June) of butter was about fourteen times as large as the through-production (February) in 1966 (Table 14). Under such circumstances, it makes little sense to think of butter plants operators in Eastern Quebec as trying to minimize the cost of a given output steadily and regularly to be produced. Stigler suggests that the objective of such firms faced with significant problems of output instability is rather to minimize the cost of a probability distribution of outputs, the probability distribution indicating the fraction of time each output is expected to be produced. He shows that the desire to obtain output flexibility might make horizontal short-run marginal cost curves a deliberate objective of maximizing behaviour on the part of those firms faced with such problems.[32]

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[32]George Stigler, "Production and Distribution in the Short-Run", Journal of Political Economy, June, 1939, pp. 312-22.

The lack of data on costs of production of butter plants in Eastern Quebec prevented use of "real" cost curves to demonstrate the validity of this theory. Suppose, however, that a butter plant in Eastern Quebec can choose between a method of production A which is very rigid and highly efficient for a particular level of output and a method of production B which is considered as a flexible but less efficient method of production (Figure 3). Let the horizontal axis denote the average butter output per month and curves A and B the average variable cost curves for methods A and B respectively. The monthly distribution of the output over the year may be such that the operator makes more profit whth method B than he might with method A. It is not clear that this hypothetical case would apply directly to the current situations of any of butter plants in Eastern Quebec.

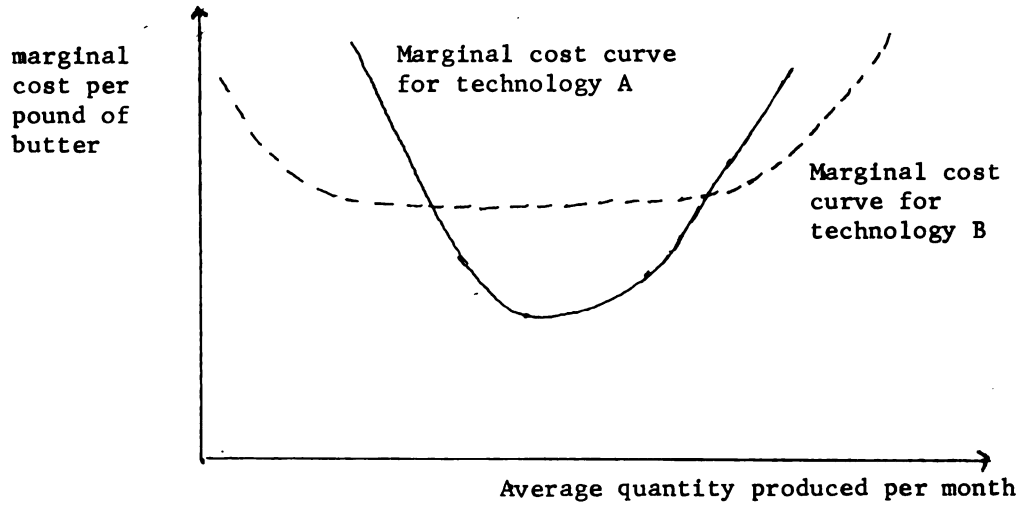

FIGURE 3. Hypothetical Marginal Cost Curves for two Different Technologies of Butter Production.

However, there are reasons to believe that Stigler's argument is of great relevance for the problem at hand.[33]

If in fact one or more methods of production of type A are available to and known by the region's butter plant operators, it may still be economically justifiable not to adopt these methods until greater monthly stability in output is achieved. Therefore, comparing resources use efficiency on these plants with that of plants in other areas such as the Montreal region where monthly output instability appears to be less than in Eastern Quebec (Table 14) must not lead one to conclude that the former are not attempting to minimize costs of production. It only allows one to conclude that the environments of both regions are substantially different and that changing those elements of the environment which cause greater monthly output instability might be one of the important conditions for further cost decreases in butter plants of Eastern Quebec.

Dairy Farmers

A major basis for assuming irrationality in resource allocations on dairy farms is the observation that significantly different patterns of resource uses are employed. However, empirical studies on the economies of production in dairy farming and the asset fixity theory show that such differences in resource combinations do not necessarily imply lack of economic motivation.

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[33]It can be suggested that the dairy processing industry is an "ideal" case where Stigler's hypothesis could be tested. It would be interesting to rank dairy processing tehcnologies along either a capital-intensity or a labor-intensity continuum and determine under what conditions one technology is more competitively efficient than another. The data which are necessary for testing this hypothesis are not currently available in Quebec.

Variable Factors

Many empirical studies of production functions for dairy cows have been made in the United States.[34] All of them tend to show that the isoquants of the forage substitution relationship have relatively small curvature. Frick and Mighell have concluded, on the basis of the earliest studies, that

> The near linearity of the isoquants of the forage substitution relationship and the annual total milk response curve both seem to indicate that the combinations of feed inputs and levels of production can be widely shifted with no great effect on profits . . . The fact that we do have extreme variations in quantity and quality of feeds consumed by milk cows and a great array of skills and experience among dairymen is some evidence that a considerable variation in feeding dairy cows is within the limits of economic tolerance.[35]

It thus appears that definite conclusions on the relative efficiency of variable resources use on dairy farms are difficult to reach. This is especially true of cases where self-feeding of pasture and hay, made possible by low land prices, saves considerable labor costs in a region like Eastern Quebec while a substantially higher price for land might not allow this practice to be pursued to the same

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[34]The results of the earliest studies are summarized in G.A. Frick and R.L. Mighell, Adequancy of Dairy Feeding Input-Output Research Data from the Point of View of the Economist, published in "Nutritional and Economic Aspects of Feed Utilization by Dairy Cows", edited by C.R. Hoglund, Glenn L. Johnson, Charles A. Lassiter and L.D. McGilliard (Ames: Iowa State College Press), 1959, pp. 107-115. More recent estimates can be found in Leo M. Hoover et als. "Economic Relationship of Hay and Concentrate Consumption to Milk Production," Journal of Farm Economics, vol. IL, no. 1, Part I, February, 1967, pp. 64-78.

[35]G.E. Frick, et als., op. cit., p. 114.

extent in a region like Montreal.

Fixed Assets

Let us shift our attention to the allocation of the so-called fixed assets on dairy farms. G.L. Johnson defines a fixed asset as one for which the marginal value productivity in its present use is greater than its disposal price and smaller than its replacement cost.[36] This definition is adopted in this study. Johnson's asset fixity theory is essentially based upon the recognition that some factor markets are imperfect for agriculture in general and more so for some specific segments of the agricultural sector. It is appropriate for this study to extend this statement a little further and argue that some agricultural factor markets may be more imperfect in some regions of a country than in others in the sense that the difference between the acquisition price and the salvage value of a given factor may be larger in the former than in the latter. The following discussion explores the implications of such a theory for resource allocation on Eastern Quebec's dairy farms.

For the sake of brevity, Johnson's logical derivation of fixed asset theory is not restated in this study.[37] However, in order to

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[36]G.L. Johnson, "Supply Function--Some Facts and Notions," Agricultural Adjustment Problems in a Growing Economy (Ames: Iowa State College Press, 1958), p. 78.

[37]A clear and concise explanation of this theory can be found in Dale E. Hathaway, op. cit., pp. 110-18.

show that this theory applies, we first need to examine the possibility of a significant difference between acquisition cost and salvage value for one or more inputs used on a given regional dairy farm at a given point in time.[38] Two inputs which come readily to one's mind are labor and land. For an individual already engaged in dairy farming in the region, the acquisition cost for his labor measured, as of 1969, would be the opportunity cost of the income foregone by not entering another occupation at the time he entered dairy farming. On the other hand, the salvage value of his labor from the dairy farm, as of 1969, is essentially the earnings that he could receive either in other industries or in the other sectors of the agricultural industry where his labor could be sold.[39] The difference between the acquisition cost and the salvage value of this person's labor may be fairly large since seniority and experience are known to improve the earnings of nonfarm workers, as Hathaway has pointed out.[40] As far as land is concerned, the acquisition cost in Eastern Quebec might be viewed as the price paid for it at the time a dairy farmer started his operation, plus the accumulated costs of clearing and improving it. The salvage value of this land is the price this farmer could receive for it if he were to sell it at the current time. Evidence indicates that the

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[38]It is important to emphasize that the discussion refers to individual dairy farms rather than to an "average" dairy farm of the region. This specification stems from the fact that the asset fixity theory leads to situations which connot be readily aggregated.

[39]D. E, Hathaway, op. cit., p. 120.

[40]Ibid., p. 121.

value of most farm land outside agriculture is very low in the region. It also indicates that the salvage value of most dairy farm land for other agricultural uses is also very low in the region. Witness, the substantial number of former farm lots which lay idle in Eastern Quebec.[41] Thus, there is likely to be a substantial divergence between acquisition costs and salvage value for land in Eastern Quebec as of now.

The inputs which are characterized by this divergence between the price of acquisition and their salvage value at a given point in time are numerous in dairy farming. For instance, fences and hay storage buildings, to name but a few, have relatively high acquisition costs but their salvage value are known to be very low.

One ot the major contributions of Johnson's asset fixity theory has been to show that in order to readjust his factors of production to make more profits a farmer must consider not only the prices of inputs (including price of acquisition and price of salvage whenever they differ) and output but also the bundle of factors that he is starting with. For instance a regional dairy farmer who finds himself with too much land might rationally decide to sell some of it until the amount of land with which he is left earns at least as much in its current use as its salvage value. A dairy farmer who finds himself

[41]Esquisse du Plan, op. cit., p. 124.

with too little land, however, might rationally decide to buy some of it until the amount of land acquired earns at least as much in its prospective use as its acquisition price. Both might have started with factors in identical quantity and of comparable quality, except for land, and end up with substantially different factor endowments once the readjustment process is carried out.

The asset fixity theory implies, among other things, that diversity among dairy set ups in a depressed region like Eastern Quebec is not by itself a valid basis for arguing that most of their operators are economically unmotivated. Even more, a larger diversity among dairy set ups in Eastern Quebec than in the region like Montreal would not be a valid basis for arguing that dairy farmers are less economically motivated in the former region than in the latter if it could in fact be shown that the markets for fixed assets are in general more imperfect in the former than in the latter region. Substantiating this tentative statement would require data which, unfortunately, are not available.

It is thought that the term "standardization of dairy farm structures", which is often used in the regional planning documents, is carried too far. The planners' expectations might be disappointed by the dairy farmers' response to the planning policies unless these policies are also successful in reducing the divergence between the acquisition price and the salvage value of those resources which are trapped in dairy farming.

The foregoing discussion can be summarized as follows. First,

evidence indicates that the feeding rations on regional dairy farms vary substantially from farm to farm (Appendix D). These differences do not necessarily imply lack of economic motivation on the part of most of these farmers. Secondly, the structures of dairy farms--whenever the structures are defined in terms of the combinations of fixed assets--may also be substantially different from farm to farm. These differences are no proof of economic irrationality on the part of most of the farmers as long as some significant imperfections exist on the markets for some fixed factors used by the farmers. Thirdly, the owners of the small butter plants in the region may not and probably do not lack economic motivation. Monthly output stability may be a crucial requirement for the technological improvement of their enterprises. This does not deny, however, the possibility that a few larger plants might achieve economies of size which are not currently within the managerial and financial reach of the smaller plant operators. But for an individual small butter plant owner, this might result in his plant going out of operation.

Government Activity on the Milk Market

Attention is shifted at this juncture to the government strategies which currently affect the demand for and supply of dairy products in Canada as a whole and in Eastern Quebec in particular. The government has been involved in affecting supply of and demand for dairy products to such an extent that these policies need to be explored.

The National Dimension

Public intervention has heavily affected the conditions of adjustment of supply and demand on the Canadian dairy products market. Since 1933 the status of milk boards has been characterized by an advance from a temporary postwar measure to a permanent position. The government of Quebec has followed the same path as other provincial governments in promoting collective bargaining by milk producers as a means of coping with the farm price and income problem. The rationale behind this type of marketing arrangement is to raise dairy farm prices and income by providing these boards with the means of achieving a monopolistic pricing technique which is commonly referred to as a two-price plan. Carried under provincial legislation, these plans take advantage of the facts that the price elasticities of demand differ in the fluid milk and the manufactured milk markets and that the cost of discriminating between the markets are relatively low. Milk going into the fluid trade sells at a higher price than manufacturing milk.

Three techniques are used to enforce this marketing system. First, supply quotas and limitations in the number of shippers on the fluid milk market are imposed upon the industry. The purpose of these measures is to stabilize supply on the privileged market (fluid) while ensuring that the income transfer from consumers of fluid milk to the dairy industry are not gradually eroded by a lack of discipline. Second, price support applies to manufacturing milk products. This price support policy is intended to improve the relative income of manufacturing milk producers in relation to fluid milk producers, or at least to prevent it from worsening. Third, as a result of the new

Agricultural Stabilization Act of 1958, the Agricultural Stabilization Board (hereafter referred to as the ASB) is assigned the task of supporting the price of butter. This institution deserves further attention, especially with regard to its impact on the agricultural economy of Eastern Quebec.

The relationships between the forces of supply and demand under the ASB system can be illustrated graphically. In its capacity to enter into the market as either a buyer (during the high milk output months), the ASB is able to maintain an effective floor price. During the high-milk-output months, the action of the Board is shown (Figure 4) to introduce a kink in the demand curve at whatever price the Board is ready to buy. Curve S_h is the horizontal sum of the marginal costs curves of the butter plants given an unsubsidized price of butterfat on production.

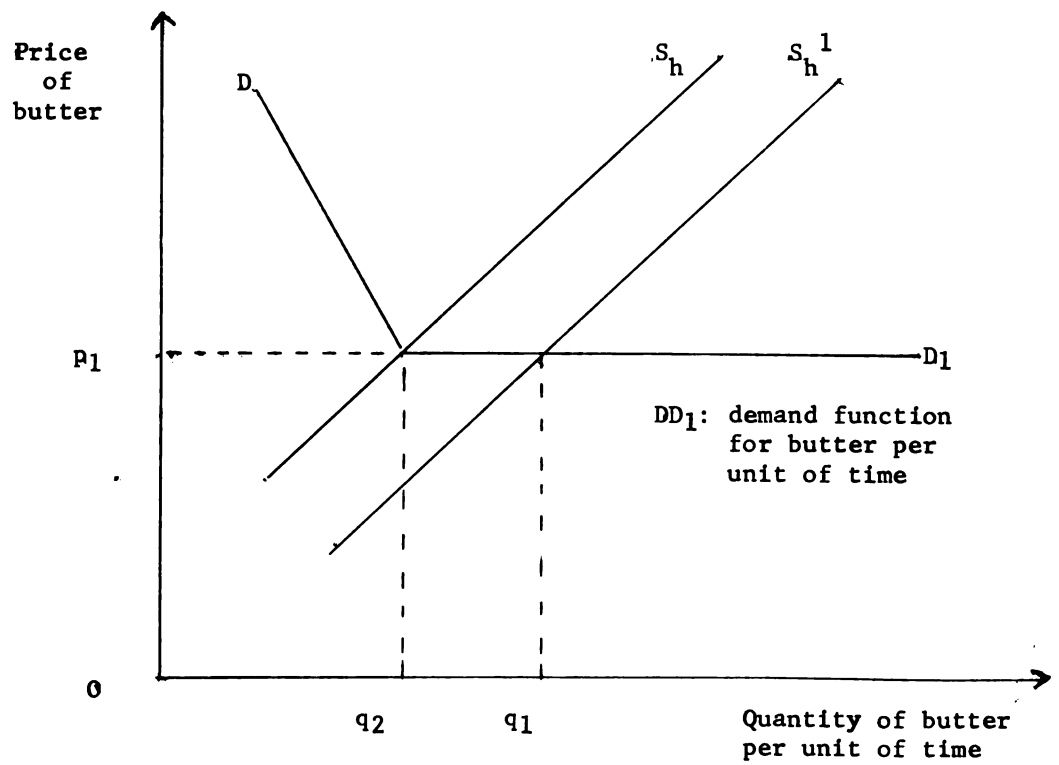

FIGURE 4. Hypothetical Market Equilibrium Situation when the Board Acts as a Buyer of Butter.

Curve S^1_h is the horizontal sum of the marginal cost curves of the butter plants given a subsidized price for butterfat in production. The equilibrium price on the market is P_1 and the total quantity sold on the market is q_1, out of which q_2 is bought by consumers and(q_1-q_2) by the board to be temporarily held in stock. The processor receives P_1 plus the subsidy per pound of butter. During the low milk output months, both S_L and S^1_L-- which are defined in the same way as S_h and S^1_h except for the time period--are shown to have an horizontal section which represents the supply of butter by the Board (Figure 5). Figure 5 is

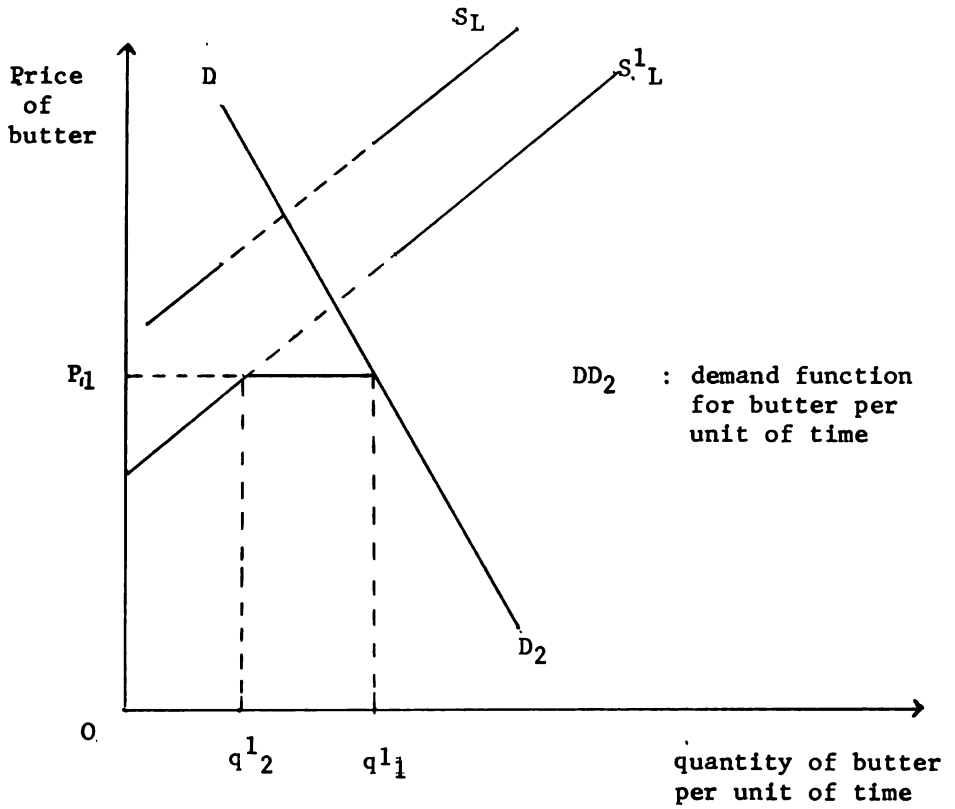

FIGURE 5. Hypothetical Market Equilibrium Situation when the Board Acts as a Seller of Butter.

built under the assumptions that (1) $q_1 - q_2$ in Figure 4 is equal to $q^1_1 - q^1_2$ in Figure 5, that is the Board will supply whatever quantity of butter it has accumulated during the previous period, (2) there is perfect foresight on the part of the Board as to the anticipated low-supply-months function, (3) the Board is willing to sell at P_1, thereby not recovering the costs of storage, and (4) the demand function is the same for both periods. Under these assumptions, the equilibrium price with both the subsidy and government entering the market either as a buyer or a seller is maintained at P_1 throughout the year.

This theoretical representation is conditional upon the assumptions made. For instance it is very unlikely that the Board will in fact be able to equate $q^1_1 - q^1_2$ with $q_1 - q_2$ year in and year out. Moreover, dividing the production year into two subperiods may not valid. There may be more than two subperiods in a year during which the aggregate supply function shifts to a significant extent. However, whatever may be the appropriate time unit for the diagram, the principle remains the same as long as the government agency remains committed to resell at whatever price will cause its temporary stock to find buyer. This price could be expected to be around P_1 if the government's supply expectations came close to being realized.

The main question which arises at this point is: To what extent do the dairy farmers supplying manufacturing milk benefit from such government's intervention? The answer is far from being evident. The butter subsidy contributes to increasing the quantity of butter effectively demanded by the consumers since the demand for butter is not

completely inelastic to price changes. This has a direct effect on the derived demand for manufacturing milk. But the presence of the ASB as a buyer during the high supply months and as a seller during the low supply months also affects the degree of competition from margarine. Since butter would probably be less expensive in high milk supply months and more expensive in low milk supply months under free market conditions than it is presently, it is difficult to determine whether or not the balance of these effects makes butter more competitive with margarine in Canada. A thorough econometric analysis would be needed for estimating these consequences.

Another important aspect of the previous question is that the price support programs in conjunction with the ASB's operations contribute to stabilize the price of manufacturing milk throughout the year. Trant holds the following opinion in that regard:

> Although the desirability of stabilizing the prices of certain dairy products throughout the year above the level of stability achieved by the free market is debatable on economic grounds, the present programme has achieved this result with fixed prices throughout the year.[42]

The question whether the Canadian dairy processing industry might benefit from a gradual return to a free market system constitutes a very complex issue. On the one hand, there are reasons to believe that a more balanced distribution of milk supply throughout the year will not

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[42]Gerald I. Trant, Recent Canadian Dairy Price Policies (Guelph, Ontario, Department of Agricultural Economics), Ontario Agricultural College, 1963, p. 10.

be achieved in Canada until a certain amount of seasonal price flexibility is tolerated. On the other hand, there are also reasons to believe that the government intervention has reduced milk price uncertainty to a certain extent, which in turn might have significantly contributed to the steady increases in total Canadian production.

It is now generally recognized that Canada is a surplus producer of both fluid and manufacturing milk. Some recent research efforts have been made in order to disentangle the host of factors which have contributed to this situation.[43] It has been found that the Canadian dairy industry has been adversely affected by the evolution of both domestic (Table 27) and foreign demand.[44] Concomittant with this trend

TABLE 27. Per Capita Consumption of Dairy Products in Canada, Retail Weight, 1951-1953 and 1961-1963.

Item[a]	Annual Averages 1951-53	Annual Averages 1961-63
	(pounds)	(pounds)
Fluid milk and cream	409.9	327.6
Butter	21.4	17.8
Cheese	6.7	8.3
Milk in ice cream	32.9	30.3
Skim milk powder	3.9	7.9
Evaporated whole milk	18.3	17.5
Other dairy products	2.9	4.5
Dairy products, total	495.9	413.9

Sources: John Dawson, Changes in Agriculture to 1970, prepared for the Economic Council of Canada, Study No. 11, December, 1964, p. 5.

[a]Unfortunately consumption figures for margarine are not available.

[43]G.I. Trant, op. cit., and William Mackenzie, op. cit.

[44]G.I. Trant, D.L. MacFarlane and L.A.Fisher, op. cit., pp.48-56.

in demand have been a series of changes in the supply of milk which appear to aggravate the imbalance between total (domestic and foreign) consumption and domestic production.[45] For the sake of brevity, these changes in supply are not discussed in this study.[46]

The dairy dilemma currently faced by the Canadian agricultural policy makers appears to be that of opting between the objective of developing a more competitive dairy farming industry and the objective of maintaining the status quo. More specifically, the long-run governmental choice seems to revolve around (1) a sudden withdrawal from processors's subsidies and direct payments to manufacturing milk producers with all the hardships thereby imposed upon this portion of the dairy subsector, (2) a phased withdrawal from the same programs with concurrent projects aimed at increasing the productivity of the farms likely to remain in the industry and facilitating the transfer of individuals who are going to leave it, or (3) no withdrawal from the former programs with the concurrent projects specified in (2).[47] Each alternative is value-loaded and a move in any direction is likely to end up in the political arena. The second option would seem the better alternative but the main ground for disagreement has to do with the programs needed for the displaced people.

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[45]The threat of imitation and filled milk may still be felt to a lesser extent in Canada than in the United States. Its future consequences cannot, however, be totally ignored. [illegible]

[46]See G.I. Trant, op. cit., pp. 3-7, for a discussion of these changes.

[47]G.I. Trant, op. cit., and William Mackenzie, op. cit., advocate new dairy policies which would fit under alternative (2). Both proposals are worth being investigated.

The analysis undertaken in the following chapters of this study is predicated on the assumption that the support price policy announced for the year commencing April 1, 1969 will be maintained in the foreseeable future.[48]

The Regional Dimension

The remaining issue has to do with the expected levels of supply and demand for the dairy products of Eastern Quebec. It must be pointed out at the outset that no systematic attempt has been made by the regional planners to project demand for the dairy products of Eastern Quebec. This is understandable under the present lack of statistical information necessary for undertaking such a task. It is therefore hoped that the following verbal discussion on some important factors which might affect the long-run demand for regional dairy products will partly fill in the gap created by the lack of empirical data.

There are many factors which are likely to affect the demand for both fluid and manufacturing milk processed in the region. The following

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[48]The support price for manufacturing milk for the year commencing on that date was set up at $4.85 a 100 pounds of milk testing 3.5 per cent butterfat. To supplement the market value and provide the $4.85 support level, the rate of direct subsidy for manufacturing milk is set at $1.25 per 100 pounds of milk for deliveries up to quota. To finance the cost of surplus disposal, however, the Dairy Commission holds back from subsidy payments an average of 29 cents per 100 pounds on milk deliveries. There is a differential rate of hold back on deliveries up to quota and on those in excess of quota. For deliveries up to quota the rate is 26 cents per 100 pounds of milk. On deliveries in excess of quota the rate is 52 cents per 100 pounds of milk.

list is restricted to those which are probably the most pertinent.

Fluid Milk

The improvement in the means of transportation between Eastern Quebec and the North Shore could be expected to substantially increase the demand for dairy products in Eastern Quebec, especially fluid milk. It appears that Eastern Quebec has already a competitive advantage in supplying fluid milk to the North Shore where agriculture is almost totally absent. The major obstacle impeding larger fluid milk shipments from the region to the North Shore appears to be the inadequacies of the marketing system, especially transportation. The size of the North Shore market is small but its increases have been substantial. The population of the North Shore was 42,664 in 1951, 60,996 in 1961 and 107,663 in 1966.

The rapid rate of disappearance of small residential farms where milk and butter are produced mostly for the family needs can also be expected to generate an increase in demand for the same products through commercial channels in the region. However, this will be true only to the extent that these families do not emigrate.

Finally, the greater discipline necessary to achieve monopolistic price discrimination will probably become easier as both the number of dairy farmers as well as the number of small farmers selling milk to consumers on a "petty trade" basis decrease. There are reasons to believe that increased local demand for fluid milk might be affected by the countervailing power of the local cooperatives, especially if

mergers among small cooperatives take place at a faster rate. Emphasis on seeking higher prices for fluid milk might be expected.

Manufacturing Milk

The income elasticity of demand for most dairy products at the farm level is believed to be very low in Canada. Estimates range from 0.2 to zero depending upon the assumptions made, the milksheds considered and the periods of the studies. The fact that regional urban incomes are substantially lower than the national urban average might lead one to expect the income elasticity for dairy products to be slightly higher than 0.1 in Eastern Quebec. This might be especially true for milk used in producing cheese, ice cream, skim milk powder and evaporated milk. However, the increases in demand to be expected because of income increases will probably be fairly small. Moreover, the planners' projection indicate that the regional population will probably be fairly stable in the foreseeable future. Increases in demand for dairy products due to regional increases in population will thus probably be of little importance.

The changes in the demand for butter processed in the region will likely continue to depend upon economic conditions external to the region as well as on the future governmental policies affecting the level of subsidies on butter. Any change in the level of the consumer's subsidy might be expected to significantly affect the entire agricultural economy of the region. Therefore, it cannot be concealed that the degree of uncertainty concerning the total demand for butter processed in the region is fairly high. The decrease in per capita comsumption

of butter in Canada (Table 27) indicates that a change in consumers' tastes may have had an unfavorable effect on this commodity.

No major efforts had been made by the local dairy processors to diversify their production until the planners suggested that five large diversified dairy processing planning plants, instead of the 46 small butter plants which existed in the region in 1964, appeared to be a feasible alternative in the region. Apparently, these larger processors would be able to compete on the skim milk powder (roller and spray) markets on a wider geographical basis. This would allow these plants to utilize the residual products of their butter enterprises (skim milk).

In summary, it appears that the future increases in demand for the dairy products processed in Eastern Quebec will mostly depend upon the potential for a greater entry into the North Shore fluid market and upon the possibility of competing on the Eastern Canadian skim milk powder market. Butter will very likely remain an important commodity processed in the region but its relative importance might decrease significantly in the next decade.

The future of the dairy farming industry in Eastern Quebec hinges largely upon the agricultural trade policies to be followed by Canada in the next future. A rapid move towards international trade liberalization measures might be a serious threat to the dairy sub-sector of the region. A slow move towards freer trade, however, might be favorable to it if the policies advocated by the planners were successful in raising the productivity of both the dairy farmers and the dairy processors in the region. It seems reasonable to

conclude that the regional dairymen cannot currently compete with Danish and New Zealand dairymen in producing butter on a free trade basis.

On The Dynamics of Resource Adjustments: A Summary

The dynamics of resource adjustments must be viewed in the context of constinuously changing regional demand functions due to population and income growth and other factors as well as changing supply functions due to changing technology and factor prices. In a dynamic framework focus is placed on estimating the rates of change of these functions in order to provide a framework for more detailed exploration of particular policies and programs to aid the development of a region.

Within this dynamic framework the standard body of economic theory leads to the following conclusion. If the organization mechanisms of market economies were functioning perfectly, all economic agents would seek to sell their labor services, as well as the services of the other factors which they own, where their marginal value product is the greatest, thereby imposing upon the economy an inherent tendency to lead to a reduction in income differences between factors, individuals and areas. The questions which naturally arise are the following: Why is it then that the returns accruing to factors of production in a region like Eastern Quebec may exhibit a persistent and significant tendency to diverge from those of other regions? And why is it that the returns accruing to factors of production in the dairy subsector of Eastern Quebec may exhibit a persistent and significant tendency to diverge from those of other sectors either inside or outside the region?

In order to answer these questions, it seems appropriate to question the relevance of some of the assumptions of standard economic theory on the basis of the information that was presented in the previous sections of this chapter. This may be a fruitful way of summarizing the foregoing description of the problems of the regional dairy subsector.

Standard economic theory classifies factors of production into groups which are supposedly homogeneous. For instance, labor is treated as a homogeneous factor of production. However, to the extent that education generally increases the salable value of one's labor services, it can be argued that the returns to labor will differ from region to region partly because of the fact that the levels of education of their people are substantially different. The pieces of evidence brought into this study tended to show that farm operators are relatively less educated than the rest of the working population in Eastern Quebec, and than farm operators in the more developed regions of Quebec. This implies that the value of the dairy farmers' labor services in Eastern Quebec tends to be low both in the current use (their MVP in dairy farming) and in the alternative employment opportunities open to these farm operators. The fact that most of these farm operators hold off farm jobs for a few months in a year is not inconsistent with the previous proposition. It only implies that those sectors which are known to demand seasonal labor services (mostly fisheries, tourism, and forestry-related operations) are creating for a few months conditions where the salvage value of farmers labor services is greater than its MVP in agriculture. Evidence shows that the regional dairy farmers respond to these job opportunities.

Static standard economic theory also assumes perfect mobility of factors of production between sectors and between regions. The content of this assumption has been challenged in at least three ways, namely in that (1) it says nothing about the costs of migration, (2) it implies perfect communication of job opportunities wherever they are, and (3) it is based upon the notion of markets free of imperfections. There are reasons to believe that the costs which a farmer's family has to bear in order to emigrate from Eastern Quebec are fairly high. However, no data are available to substantiate this proposition. Evidence available shows that the size of these families is very large-- the average ranging from 6 to 8 persons on census farms --and that there is a strong tendency for those leaving the region to be in the lower ages.[49] The fallacy of the assumption of perfect communication of job opportunities is self explanatory. The issue of imperfect markets was also raised in the previous discussion. It was argued that some fixed assets currently utilized in regional dairy farming are trapped into agriculture because of the significant divergence between their acquisition price and their salvage value. The suggestion that this divergence may be even larger in Eastern Quebec than in the other region of Quebec was tentatively proposed.

The foregoing description of the dairy subsector in Eastern Quebec leads to the conclusion that resource adjustments have taken place in the region despite the fact that factors currently used

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[49]Compiled from 1966 Census of Canada, Catalogue No. 96-606, op. cit., The low average of six persons per census farm was for Gaspé-East and the high average of eight persons per census farm was for Matane.

in this subsector tend to earn income which is substantially lower than provincial averages. The main adjustments have been the following:

1. The diminution in the number of dairy farming operations has proceeded at a relatively rapid rate during the last decade.
2. Dairy farming has attracted relatively few of the younger elements of the working population during the last decade.
3. The size of the remaining dairy farms slowly increased over time.

The nature of government intervention may have considerably slowed down the rate of resource adjustments in the dairy subsector. Its main effect is probably to increase the MVP of most resources used in the production of dairy products in the region. In the past, emphasis has been laid on government intervention through income redistribution measures such as subsidized production in preference to policies which would have increased the physical efficiency of the production factors.

The discussion of the comparative advantage of the regional dairy subsector leads to the conclusion that Eastern Quebec might be able to compete--on a real cost basis--with other dairy farming regions of Quebec, at least in the regional market. However, the potential for its growth will largely depend upon its capacity to increase its share of the North Shore fluid market where it appears to have a comparative advantage and upon its ability to shift to other commodities such as dried skim milk which might make the regional farming industry more competitive on the larger Eastern Canadian market.

In conclusion it appears that the problems of the dairy subsector in Eastern Quebec are shared, to a significant extent, by the other regions of Quebec, with the possible exception of the region of Montreal where the process of agricultural resource adjustments seems to have proceeded more rapidly. The increases in the costs of some important factors of production--notably labor and land-- are likely to have been substantially higher in the region of Montreal than in the other regions of Quebec. This might partly explain why land-saving and labor-saving technologies have been introduced more rapidly in the former region than in the latter ones. One might think of the modern dairy housing and dairy milking arrangements as being labor saving technologies as compared to the traditional types of dairy technologies that are still commonly found in Eastern Quebec. One might also think of pasture fertilization and changes in dairy feed rations towards greater use of grain concentrates as being land-saving technologies in dairy farming, the latter case being self explanatory whenever purchased grain concentrates are substituted for other feeds which were produced on dairymen's own farms. The differences in the structures of dairy farms of Eastern Quebec as compared to the region of Montreal are found to be consistent with this pattern of resource allocation. The marginal use of freight-assisted feed grains by dairy farmers of Eastern Quebec is also logically consistent with these propositions.

Disagreement with the planners' interpretation of the current resource allocation in the dairy subsector of Eastern Quebec is expressed in the study. It is argued that lack of economic motivation cannot be proved on the basis of the present patterns of resource allocation in the regional dairy subsector. However, there are reasons to agree with

the planners' views that (1) the dairy subsector can only be developed with the rest of the regional economy but not despite of it, (2) the development of the dairy subsector will entail a substantial reduction in the number of dairy farms and butter plants, and (3) government intervention needs to shift from income redistribution measures to programs which would increase the productivity of the agricultural resources of the region. The general conclusion is that the regional agricultural economy needs more productive resources, including the human resources, and freer entries into other markets in order to be able to compete with other dairy areas of Canada. The planners' argument that it is desirable to encourage dairy farming in the most promising zones (A and B) and to discourage dairy farming in the less ecologically suitable zones (C, D and E) of the region seems acceptable.

PART II

Analysis of Alternative Regional Dairy Development Strategies

CHAPTER V

ALTERNATIVE DAIRY DEVELOPMENT STRATEGIES AND FARMERS' INTENTIONS

Introduction

Conflicting values and beliefs are held concerning the future orientation of dairy farming in Canada. It appears that this issue has reached its greatest momentum ever since the total quantity of Canadian dairy products sold per year has flattened down.[1] The fact that "almost three-quarters of the volume of milk being used in Canada is produced as a specialized activity by one-quarter of the farmers (who produce milk)" indicates that the problem has at least two dimensions on the supply side.[2] On the one hand, it has been argued that the long run goal of the future Canadian dairy policy should be to move the industry toward the goal of greater competitive efficiency in production. This point of view is usually associated with the belief that higher production efficiency can only come through specialized dairy

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[1]W. Mackenzie, speculates that the total demand for Canadian dairy products might start decreasing in the foreseeable future. It appears that the new trend towards stability in total Canadian consumption of dairy products has started in the late 1950's. See W. Mackenzie, op. cit., pp. 1-4.

[2]Ibid., p. 4.

farming with dairying as the sole or dominant enterprise of the farm.[3] On the other hand, it has been argued that one of the major issues currently faced by the Canadian dairy industry is the intra-industry income distribution problem. This point of view is commonly associated with the belief that the price differential between fluid and manufacturing milk and differences in managerial skills are partly responsible for the fact that fluid milk producers have moved faster towards specialization and the use of modern technology than non-fluid milk producers.[4]

Most researchers who have been concerned with dairy farming in Canada recognize, however, that the volume of milk currently sold in Canada could be produced on fewer dairy farm operations with the use of substantially fewer resources per pound of milk produced. For instance the argument has been advanced that "there were enough apparently fixed resources on Ontario fairy farms to permit an expansion of cow numbers by 18 per cent."[5] There are several reasons of suspecting that the same argument might hold, at least to the same extent, for the Eastern Quebec dairy farming industry as of now.

In the following parts of this study the long-run government objective for the regional dairy farming industry is presumed to be the goal stated by the regional planners. This goal is the promotion of production efficiency.[6] It is therefore assumed that the other agricultural planning programs will be successful in facilitating the transfer of human

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[3]Ibid., p. 44.

[4]See W.J. White, op. cit., p. 30.

[5]G.I. Trant, op. cit., p. 6.

[6]Development Plan for the Pilot Region, op. cit., p. 40.

resources from agricultural to other sectors of economic activity. The discussion that follows is also predicated on the assumptions that the regional dairy farmers are economically motivated and that they are likely to respond to larger income opportunities as they perceive them.

Alternative Dairy Development Strategies

The planning approach which has been proposed for raising the levels of productivity and the profitability of dairy farming in Eastern Quebec comprises two general groups of programs. The first group of programs aims at facilitating the transfer of human resources from non-commercial farms to other sectors of economic activity located either inside or outside the region.[7] While these program strategies are important to aid in improving resource adjustments in the region, they are beyond the scope of this research. Let it be sufficient to recall that approximately 65 per cent of all the census farms recorded in the region in 1966, or 5,798 out of 8,906, were non-commercial. The second group of programs aims at facilitating the acquisition or more and higher productive resources by farm operators who choose to continue farming. This study is exclusively concerned with this second general group of programs.

According to the regional development plan, three major dairy development strategies which fit into the second general group of programs, would be given priority during the first planning horizon (1968-75). These

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[7]There is an important issue related to this group of programs which is not explored in this study but which must be mentioned. This issue consists in the fact that approximately 33 per cent of all the operators of non-commercial farms in the region, or 1,915 out of 5,798, were 55 years old or more in 1966. Presumably, most of these older farmers do not have many off farm opportunities.

strategies are as follows:

Strategy I: Improvement of Dairy Stock

The further development of specialized dairy stock raising farms is one project for improving dairy stock in the region. Private dairy farms located in agricultural zone C (Figure 2) would be encouraged to buy some dairy stock from other areas of the Province of Quebec and to specialize in raising dairy stock. These farms would raise heifers with higher production capacity (through progeny testing and preferential use of superior sires) than those which are now commonly raised on the regional dairy farms. The heifers would be offered for sale to the dairy farmers of the region prior to their first calving. The regional planners suggest that the average production (mature-equivalent basis) of these heifers might be around 8,000 pounds per year and that they would sell for about $250. While recognizing that this objective is rather low, the planners seem reluctant to suggest that very high production-capacity cows should be immediately introduced in the region. The sources of their reluctance are not, however, clearly spelled out in the regional planning documents. The planners' point of view appears to be based on the presumption that a gradual adoption of more suitable dairy management practices will have to be followed before very high productive cows can be systematically introduced in the area. The figures on cow productivity suggested by the planners will be used in the main analytical part of the study while more productive cows will be considered in the sensitivity analysis.

It is thought that there are at least two additional stock replacement strategies which are worth analyzing also. One alternative strategy would

consist in selling heifers raised on the specialized dairy stock farms at a subsidized price. The subsidized price which this study intends to consider will be specified later. A third strategy would consist in the improvement of dairy stock in the region through articifial insemination.

Strategy II. Improvements in Feeding Rations.

The planners have expressed the opinion that a significant increase in the yields of dairy cows could be achieved in Eastern Quebec through major improvements in the feeding rations. Unfortunately, this opinion has not yet been adequately substantiated. The main question, however, is whether or not an improvement in dairy feeding rations is economically justifiable, given the input and output prices faced by the regional dairy farm operators.

It appears that there are two main possibilities for improving the dairy feeding rates in the region. The first possibility consists of increasing the quantity of forage and/or grains fed to dairy cows. This could be done either by increasing yields of dairy crops possibly by increased fertilization[8] or by expanding crop acreage through buying or renting. The second possibility consists of improving quality and feeding value of the forage crops. This could be done by earlier and more frequent harvest or by shifting from hay and oats for grain to silage. Since intake of forage is related to quality, improved quality forage can increase milk

[8]Increased fertilization appears to be technically suitable for the region since the high moisture conditions which prevail in the area are known to be favorable to the response of hay and pasture crops to fertilizer applications. It is generally recognized, however, that pasture fertilization increases dry matter production and yields of native herbage, though generally not to such an extent as is obtained when improved species are seeded. No research results have yet indicated that fertilization of hay and pasture crops might have a high payoff in the region. This study submits

yields without increasing rates of grain feeding.

According to the regional planners both possibilities can be pursued in the region. It is believed that regional supply and demand for land ecologically suitable for dairy farming can be equated at relatively low price levels. On the one hand, the planners foresee that the new exit opportunities which will be offered to the regional farmers will contribute to shifting the land supply function to the right. On the other hand, a greater discrimination in the allocation of quotas on the part of the federal government, especially to very small dairy operations, may be expected to substantially reduce the price of land on those operations which lost or expect to loose their quotas since the quotas are mostly capitalized in the value of land. Under such circumstances, there might be a real possibility for those dairymen who want to continue farming to expand their crop acreage. It is also believed that production of total digestible nutrients can be significantly increased on local dairy farms by shifting from oats harvested as grains to oats harvested as silage. Investments in silos and silage equipment would be necessary in the latter case.

In order to substantiate these beliefs, this study considers a range in feed quality and characteristics that serve to demonstrate the effects of variations in feed quantity and quality that might reasonably occur in the region. Information collected in the survey is used to estimate current

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that this alternative strategy for increasing dairy feed supply in the region is worth being further investigated. Widespread use of plant nutrients on hay and pasture crops does not appear to have yet caught on in Eastern Quebec. It is highly unlikely that there will be any immediate and sharp increase in the use of fertilizer on these crops. This practice might increase in the region, albeit slowly.

feeding rates on various farms of the region. These estimates are combined with information on species of grasses and legumes grown in the area to specify the range of dairy rations used in this analysis. A thorough discussion of these feeding rations is presented in the following chapter.

Strategy III. Farm Consolidation and Community Pasture Programs

Farm consolidation and community pastures have been advocated by the planners in order to facilitate the expansion of dairy farm sizes. From a purely pragmatic point of view, both policies could be considered as constraints in this study because these policy recommendations have already been accepted, and thus the market for agricultural land will be controlled by a government agency.

The activities originally proposed for the government agency (Service Technique Agricole) which is to dominate the land market of the region are as follows:

> This Service (Service Technique Agricole) will have the task of preparing agrarian schemes by zones and sub-zones. It will have the power to buy, rent, enlarge, improve and determine the potential use of land as well as the power to administer community pastures and to select . . . those operators who can utilize them. For the purpose of facilitating its task and in order to accelerate the farm enlargement and the land improvement processes, it will be endowed with a preemption right on all the land offered for sale in the agricultural zones. Moreover, in cases where agricultural land will have laid idle for five years, this Service will be given the power to temporarily withdraw the owner's right of use and transfer this right to someone interested in renting this land.[9]

It is not the purpose of this study to question whether such a government agency needs to be established in order to correct market

[9]Plan de Développement, Cahier 3, op. cit., pp. 144-45.

imperfections in the region. The planners have expressed the opinion that lagging adaptation in land sizes of regional farms are due to malfunctioning of the regional land market. Apparently, regional agriculture is faced with a serious problem of fragmentation of crop land which makes it difficult to develop contiguous farm units. One might argue that regional land market imperfections will correct themselves by the improved interaction of free market forces as further economic development proceeds in the region. However, more convincing voices have apparently led the policy decision-makers to believe that effective government intervention is necessary for launching further agricultural development in the region.

The presence of the government agency on the regional land market might give rise to two slightly different situations. In the first situation, the agency would exercise its preemption right in all agricultural land transactions. In the second situation, the agency could exercise its preemption right only in those instances where it is felt that some very serious market imperfections need to be corrected. In the former situation the regional agricultural land market would be completely dominated by the government agency whereas a free agricultural land market would continue to operate in the latter situation. Tight controls may also be expected in the former situation. If a dairy farmer's ability to either buy or rent land from the government agency is to be determined on the basis of the quantity of cropland that he already owns, then one can foresee the possibility that his growth objectives might be hampered by these controls.

This study proceeds under the assumption that government intervention in the regional land market will be minimal. Two price levels for land devoted to agriculture are considered. Current agricultural land market prices are used in most experiments simulated while the likely consequences of increased price of agricultural land are considered in the sensitivity analysis.

Other Dairy Development Strategies

Other planning programs have been recommended for increasing the productivity and profitability of dairy farming in Eastern Quebec. These programs may be classified in two groups. The first group comprises a set of incentives for young farmers to acquire more adequate vocational training. It also includes recommendations for improving the teaching methods and the vocational school training facilities in the region. The second group includes a set of incentives for the regional dairy processing industry to consolidate its operations and to diversify its production. It is very unlikely that these programs will have an immediate impact upon the profitability of dairy farming in the region. In the long run, however, it might be expected (1) that investments in human resources will have a substantial payoff in the region and (2) that product diversification in the dairy industry will contribute to raising the price received by regional farmers for their milk output. Quantifying the net benefits to be derived from these programs would in itself constitute a major

research study.[10]

This study is restricted to analyzing the likely consequences of the alternative dairy development strategies described as strategies I, II, and III. It is necessary to recognize that significant improvements in the dairy farmers managerial ability might be achieved in the region because of the implementation of strategies which are not considered in this study. Such improvements might substantially contribute to increasing these farmers' capacity to discover and select between new dairy income opportunities. The fact is, however, that these farmers are now faced with a choice of either making a positive response or making no response whatsoever to some specific regional dairy development programs. Some evidence on the intentions of a selected group of regional dairy farmers with regard to these programs is presented in the following pages.

The Regional Dairy Farmers' Intentions

One of the main objectives of this research is to find out how a dairy farmer in a given situation is most likely to react to the new

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[10]Two major difficulties may be anticipated by the researchers who would undertake such a study. First, almost all the relevant data will have to be collected through survey. Secondly, the uncertainty concerning the future orientation of the federal milk subsidy program would greatly affect the confidence limit for the estimates obtained. For instance, the potential market price increases received by the regional dairy farmers because of product diversification at the processing level might be readily erased by a reduction in subsidies. The latest changes in the federal milk price policy indicate that a gradual return to a freer milk market might be forthcoming in Canada. Predicting when and how fast these changes are going to take place is an intractable problem.

government programs. The likely response of the regional dairy farmers to the new programs may be classified as follows:

1) farmers who continue in dairying and make a positive response to the new dairy development opportunities;
2) farmers who continue in dairying but make no response to the new dairy development opportunities;
3) farmers who opt to leave dairying as a result of exit opportunities in the new government programs or for other reasons.

The empirical evidence presented in the following parts of this study covers a limited segment of the total number of regional farms reporting dairy enterprises. It is therefore necessary to begin this discussion by placing the surveyed population in the perspective of the total population.

The Surveyed Population

Seventy-eight Eastern Quebec dairy farmers were surveyed in the summer of 1969. Each farmer participated in a personal interview in which he was asked a series of questions including some regarding the future growth potentials of his dairy enterprise as he perceives them and the most likely course of action that he intends to follow in order to make his dairy enterprise more profitable.

The farms included in the survey were not selected on a probability sample basis.[11] As a result, these farms are not necessarily representative of all the commercial dairy farmers in the region. There is unsuf-

[11]See appendix A for details on the design and execution of the survey. The original questionnaire can be found in appendix A.

ficient information available on a probability sample basis for Eastern Quebec commercial dairy farms to permit an estimate of the extent to which the estimates presented in this study tend to approximate, or to diverge from, the estimates that would result from information on a probability sample of all regional commercial dairy farms.

The criteria which were used to select the communities where the survey was conducted are explained in details in Appendix A. These criteria are likely to result in a sample of commercial dairy farms from which limited inferences can be drawn about commercial dairy farms located within the two major regional milksheds. Commercial dairy farms located within the boundaries of these two milksheds probably have more adequate resources than other commercial dairy farmers in the region. The likelihood that they will continue farming may be fairly high. It is therefore necessary to emphasize that the farms surveyed are not necessarily representative of other strata within the regional dairy farming industry.

General Results

The results of the survey indicate that a high proportion (62.8 per cent) of the respondents intend to increase both the size and the production capacity of their dairy herds. A third of the respondents said that they intend to increase the production capacity of their herds but that they do not plan to milk more cows in the next five years (Table 28). This leaves a small minority (3.9 per cent) of respondents who wish to either leave dairying or continue in dairy farming with the same number and the same type of cows..

TABLE 28. Respondents' Intentions Concerning Their Dairy Farming Enterprises.

Specified Strategy	Number of Respondents	Percentage of Respondents in each category
	(number)	(percentage)
Increase herd size and production capacity of cows	49	62.8
Increase production capacity of cows only	26	33.3
Increase herd size only	0	0.0
No change planned	1	1.3
Leave dairying	2	2.6
TOTAL	78	100.0

Source: Eastern Quebec Dairy Farms Survey, 1969.

Most of these farmers thus seem to recognize that increases in either dairy herd sizes or in production yields of cows (or both) might significantly contribute to improving their income situation. There is substantial disagreement, however, among the respondents as to how they should go about increasing the size and the yield of their dairy herds. On the one hand, a large majority (85.7 per cent) of the respondents who wish to increase the size of their dairy herds intend to raise their own heifers (Table 29). A rather small minority (14.3 per cent) of the respondents wish to buy either all of or only some of their new heifers.

On the other hand, a slight majority (61.3 per cent) of the respondents who declare that they want to increase the yield of their cows believe that they can achieve this objective by improving the quality of their sires and thereby raise cows with higher production capacity (Table 30).. This belief is shared, to some extent, by a smaller proportion of the respondents (22.7 per cent) who feel that they also need to increase feeding rations in order to achieve this objective. A smaller group of farmers (8.0 per cent) intend to raise heifers with higher production capacity and to improve feeding rations but fail to mention how they expect to go about raising more productive cows. All other respondents (8.0 per cent) would apparently resort to buying all of or some of their replacement animals, in conjunction with some combination of other strategies, in order to increase the yield of their dairy herds.

These results raise some serious questions concerning the establishment of specialized dairy-stock-raising farms in the region. Apparently some deep reluctance towards shifting from a raising-own-replacements strategy to a buying-replacements strategy might be expected on the part of a large majority of these regional dairy farmers. Two factors might, however, substantially contribute to reducing their reluctance. First, lowering the price of the heifers (possibly through a subsidy) to be sold by the specialized dairy-stock-raisers might be expected to increase the number of buyers. Secondly, a momentum for adoption of buying-replacements strategy might build up over time if (1) the early adopters thereby significantly increased the productivity and the profitability of

TABLE 29. Respondents Favoring a Specific Strategy for Increasing Size of Herds, Number and Percentage.

Specified Strategy	Number of Respondents	Percentage of Respondents in Each Category
	(number)	(percentage)
Raise all replacement cows on own farms	42	85.7
Buy all replacement cows	5	10.2
Raise and buy replacement cows	2	4.1
TOTAL	49	100.0

Source: Eastern Quebec Dairy Farms Survey, 1969.

TABLE 30. Respondents Favoring a Specific Combination of Strategies for Increasing Yields of Dairy Herds, Number and Percentage.

Specified Combination of Strategies	Number of Respondents	Percentage of Respondents in Each Category
	(number)	(percentage)
Improve quality of own sires and raise more productive heifers on farm	46	61.3
Improve quality of own sires, feed more hay and grains and raise more productive heifers on own farm	17	22.7
Feed more hay and grains and raise more productive heifers on own farm	6	8.0
Feed more hay and grains and buy new heifers	3	4.0
Buy all or some of the new heifers	3	4.0
TOTAL	75	100.0

Source: Eastern Quebec Dairy Farm Survey, 1969.

their enterprises, and (2) the gains accruing to the adopters become visible to the non-adopters. The results of the survey confirm none the less that a significant group of respondents (24.4 per cent) might shift either partially or totally to a buying replacements strategy in the coming years.[12] Some evidence also indicates that this group of farmers would make a positive response to reductions in the price of heifers sold by the specialized dairy-stock raisers (Table 31).

It hardly needs to be pointed out, however, that a strategy which would allow these dairy farmers to raise more productive heifers on their own farms might gain wider and faster acceptance among them than a generalized buying replacement strategy, especially if purchases of more productive heifers were not subsidized. These findings strongly suggest that artificial insemination may be one of the most suitable alternatives to recommend for the region. Conforming to the general organization of this research, the following discussion presents some evidence on the likely response of regional dairy farmers to this alternative before analysing its economic consequences.

The results of the survey indicate that a majority (52.6 per cent) of the respondents have used artificial insemination in the past and will probably continue to use it in the future, especially if its cost decreases (Table 32). A few of the respondents (5.1 per cent) have used it in the past and said they will not use it in the future even if it becomes less expensive. The most astonishing finding, however,

[12]This comprises 8 per cent of the respondents who generally favor a buying-replacement strategy (Table 30) plus 16.4 per cent of the respondents who do not generally favor a buying-replacement strategy but who might shift to it if the price of heifers sold by specialized dairy-stock raisers is not higher than $250.

TABLE 31. Number of Heifers that Some Local Dairymen Might Buy Per Year from the Dairy Stock Raisers at Various Prices.[a]

Price of Heifers	Average Number of Heifers Likely to be Bought Per Farm Per Year[b]
$250	2
$200	3
$100	6

[a]Based on 19 respondents' answers.

[b]Round numbers.

Source: Eastern Quebec Dairy Farms Survey, 1969.

TABLE 32. Respondents Holding Specified Opinion Concerning Artificial Insemination, Number and Percentage.

Specified Opinions	Number of Respondents	Percentage of Respondents In Each Category
Has used A.I. in the past and will probably use it in the future, especially if less expensive	41	52.6
Never used A.I. in the past and will probably not use it in the future, even if less expensive	32	41.0
Has used A.I. in the past but will probably not use it in the future even if less expensive	4	5.1
Never used A.I. in the past but will probably use it in the future if less expensive	1	1.3
TOTAL	78	100.0

Source: Eastern Quesbec Dairy Farms Survey, 1969.

has to do with the relatively high proportion (41.0 per cent) of respondents who said that they never used artificial insemination in the past and will probably not use it in the foreseeable future even if it becomes less expensive. As a matter of fact, only one respondent declared that he never used it in the past but would probably give it a try if it became less expensive. Some 43 out of 45 respondents who declared having used artificial insemination in the past said that they paid $5.00 per cow serviced. Some 32 out of 42 respondents who said that they will probably use it in the future if it becomes less expensive expressed the opinion that $3.00 per cow serviced would seem a reasonable price for them. It must also be pointed out that, apparently, none of those respondents who have used artificial breeding in the past has completely shifted to this practice, witness the fact that all of them still own one or two dairy sires.

These finding on the respondents' apparent opinions concerning artificial insemination bring forth the following remarks. There are reasons to suspect that the adoption of artificial breeding might have impinged upon some serious barrier in the region. However no evidence is available for confirming whether or not this barrier can be associated with either a general lack of education or with some serious sociological and religious hindrances, but it appears that improvements in technical information might substantially contribute to more widespread adoption among the regional dairy farmers.

It has been argued that dairymen in thinly populated and/or remote areas of countries where A.I. became firmly established still continue

to prefer natural service.[13] The facts which could explain this situation have not yet been adequately investigated but it appears that the conditions of supply of A.I. services in these areas might be relatively deficient when compared to areas located near major urban centers. It is thought that poor supply conditions may be as important as factors related to demand conditions in explaining the low level of adoption of A.I. services by dairy farmers in remote areas of countries with advanced dairying. The very scatter and low density of cows in such areas probably makes it costly or unprofitable for the inseminators. This factor is important because the services of the inseminator must be available within the specified period of time when cows are in heat for A.I. to be profitable.

Supply and demand conditions notwithstanding, the fact remains that the appeal of alternative breeding methods to dairymen varies from one dairy operation to another. The following section attempts to determine whether the response of a regional dairy farmer to alternative dairy development strategies is likely to be related to the current size and milk yield of his dairy herd.

Factors Associated with the Respondents' Preferences

It may tentatively be argued that the farmers' response to alternative dairy development strategies is likely to differ significantly on farms of different herd sizes and of different levels of productivity as measured by the herd's average milk production per cow. These hypotheses are based on four presumptions. First, operators with relatively

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[13] I. Micheal Lerner and H.P. Donald, Modern Development in Animal Breeding, (London; Academic Press, Inc., 1966), p. 137.

large herds are expected to be more innovative and more financially secure than other dairy farmers in the region. Secondly, operators with relatively large herds are expected to have greater managerial capacities than other regional farmers. Thirdly, respondents who already own the most productive dairy herds are expected to more likely continue to raise their own dairy replacements then other respondents. Fourthly, operators with relatively large dairy herds are expected to be in a preferable position to assume whatever risks a dairy herd expansion strategy might currently entail.

As expected, the results concerning the respondents' preference for higher dairy herd expansion or no herd expansion during the next five years support the hypothesis that current dairy herd size may be an important factor associated with the decision to expand the size of the dairy enterprise (Table 33). As a matter of fact, the results show that respondents with average (18 to 25 cows) and relatively large (26 cows or more) dairy herds are almost equally likely to favor a dairy herd expansion strategy whereas the respondents with relatively small herds (17 cows or less) are less likely to favor expansion.[14] The overall results, however, fail to support the hypothesis that current average dairy herd production per cow may be an important factor associated with the decision to expand or not to expand the size of the dairy enterprise (Table 34). This finding sounds astonishing, especially with regard to the factual evidence indicating that one is more likely

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[14]It is interesting to note that respondents favoring expansion appear to be distributed according to a bimodal probability function.

TABLE 33. Respondents in three Dairy Herd Size Categories Who are Likely to Either Expand or not Expand Herd Size in the Next Five Years, Number and Percentage.[a]

Favored Strategy	Herd Size (number of cows) 17 or less	18-25	26 or more	Total
Number of farmers	33	31	14	78
		- - - % - - -		
Expand herd size	45.5	77.4	71.4	62.8
Not expand herd size	54.5	22.6	28.6	37.2

Source: Eastern Quebec Dairy Farms Survey, 1969

[a]A two-way chi-square test between herd size and the decision to either expand or not expand herd size is significant at the 0.05 level of test. The calculated value of the Chi-square was 6.31 compared to 5.00 at the five percentage point of the Chi-square distribution with two degrees of freedom. Thus the null hypothesis that the two factors are independent must be rejected at that level of the test.

TABLE 34. Respondents in Three Classes of Average 1968 Herd Production Per Cow Likely to Either Expand or not Expand Herd Size, Number and Percentage.[a]

Favored Strategy	Average 1968 Dairy Herd Production Per Cow less than 6,000	6,000-6,999	7,000 or more	Total
Number of Farmers	22	34	22	78
		- - - - % - - - - -		
Expand herd size	54.6	70.6	59.1	62.8
Not expand herd size	45.4	29.4	40.9	37.2

Source: Eastern Quebec Dairy Farms Survey, 1969.

[a]A two-way Chi-square test between average herd production per cow and the decision to either expand or not expand herd size is not significant at the 0.05 level of test. The calculated value of Chi-Square was 1.61 compared to 5.99 at the five percentage point of the Chi-Square distribution with two degrees of freedom. Thus the null hypothesis that the two factors are independent cannot be rejected at the level of the test.

to find the most productive dairy herds on farms with relatively large herds than on those with relatively small herds (Table 35).

It may also be hypothesized that dairy herd size and present herd productivity may be important factors associated with the respondents' likely decision to pursue one the following options: (1) keeping on raising their own replacement cows by natural service, or (2) buying some or all of their replacement cows, or (3) keeping on raising all replacements animals while attempting to breed more productive cows through more frequent use of artificial insemination. However, the results of the survey fail to support the hypotheses that dairy herd sizes (Table 36) and average herd yields per cow (Table 37) may be important factors associated with the respondents' expressed preference for either one of these options. This implies that present herd sizes and present herd productivity are not strong bases for predicting which dairy herd expansion and/or improvement strategy might be preferred by a given dairy farmer.

The overall results thus lead to the following conclusion. As expected, the survey results indicate that the respondents with relatively large dairy herds (18 or more) are likely to further expand their dairy enterprise than respondents with relatively small dairy herds (less than 17 cows). The overall results, however, fail to support the hypotheses that current herd sizes and current average herd yields per cow are related to the respondents' expressed preference for alternative means to expand their dairy enterprise.

In conclusion it appears that the respondents with relatively small herds tend to show greater reluctance to further commit themselves

TABLE 35. Respondents in Three Classes of Average 1968 Herd Production Per Cow Reporting a Specified Herd Size, Number and Percentage.[a]

Herd Size (Number of Cows)	Average 1968 dairy herd production per cow: less than 6,000	6,000-6,999	7,000 or more	Total
Number of Farmers	22	34	22	78
		- - % - -		
17 or less	63.6	50.0	18.2	44.8
18-25	31.8	35.3	45.4	37.2
26 or more	4.6	14.7	36.4	18.0

Source: Eastern Quebec Dairy Farms Survey, 1969.

[a]A two-way Chi-square test between herd size and average herd yield per cow (combining the last two rows in order to avoid having last row cell frequencies less than 5) is significant at the 0.05 level of test. The calculated value of Chi-square was 9.82 compared to 5.99 at the five percentage point of the Chi-square distribution with two degrees of freedom. Thus the null hypothesis that the two factors are independent must be rejected at that level of the test.

TABLE 36. Respondents in Two Dairy Herd Size Categories Who Tend to Favor Specified Practices, Number and Percentage.[a]

Herd Size	Specified Strategy: Will probably use A.I. more intensively	Will probably buy some of or all new replacements	Will probably continue to raise all replacements on own farm with natural service	Total
No. of Respondents	(35)	(20)	(23)	(78)
		- - % - -		
17 or less	45.7	40.0	39.1	42.3
18 or more	54.3	60.0	60.9	57.7

Source: Eastern Quebec Dairy Farms Survey, 1969.

[a]A two-way Chi-square test between herd size and likely decision to pursue a given strategy is not significant at the 0.05 level of test. The calculated value of Chi-square was 0.34 compared to 5.99 at the five percentage point of the Chi-square distribution with two degrees of freedom. Thus the null hypothesis that the two factors are independent cannot be rejected at that level of the test.

TABLE 37. Respondents in Two Classes of Average 1968 Herd Production Per Cow Who Tend to Favor Specified Practices, Number and Percentage.[a]

Average 1968 dairy herd production per cow (pounds)	Will probably Use A.I. more intensively	Will probably buy some of or all new replacements	Will probably continue to raise all replacements on own farm with natural service	Total
Number of Respondents	35	20	23	78
		- - % - -		
6,500 or less	51.4	50.0	52.2	51.3
more than 6,500	48.6	50.0	47.8	48.7

Source: Eastern Quebec Dairy Farms Survey, 1969.

[a]A two-way Chi-square test between average herd production per cow and likely decision to pursue a given strategy is not significant at the 0.05 level of test. The calculated value of Chi-Square was 0.03 compared to 5.99 at the five percentage point of the Chi-square distribution with two degrees of freedom. Thus the null hypothesis that the two factors are independent cannot be rejected at that level of the test.

to dairy farming than those respondents with relatively large dairy herds.[15] Determining whether the small dairymen are actually holding back from investing in dairying while waiting for favorable changes in exit opportunities is beyond the scope of this research.

[15]The farmer's age is probably an important factor related to these differences. This factor was not considered in this study but the conclusions presented in this section indicate that one might need to give it some consideration in order to explain differences in the regional farmers' intentions.

It hardly needs to be emphasized that the survey results fail to clearly indentify a single group of strategies which a large majority of the regional dairy farmers might adhere to in the short run. The variety of beliefs concerning the most appropriate combination of means for increasing net income from dairying in the region raises some serious questions concerning the relative merit of alternative combinations of dairy development strategies as perceived by the farmers themselves.[16] This study puts forward the argument that one of the following three situations might exist which could partly explain the existence of these divergent beliefs on the part of the respondents. First, it is possible that all combinations of strategies considered in this study were perceived by the respondents as being of equal merit, i.e. each one of the strategies might allow them to increase their dairy net income by about the same amount in the foreseeable future. Secondly, it is also possible that not all combinations of strategies over which they were questionned were perceived as being of equal merit but that the most economically justifiable ones might entail too great a loss in freedom to attract the revealed preferences of the majority of respondents. Thirdly, the regional dairy farmers may conceivably have developed a negative attitude towards all governmental programs in general. Such an attitude would imply that they tend to assign very high discount rates to new income opportunities

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[16]A still wider spectrum of beliefs might be expected if the respondents were asked to formulate their preferences from a larger number of alternatives.

originating via further government's intervention.[17]

In the following chapters of this study we shall attempt to analyse the economic consequences of each alternative set of strategies and determine whether any one of them might have a significantly higher payoff than others, at the farm level. We thus tentatively presume that the first situation above is very unlikely to arise.

Summary

Three major means of increasing productive efficiency of regional dairy farming enterprises were described in this chapter. They were (1) improvements in herd stock, (2) varying feeding practices, and (3) farm consolidation and community pastures programs. Information obtained from a survey of regional dairy farms--representative of a limited segment of the total regional dairy farming industry-- was then used to determine whether or not the regional dairymen intend to expand herd sizes, improve feeding rates and/or increase the production capacity of their cows, and if so how.

Among the results, probably the most pertinent were the following:

1. Approximately 63 per cent of the respondents might be expected to further commit themselves to dairy farming in the foreseeable future. These respondents wished to increase

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[17]While conceding that the Canadian dairy pricing policy has, in general, been consistently favorable to fluid milk producers, it is appropriate to reemphasize the fact that, in recent years, about 25 per cent of manufacturing milk producers' gross income derived from the sale of milk consisted in subsidy payments. The amount of the subsidy is subject to revision each year, which is giving rise to some uncertainties among manufacturing milk producers.

the size and the milk yield of their dairy herds. These farmers might make a positive response to the government's proposed program despite the fact they held substantially different opinions concerning the most adequate stock replacement strategy to be followed. Approximately 60 per cent of respondents indicating positive response tended to favour raising their own replacement cows while the other 40 per cent might choose to buy some of or all of their replacement animals. The results of the survey also indicated that articifial breeding might attract a large proportion of its potential users among those respondents who currently favour raising their own replacement cows.

2. Approximately 34 per cent of all the respondents might be expected to hold back, at least temporarily, from further major investments in dairying. Some 60 per cent of these owned relatively small herds of 18 cows or less.
3. Only 3 per cent of the population covered by this sample might be expected to leave dairy farming within the next five years.
4. As expected, the number of cows currently milked appeared to be associated with expansion intentions. No statistical relationship was found, however, between current herd size and the respondents' expressed intentions to improve their herds' milk yields. Moreover, no apparent statistical relationship between current herd size and the respondents'

expressed preferences for an alternative stock replacement strategy was revealed by the survey results.

5. The current milk yields of the respondents' herds were found not to be statistically associated with either the likely decision to further expand herd's size or the respondents' expressed preferences for an alternative stock replacement. strategy.

The major conclusion which emerges at this juncture is that there is substantial disagreement among the respondents as to what is the most appropriate course of action for them to follow in order to improve their earnings while remaining committed to dairy farming. These results clearly indicate, in our opinion that there is a serious need for further investigation of the micro consequences that might be expected from alternative courses of action.

CHAPTER VI

MODEL AND DATA USED FOR SIMULATED EXPERIMENTS

The main objective pursued in the following two chapters is to estimate the probable impact that alternative dairy development strategies might have on the profitability of representative dairy farming enterprises in Eastern Quebec. To do so two dairy farming enterprises are simulated by use of a computer. This chapter describes the model, lays down all the assumptions made and specifies the levels of the variables used in the model. In the next chapter the findings are analysed and the most relevant implications are derived.

On Simulation

The technique used in this analysis is a simulation model. It is appropriate at this juncture to briefly describe the nature and the properties of the simulation technique.

There is no consensus among the people who use the term simulation as to its exact meaning. Naylor et als. define simulation somewhat narrowly as "numerical technique for conducting experiments on a digital computer, which involves certain types of mathematical and logical models that describe the behaviour of a business or economic system (or some

components thereof) over extended periods of real time."[1] A much broader concept of simulation is presented by Shubik in whose opinion, "A simulation of a system or an organism is the operation of a model or simulator which is a representation of the system or organism."[2] The definition that is used throughout this study is formulated as follows: "Computer simulation is a system analysis tool which utilizes subject matter theory, certain mathematical structures, programming logic and empirical analyses to condense a complex system into a mathematical formulation duplicating the essence of the real system.[3]

There appears to be a consensus, however, among research workers as to what is involved in setting up a simulation model. Simulation, as a technique of analysis, involves setting up a model picturing the essence of a real situation and then performing experiments on the model. Each individual simulation run may be conceived as an experiment performed upon a model. A given experiment would thus involve operating a model after having specified the set of initial conditions, the set of values of the parameters used by formulating relations

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[1]T.H. Naylor, J.L. Balintfy, D.S. Burdick, and Kong Chu, Computer Simulation Techniques, John Wiley and Sons, Inc., 1966, p. 3.

[2]Martin Shubik, "Simulation of the Industry and the Firm," American Economic Review, vol. L, no. 5, December, 1960, p. 909.

[3]M.L.Hayenga, T.J. Manetsch, and A.N. Halter, "Computer Simulation as a Planning Tool in Developing Economies," American Journal of Agricultural Economics, vol. L, no. 5, December, 1968, p. 1755.

specific to the model and finally the time paths of those variables treated as exogenous.[4]

Some of the major advantages of simulation over other research techniques have been explored by Orcutt. He argues (1) that simulation techniques make possible the effective study of models containing large numbers of components, variables and relationships of almost any desired form, (2) that simulation techniques readily lend themselves to carrying out sensitivity analyses on the model considered, (3) that simulation techniques make it possible to carry out testing at various levels of aggregation and finally (4) that these techniques enable operating characteristics to be fitted to various sets of data by systematic trial-and-error procedures.[5] Another major advantage of simulation has been pointed out by G.L. Johnson. He argues that "mathematical simulation and system analysis offer an interdisciplinary

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[4]Although it is beyond the scope of this study to go deeply into technical and methodological problems involved in using simulation it is appropriate to point out that there are several basic references available to those wishing to gain even a casual acquaintanceship with the use of simulation. An uninitiated agricultural economist may find it convenient to refer to L.L. Manderschied, and G.L. Nelson, "A Framework for Viewing Simulation," Canadian Journal of Agricultural Economics, vol. XVII, no. 1, February, 1969, pp. 33-41, and consult the references presented therein. An individual with advanced statistical knowledge may in turn find it convenient to read T.Y. Ling, Introduction to a Statistical Concept of Statics and Dynamics in Simulation Experiments, paper presented at the Symposium on the Design of Computer Simulation Experiments Held at Duke University, October 14-16, 1968.

[5]G.L. Orcutt, "Simulation of Economic Systems," The American Economic Review, vol. L, no. 5, 1960, pp. 900-901.

approach for interrelating the different aspects of complex problems to see the consequences through time of alternative policies and programs (as reflected in different initial conditions and parameters)."[6] Johnson also holds the opinion that simulation provides the research worker with a convenient way of getting around the intractable problem of reducing many objective functions to a single desirable outcome. The user of simulation is allowed to specify as many objective functions as he desires as long as they are logically linked to the factors and relationships considered in the model.[7]

The early simulation studies led some researchers to believe that simulation in general and the results that it yields in particular generally lack the sharpness of focus obtained by other methods, such as linear programming. This argument, however, is debatable. Some people now condider linear programming one among many forms of simulation models. Recent simulation studies indicate that simulation does not necessarily lack sharpness of focus when the simulation model is designed correctly. The fact remains none the less that statisticians and econometricians tend to conclude that simulation models can produce relative results much more efficiently than absolute results. Thus they argue that statistical

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[6]G.L. Johnson, Relevant Rural Development Research for West Africa, paper presented at a Seminar on Research on an Agricultural Development in East and West Africa, Michigan State University, June 9-14, 1968, pp. 25-26.

[7]Other advantages of simulation techniques are described by R. Suttor, and R.J. Grom, "Computer Models and Simulation," Journal of Farm Economics, vol. 46, no. 5, December, 1964, p. 1342.

inference drawn from simulation is mostly useful for a conditional, comparative and relative prediction.[8]

In general, most methodological discussions concerning simulation boil down to the crucial issue of how one should go about validating his results. The usual procedure is to design a model, specify the variables, the relationships and the parameters and have the computer program simulate a situation which is familiar to the researcher, who can then compare the results with his prior knowledge.[9] Another procedure which is now being developed advocates thorough investigation of the statistical properties of probabilistic simulation models. Research in "simulation statistics" just started in recent years, which partly explains why it is not yet commonly used. The apparent reluctance on the part of simulation users towards elaborate statistical validation is thus understandable since the proponents of the statistical validation approach have yet to develop statistical tests readily applicable to simulation models. Therefore, the former validation approach will be used in this study.

Description of the Model

The model used in this analysis has five major components (Figure 6). These are (1) the unit of analysis constituting the core component

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[8]See T.Y. Ling, op. cit., pp. 16-17, for a discussion of the concept of simulation inference and its applicability. It is interesting to note that some authors have attempted to dispel this criticism by arguing that simulation is not aimed at long-run predictions and that the objective of a long-run simulation study is not forecasting but rather designing strategy for an unpredictable future. See E.P. Holland, and R.W. Gillespie, Experiments on a Simulated Underdeveloped Economy, Cambridge, Mass., The MIT Press, 1963, p. 209.

[9]L.V. Manderschied and G.L. Nelson, op. cit., pp. 34-35.

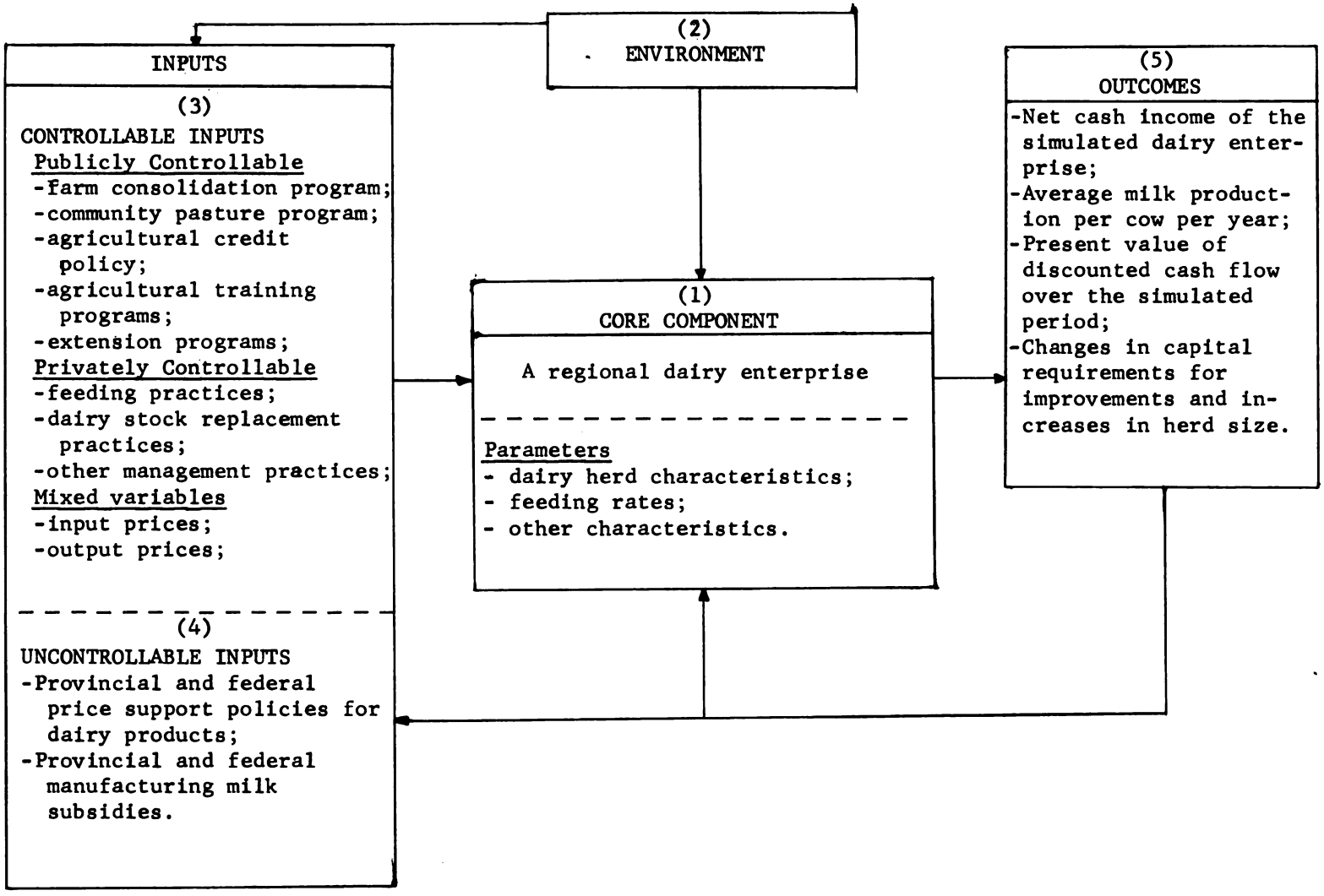

Figure 6. System Relationships

of the system (a dairy farming enterprise), (2) the environment within which this unit operates, (3) a set of controllable inputs which are subject to change in the region as a result of the planners' policy recommendations, (4) a set of uncontrollable inputs which are subject to change at the national and/or provincial levels of policy decision-making but over which the regional authorities have no control, and finally (5) the outcomes of the system. The direction of influence between the components is shown by the arrows. The components and their subcomponents are discussed below.

Components of the System

Environment

The environment is defined to include variables which might significantly affect other variables in the system but which are not likely to be significantly affected by the specified outcomes of the system over the period considered. There is a sharp disagreement among scholars as to how much emphasis must be laid upon environmental variables in explaining the process of economic development.[10] The

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[10]This disagreement is illustrated in the following quotations from Myrdal and Schultz. In Myrdal's opinion, "To engender and accelerate development, induced changes in all social conditions and relations must be assumed to be instrumental or even to play a strategic role in the cumulative causation of a development process." G. Myrdal, Asian Drama, Vol. I, Pantheon, New York, 1968, p. 43. In Schultz's opinion, "Since differences in profitability are a strong explanatory variable (related to farmers' acceptance of new agricultural factors), it is not necessary to appeal to differences in personality, education and social environment." T.W. Schultz, Transforming Traditional Agriculture, Yale University Press, New Heaven and London, 1965, p. 164.

point of view adopted in this study is that economic profitability is necessary but not sufficient for explaining the likely rate acceptance of new factors among Eastern Quebec dairy farmers. The analysis therefore proceeds under the assumption that the relationship between changes in controllable inputs and changes in the profitability of dairy farming in the region is important but must be studied within the context of the given environment. For instance, the short length of the growing season must be considered as a major factor limiting the range of alternative enterprises feasible for a local dairyman. There are other less apparent socio-economic and ecological factors which might also partly explain the rate of acceptance of new dairy practices among the regional dairy farmers. Aside from the most apparent ecological limitations faced by the local dairymen which are taken into account, no attempt is made in this study to quantify the relationship between environment variables and the other variables included in the model.

Uncontrollable Inputs

The uncontrollable inputs consist of variables which are subject to changes mostly as a result of decisions taken by policy decision-makers at either the provincial or the national levels. Price support policies for dairy products and manufacturing milk subsidies are known to affect the profitability of regional dairy farming in both the short and the long run. It is highly improbable that these policies will be regionalized in the foreseeable future. Hence

the rationale for introducing them as constraints in the model.

Controllable Inputs

The controllable inputs include variables which can be changed by the local dairy farmers or by the authorities responsible for implementing the regional development plan. They are arbitrarily divided into publicly controllable variables, privately controllable variables and mixed variables. The publicly controllable variables (farm consolidation program, community pasture program and other programs recommended in the plan) comprise policies which might affect the total supply and thus the relative prices of agricultural resources in the region in the near future. The privately controllable group is intended to include management decisions (feeding practices, dairy stock replacement practices and other management practices) taken and carried out by the dairy farm operators themselves. Finally, dairy input and output prices are classified as mixed variables because they are generated through the interaction of supply and demand forces, both of which are affected by current government policies and the local farmers' decisions.

Core Component

The core component of the system is a dairy farming enterprise which includes dairy related crops. Other agricultural enterprises which are commonly found on the regional farm operations reporting dairy enterprises are not considered in the study.[11] For this

[11]See p. 40 for information on these enterprises.

reason the model cannot be used to answer questions relating to the problems of resource allocation on a farm between enterprises. The model can be used, however, to answer questions relating to the profitability and productivity of resources allocated to either dairy-related crop enterprises or the dairy farming enterprise itself.

Outcomes

The net cash income accruing to the dairy enterprise is the determinant of growth of the enterprise in the model. This specification rests upon the assumption that the operator whose dairy enterprise is analysed is striving to increase profits rather than for other objectives. An example of another objective would be if a farmer who placed a premium on relatively high average herd production were attempting to establish a reputation favorable to later sales of breeding stock. Such cases of other objectives are believed to be exceptional.

In the model used in this study, the objective function specifying the expected behavior of the farmer consists in equating the marginal cost of feed to the marginal value of the product (milk) for each cow. Feed costs are computed at a level of output most profitable for each cow. The average yearly production per cow is therefore obtained. It provides an additional measure of the performance of the herd over time. For reasons which will be explained later, it was not possible to estimate the net profit of the dairy enterprise. A gross margin approach is therefore used in the study. It must be emphasized

that the changes in the capital requirements which are estimated are exclusively due to improvements or increases in herd sizes. The costs of financing additional equipments and buildings were not estimated. The rate of return on these investments cannot therefore be obtained in this study.

The Logic of the Model

The accompanying generalized flow chart shows the steps of the simulation model (Figure 7). The first computer operation is to read and store data describing the experiment. In the next operation, feed costs are calculated at levels of milk output most profitable for each cow. Feed quality characteristics of the herd at the start of the analysis, costs of feeds and other inputs and prices of milk and inputs are part of the information provided by the surveyed farmers.

The next operations result in computation of net cash income projections for each replacement heifer. Although this is done by the same program steps as those mentioned above for computing net cash income from cows it is shown on the flow chart as separate steps for simplicity of exposition.

System Specifications

The specific model upon which this analysis is based is "A Simulation Technique for Making Management Decisions in Dairy Farming," by Robert F. Hutton.[12] The model itself is fully described by Hutton.

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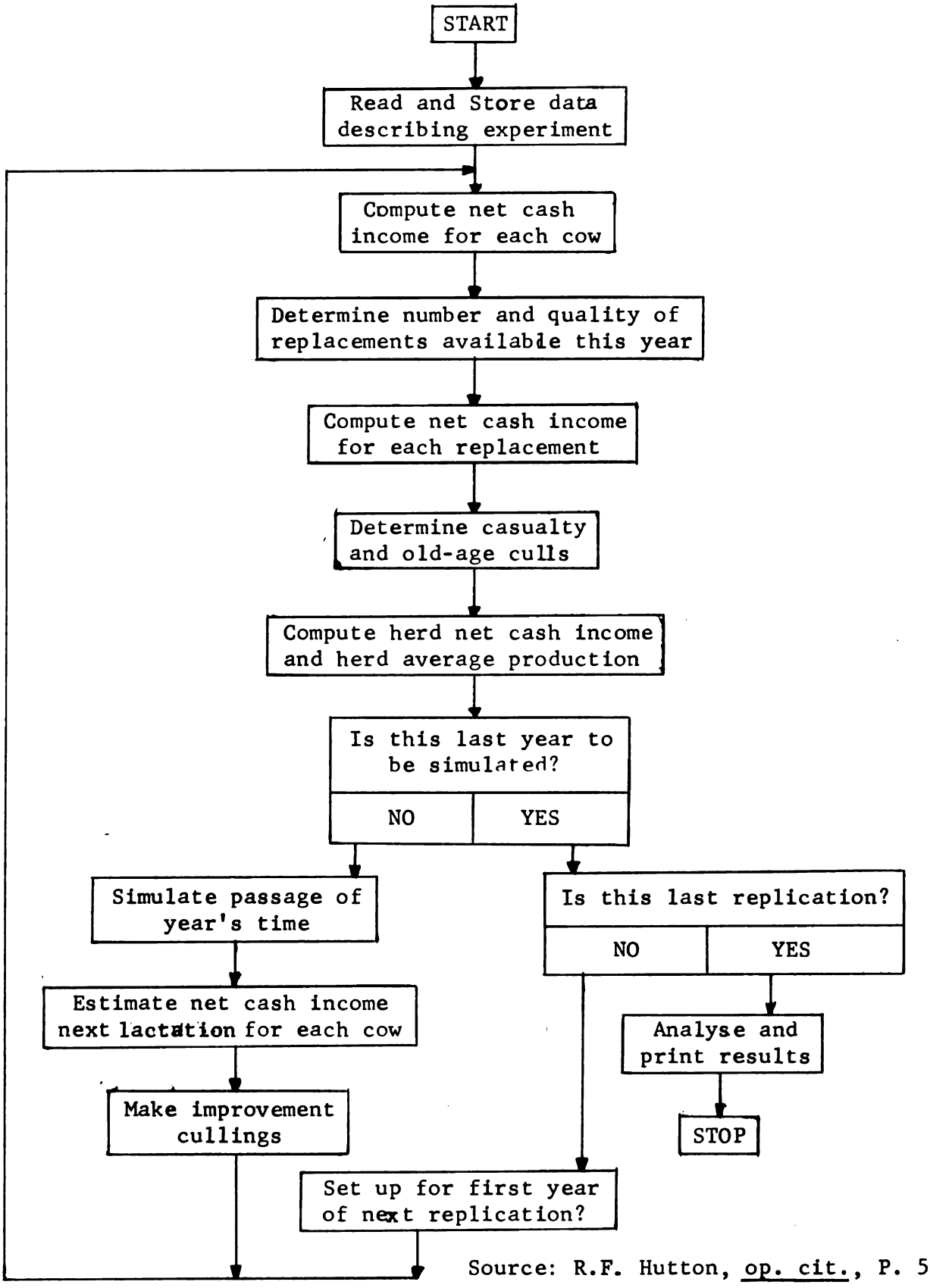
[12]Robert F. Hutton, op. cit.



Source: R.F. Hutton, op. cit., P. 5.

FIGURE 7. Generalized Flow Chart for Simulation Model.

Very limited knowledge of computer programming is required for complete understanding of its logical sequences. This section is directly adapted from Hutton's report.

The sequences of operations which the model performs are essentially the following. Each dairy cow in a pre-specified herd-- the specifications having to do with age and annual milk production of each cow--is submitted to a series of tests. Test one determines, on the basis of information on length of the lactation period, rations fed, price of milk and cost of feed, the most profitable level of production of each cow. The annual production level sought from each cow is that at which the marginal cost of feed equals the marginal value of the product (milk). In test two, the probability of a cow having a heifer calf during the year considered is computed. This is a joint probability based on the herd's calving rate and the probability of the calves being female. The program is based on a 50 per cent probability of each cow dropping a heifer calf. It must be pointed out that, before a cow is considered a prospect for producing a replacement heifer, she must pass the test for age and production potential. All heifer calves from eligible cows are considered eligible for replacements in the model.[13]

In the third and final test, each cow in the pre-specified herd

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[13]Two measures of production capacity are associated with each heifer. One measure consists of what the operator would normally expect a heifer of her parentage to have. The other consists in the actual or effective production capacity derived by a random selection process. Actual or effective production capacity is treated in the model as being that drawn from a population having an average equal to the heifer's expected production capacity. Variability in the quality within this population is derived from data characterizing the experiment analysed.

is exposed to being culled by reasons of old age, low production, death, disease or other causes. The probability of loss from each cause, which is specified in each experiment description, constitutes the basis according to which each cow is either culled or kept in the herd. Cows removed by culling are either replaced by heifers previously raised on own farm (at some specified cost) or by purchased replacements, depending upon the general strategy followed by the operator. The heifers with the highest expected productivity available in a given year are used for replacing culled cows. Any remaining heifers may be used to replace additional cows in improvement culling and increase herd size if the experiment provides specifications for the latter objective.

After replacement of culls, net income[14] from the dairy herd and average milk production per cow are computed for each year. Effects of improvement culling are not reflected until the following year sequences are simulated.

As we already pointed out, the model can also be used to run an experiment where all replacements are bought. The production capacity of purchased heifers can be specified in either of two ways in the model. On the one hand, one can use the model to analyse conditions where all animals available for purchase are expected to have the same production capacity and therefore the same price, except for age adjust-

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[14]Defined according to model user's specifications of costs or items claiming a share of gross income generated by the dairy enterprise. The net cash income concept is used in this study.

ment. On the other hand, one can use the model to analyse conditions where replacements can be bought from a market having various quality classes. In this case, the segment from which a replacement is purchased is chosen at random with its chance of being selected proportional to its relative importance in the total population of replacement animals available for purchase.

The sequences of operations which were previously described are performed according to certain rules or functional relationships. For instance, one of the most important set of functional relationships involved in this model has to do with the determination of feed requirements. Its importance stems from the fact that the objective function specifying the expected behavior of the farm operator consists in equating the marginal cost of feed to the marginal value of the product for each cow. In the model feed requirements for dairy cows are computed in four steps. First, the maintenance requirement specified as a function of weight of the cow is assumed to be 0.8 pound of TDN (Total Digestible Nutrients) per cow per day. Second, growth requirements are allowed for cows in their first and second lactation periods. This specification is based on the fact that cows of most common breeds do not reach their full growth potential until their third or fourth lactation. For cows in their first and second lactation, the assumed growth requirement is 660 and 300 pounds of TDN, respectively. Third, TDN requirements for gestation are also a function of weight of the cow. The dairy allowances for gestation, which are presumably fed during the last two or three months of gestation, are assumed to range

from 5.5 pounds of TDN per day for cows weighing less than 800 pounds to 7.0 pounds of TDN per day for cows weighing 1,100 pounds or more. The total herd requirements for gestation are adjusted, in this model, by the ratio of calves per cow per year. In this analysis an 87 per cent calf crop is considered. Fourth, TDN allowance for milk production is estimated according to the following quadratic function;[15]

$$Y = a + B_1 X + B_2 X^2$$

where:

Y = TDN per pound of milk,

X = pounds of milk per cow per day,

a = .306 (a predetermined coefficient)

B_1 = .00057 (a predetermined coefficient)

B_2 = .0000053 (a predetermined coefficient)

For the sake of brevity other details of the model are not described in this study. They are technical steps involving translation of the model sequences into computer language.[16]

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[15]The reasoning and evidence to support the function as well as the estimated values of the coefficients are reported by R.S. Adams, R.F. Hutton, and D.N. Putnam, "Improved Method of Electronically Computing Grain Feeding Requirements for Individual Cows," Journal of Dairy Science,46: 10174, October, 1963. These requirements vary slightly from those reported later by J.T. Reid, P.W. Moore, and M.R. Tyrred, "Symposium: Re-evaluation of Nutrient Requirements for High Producing Cows, Energy and Protein Requirement of Milk Production," Journal of Dairy Science, No. 2, February, 1966. For instance, for a cow producing 6,000 pounds of milk in a 300-day lactation, the former function would set Y = .32834 whereas the latter function would set Y = .332. It appears that the slight difference between the two estimates can be partly attributed to the fact that some characteristics of the cows studied differ substantially from one group to the other. Reid et als. point out that, for smaller cows, the TDN requirements would be

Assumptions for this Simulation Model

The system to be described is intended to represent a dairy enterprise operating within the regional economy of Eastern Quebec. The core of the system thus consists of certain characteristics of the dairy enterprise to be simulated. The purpose of this analysis is to have the dairy enterprise subjected to changing circumstances as specified by the different economic conditions which the typical regional dairy farmer might face in the future if some specific sets of policies were implemented.

Certain basic assumptions are made at this juncture to limit the scope of the model. These assumptions are the following:

(1) the net milk price received by the dairy farmer will remain fixed throughout the period simulated (1969-75) for any

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greater than those that were estimated in their study. The absence of similar research on dairy herds meeting specifications that would be comparable to those characterizing the type of cows most commonly found in Eastern Quebec prevents us from further commenting on the appropriateness of either one of these estimates. The Adams group's function as well as their estimated coefficients are used in this study for the following reason. The Adams group's function yields TDN allowance requirements for milk production that are slightly higher than those generated by using the Reid group's function, and thus more likely to reflect the true requirements of the small type of cows most frequently found in the region. Our own estimates of the average milk production per cow on the farms that we surveyed provide a basis for determining whether the simulated milk output per cow constitutes a plausible outcome for the real system under study.

[16]The reader who is eager to understand this model in its fullest details should read Hutton's report. Hutton explains the model step by step by using both narrative statements and a flow chart. The computer program which corresponds to this model as well as the results generated in the several computer runs made for this analysis are available from the author upon request.

given experiment simulated;

(2) the input prices will remain constant throughout the period simulated for any given experiment considered;

(3) land will be available to the operator if and when needed at the price level now prevailing the region;

(4) the cost of purchasing dairy-related crops from neighbor farmers reflects the true opportunity cost of resources devoted to their production on the operator's own farm;

(5) the operator of the dairy enterprises which are to be simulated have a certain capital fund to start with;

(6) the cows which will be used as replacements will have general characteristics which do not significantly differ from those describing the original herds;

(7) there will be no significant change in either the type or the quality of feeds fed to dairy cows over the simulation period for any given experiment;

(8) the level of technology specified for any given experiment will remain fixed over the simulated period;

(9) the manager has the ability to manage the particular sizes of operation considered in this analysis.

Assumption (1) automatically excludes the possibility of net (at the farm) milk price varying from year to year for any given operator.[17] Assumption (2) does not exclude the possibility of temporal

[17]Includes net market price plus net government subsidy.

shifts in either the supply functions of or the demand functions for dairy inputs in the region over the period considered. It corresponds, however, to predicting that these shifts will be self-compensating in the sense that all macro equilibrium points, for any given relevant input market in the region, will lie on a straight line which is perpendicular to the price axis.

Assumption (3) merely restates one objective of the regional development plan, which is to insure that most farmers eager to expand their current acreage will find the land they need at a reaonable price. A substantial amount of discussions spread throughout the planning documents indicates that the cost of the services of land for agricultural purposes might remain fairly stable in the region if the farmers' retirement policy is successful. It must be pointed out, however, that the planners' conclusion concerning the future regional trend in the price of agricultural land is tentative. For this reason, this assumption is relaxed at a later stage of this analysis in order to determine how sensitive the output of this model is to changes in the cost of land.

Assumption (4) asserts that the cost of purchasing hay (or some other dairy-related crop) in the region at any given time is equal or almost equal to the real resource costs that its production entails on any typical dairy farm in the region.[18] In other words, the cost of purchasing hay (or some other dairy-related crop) in the region is treated as a reasonable proxy variable for its total average cost

[18]More specifically, price of purchase minus transportation and handling costs.

of production on any given farm. This assumption allows us to circumvent the intractable problem of estimating the costs of production of dairy-related crops in the region. It must be pointed out that the use of acquisition price as a proxy for cost of production excludes the possibility for dairy-related crop enterprises to generate net returns since all costs, including the cost of capital, are supposedly included in or at least reflected by the market value.

Assumption (5) is self-explanatory. It is recognized that getting hold of additional capital funds is often one of the most crucial problems faced by farm operators. We do not intend, however, to deal with this problem in this study. It is therefore assumed that the representative dairy farmer has access to enough capital funds or credit to finance whatever dairy herd expansion strategy he might wish to follow.

Assumption (6) is compulsory since some of the coefficients (such as size of cows, and fat content of milk) which need to be included in the model depend upon the type of dairy breed considered. Relaxing the assumption of herd homogeneity over time would yield doubtful results. For this reason, it is assumed that the mixed-bred cows so commonly found in the region, or other breeds having the same general characteristics, will continue to prevail in the region in the foreseeable future.

Assumptions (7) and (8) imply that feeding rations and technologies of either the dairy enterprise or of dairy-related crop enterprises can be varied from one simulated experiment to another. Once the conditions of an experiment are specified, however, these factors will not be

allowed to change over the period simulated.

Data Used in Simulated Experiments

Two types of information are required in this analysis. These are the functional relationships and the initial conditions. The functional relationships are built into the model itself. They consist of the relationships among the variables. Most of these relationships were previously discussed.[19] The second type of information is that which is used to set up appropriate values for the variables when you begin a particular simulated experiment. This information includes the following: (1) age and production level of each cow in original herd, (2) quality of forage normally fed, (3) cost per ton of forage and concentrate, (4) length of lactation, (5) nonfeed costs per cow, (6) casualty culling rates, (7) interest rate on capital (8) reservation use of income, (9) milk price, (10) cost of raising replacements, (11) price of culls and calves sold, and (12) cost of buying replacements.

Since the model is to be used to answer real world problems, it is essential not only that the assumptions be realistic but also that information fed into the computer accurately reflect the real world situation described. Most of the data which are presented in the following pages are drawn from the survey that was conducted in the region in the summer of 1969.[20]

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[19]See pp. 161-165.

[20]See Appendix A for methodological considerations on the design of the survey.

Before summarizing the survey results it is necessary to emphasize the following considerations. First, the data used are limited to those obtained from farms which milked ten cows or more and whose herds were entirely made up of mixed-bred cows. Second, those farms which meet these two requirements are divided into two groups on the basis of the number of cows that they were milking in July 1969. This is done because evidence presented in the previous chapter indicated that a number of important variables such as yearly production per cow might be related to herd size. Therefore a representative dairy farming enterprise is synthesized for each group.

Size and Composition of Simulated Herds

The distribution of respondents according to herd sizes is given in Table 38. One respondent out of two reported dairy herd sizes varying from 13 to 21 cows and one respondent out of three reported herd sizes varying from 16 to 18 cows. Slightly less than half of the respondents reported herd sizes larger than 21 cows. The shape of this distribution led us to divide the respondents into two groups. Group 1 comprises the 43 farms reporting 20 cows or less whereas Group II includes the 25 farms reporting 21 cows or more. The average herd size was found to be 18 cows in Group I and 25 cows in Group II. From now on, for the purposes of the model, we shall refer to the two sizes of farms as farm I and farm II respectively.

The respondents were asked to classify their milk cows by age and production in 1968. The answers to this question are used to

estimate the percentage distribution by lactation number and annual milk production of the mixed-bred herds reported by the respondents (Table 39). From these data the two hypothetical herds are synthesized. They can be referred to as representative herds since they represent the average characteristics of cows in the respondents' mixed-bred herds.

It is interesting to note that the average characteristics of cows differ somewhat from one group to the other. First, the respondents who milked 20 cows or less have more old cows (lactations 6 to 10) than the respondents who milked 21 cows or more. Second, the yearly yields of each cow are somewhat less widely spread in the former group than in the latter. Third, herds in the former group are slightly less productive, on the average, than in the latter group.[21]

TABLE 38. Distribution of Herd Sizes on 68 Farms, Eastern Quebec, 1969.

Herd Sizes	Proportion of Farms reporting given herd sizes[a]
	(per cent)
10 to 12 cows	7.3
13 to 15 cows	13.3
16 to 18 cows	30.9
19 to 21 cows	16.1
22 to 24 cows	10.3
25 to 27 cows	11.8
28 to 30 cows	3.0
31 to 33 cows	4.3
34 or more cows	3.0
	100.0

Source: Eastern Quebec Dairy Farms Survey, 1969.
[a]The mean herd size for all 68 respondents is 20 cows.

[21]No statistical tests were carried out to determine whether or not these differences in herd characteristics from one group to the other are statistically significant.

TABLE 39. Composition of Herds With Respect to Age and Milk Production per Cow on 43 Small Herds and 25 Large Herds, Eastern Quebec, 1969.

A. Small Herd Group (20 cows or less)

Annual milk production[a]	Lactations[b]				Total
	1 and 2	3 to 5	6 to 8	9 to 10	
(pounds)	--	per cent		--	
4,000	1				1
5,000	9	7		3	19
6,000	18	4	8	8	38
7,000		17	14	1	32
8,000		5	2	2	9
9,000		1			1
10,000					--
Total	28	34	24	14	100

B. Large Herd Group (21 cows or more)

Annual milk production[c]	Lactations[d]				Total
	1 and 2	3 to 5	6 to 8	9 and 10	
(pounds)	--	per cent		--	
4,000	5	1			6
5,000	6	2	1	1	10
6,000	12	12	2	2	28
7,000	9	10	11	4	34
8,000	3	4	3		10
9,000		2	2	3	7
10,000		3	2		5
Total	35	34	21	10	100

Source: Eastern Quebec Dairy Farms Survey, 1969.

[a]Mean annual milk production per cow in small herds is 6,320 pounds of milk per year.

[b]Mean lactation of cows in small herds is 5.

[c]Mean annual milk production per cow in large herds is 6,700 pounds of milk per year.

[d]Mean lactation of cows in large herds is 4.

It is common knowledge among dairy scientists that the dairy cow gains and then loses productivity as she grows older. Indexes of how production normally varies by lactation are available for common breeds of dairy cows. By combining the information on the characteristics of respondents' cows which is presented in tables 39A and 39B, it is possible to estimate age conversion factors for this particular mixed-breed (Table 40). These estimates are comparable to standard age conversion indexes developed by dairy scientists.[22]

Other Dairy Herd Characteristics

The respondents were asked the average length of a lactation (in days or months) in their herds. The average lactation length was a little less than nine and one half months (280 days) on farms in group I and little less than ten months (290 days) in farms in group II.[23]

The respondents were also asked to estimate the average body weight of the mature cows in their herds. The average body weight of mature cows was 1,050 pounds (standard deviation = 101 pounds) in group I herds and 1,080 pounds (standard deviation = 85 pounds) in group II herds.

Quantity, Quality and Price Specifications for Feed

Characteristics of feeds that determine the quality of dairy rations may vary not only from area to area but also from farm to farm within the same area. The characteristics of the hay, silage and pasture fed and their relative contribution to the total ration, as well

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[22]Age conversion factors for mixed-breeds which are almost identical to those estimated herein can be found in J.M. Wing, Dairy Cattle Management: Principles and Applications, Reinhold Publishing Corporation, 1963, pp. 337-38.

[23]More specifically, those estimates are 9.3 and 9.7 months respectively. Standard deviations are .74 month for group I and .79 month for group II.

TABLE 40. Factors for Conversion of Records of Milk Production to the Mature-Equivalent Basis for Mixed-Bred Herds in Eastern Quebec.

Lactation Number	Conversion Factor
1	1.25
2	1.15
3	1.07
4	1.02
5	1.00
6	1.00
7	1.00
8	1.03
9	1.06
10	1.10
11[a]	1.15
12[a]	1.25

Source: Eastern Quebec Dairy Farms Surveyed, 1969.

[a]Extrapolated.

as the composition and nutritive value of the concentrates fed determine the composite quality of a ration. Quality can also be associated with palatability. A cow will usually eat a larger proportion of a high quality ration than a poor quality one.

Four feeding rations are considered in this study. It must be pointed out that these feeding rations may not (and probably do not) cover the full range in feeding practices that are found on Eastern Quebec dairy farms. The first three feeding levels are directly derived from the survey results which are summarized in Appendix D. The characteristics of the four feeding rates for use in the model are specified in Table 41. The fourth feeding rate which is designated as "hypothetical" is intended to represent a set of plausible ration specifications on regional farms where (1) oats would be harvested as silage rather than as grain and (2) hay would be artificially cured to lower its moisture content after harvesting. The fourth feeding ration thus differs in composition from the first three.

Feed prices can be considered as the market value of the feed or the farm costs of producing it. Under normal environmental conditions, the market value of the feed might be viewed as the upper limit of feed costs. If feed production costs on a farm were significantly greater than its acquisition cost, there would be no economic justification for the farmer in producing his own feed. In this study, the market value concept is used to estimate feed costs.

The respondents were asked how much it costs them to buy a ton of hay in their community. Seven respondents answered $15 to $18,

TABLE 41. Specifications for Four Dairy Rations Considered in this Study.

Item	Feeding Rates			
	Low	Medium	High	Hypothetical[g]
1. Maximum daily intake:[a] (lbs. of dry matter available per 100 lbs. of body weight.)	2.4	2.6	2.8	2.8
2. Minimum intake of forage[b] (lbs. of hay equivalent per 100 lbs of body weight).	1.0	1.0	1.0	1.0
3. Percent of forage TDN fed as:[c]				
Hay	85	85	85	50
Silage	-	-	-	35
Pasture	15	15	15	15
4. Dry matter percent of fed weight[d]				
Hay[d]	85	85	85	90
Silage	-	-	-	30
Pasture[e]	30	30	30	30
Concentrate mixture[f]	85	85	85	85
5. TDN percent of feed (fed weight)				
Hay[d]	40	40	40	40
Silage	-	-	-	15
Pasture[e]	15	15	15	15
Concentrate mixture[f]	70	70	70	70

[a]This is intended to represent a maximum total intake of dry matter. It is highly probable that the actual intake would be less than the quantity specified herein since losses in handling and storage are not substracted from feed apparently available. The low, medium and high estimates for annual feeding rates per cow correspond to the figures appearing on lines two, three and four of Appendix Table 2. Note that the lower limit of each relevant class interval of grain mixture fed is used to indentify concentrate feeding levels. These apparent annual feeding rates per cow are then converted to apparent quantities of dry matter fed by multiplying each component of the above rations by their percentage of dry matter content as specified in item 4 of this table. The results obtained are then multiplied by .9 to express quantity fed into apparent quantity consumed (see footnote c of Appendix, Table 2).

(Table 41 continued)

These results are finally divided by 3,650 (365 x 10) in order to convert annual figures per cow into daily figures per hundred pounds of body weight.

[b]It is assumed that the smallest intake of forage that a regional farmer would feel safe in feeding is one pound of hay equivalent per 100 pounds of body weight per day.

[c]Derived from respective annual feeding rates specified in footnote a) adjusted for TDN percentage of specific ration components as described in item 5 of this table.

[d]In view of the relatively high probability of weather's adverse effect on the quality of hay in Eastern Quebec, the values presented here are somewhat lower than values reported for medium-quality hay harvested under ideal conditions. Kind of hay, stage of maturity and weather conditions during harvest, among other things, are known to affect its TDN analysis. A large proportion of the seeding used in Eastern Quebec is a mixture of clover (red and alsike and millet hay). The values shown here for dry matter and TDN contents may be conservative compared to average compositions reported by F.B. Morrison (Feeds and Feeding, 22nd Edition, The Morrison Publishing Co. Ithaca, New York. 1956, p. 1016), but they do represent, in our opinion, a quality range which may reasonably be expected in Eastern Quebec.

[e]The values shown here may be conservative.

[f]Mostly oats fed as grain. The values shown here are conservative compared to average found in F.B. Morrison (op. cit., p. 1058).

[g]This specification is intended to represent an improved feeding practice which would correspond to a shift from oats fed as grain to oats mainly fed as silage. It has been argued that production of total digestible nutrients can be substantially increased for oats when they are harvested as silage rather than as grain (see C.R. Hoglund, and R.O. Olson, "Research Problems in the Economics of Forage Production and Utilization", Published in C.R. Hoglund et als., op. cit., p. 78). The dry matter content and the TDN contents specified for silage are for oats with molasses added. Again the values shown here may be conservative. Furthermore, the dry matter content for hay is increased to 90 per cent. This is intended to represent the range of dry matter content that might be expected by a regional farmer using artificial cool-air drying for hay.

fifty-six answered $20 and five respondents answered $25. The acquisition price for hay is therefore estimated at $20. It has been argued that the cost of purchased hay laid down at the barn door may exceed its market price by more than a fourth.[24] In this study, it is assumed that the cost of purchased hay delivered on the buyer's farm does not exceed its market price by more than a fourth. It is therefore estimated that a ton of hay costs about $15 to produce on a typical regional farm at the present time.[25]

The respondents were also asked how much they have to pay for renting one acre of pasture land in their community at the present time. The average answer is estimated at $3.90 (Standard deviation = $0.93). On the basis of this figure a plausible pasture market value in terms of utilized hay equivalent is estimated at approximately $6 per ton in the region.[26]

It was not possible, for several reasons, to directly estimate the market value of feed oats in the region. Historically, the price of a ton of feed oats has usually been 2½ to 3 times as much as the price of a ton of hay in most dairy areas of Canada, under normal weather conditions. Assuming a three to one ratio for Eastern Quebec the net

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[24]G.L. Johnson, and L.S. Hardin, Economics of Forage Evaluation, Purdue University, Station Bulletin 623, April, 1955, p. 5.

[25]This seems reasonable in view of the facts that suitable agricultural land sells for about $50 per acre in the region and that the services of part-time labor normally can be bought at about $1 an hour.

[26]The formula used for this conversion is the following:

$$\frac{3.90}{\text{normal pasture yield per acre}} \times \frac{\text{TDN content of hay}}{\text{TDN content of pasture}}$$

where = normal pasture yield = 1.8 tons per acre and dry matter content of hay and pasture are 40 and 15 per cent respectively.

(at the farm) market value of a ton of oats in the region is about $45 at the present time.[27]

Most regional dairy farmers are also marginal buyers of protein supplements. Despite likely differences in both the quality and the composition of these protein supplements, the range of prices paid by local farmers appears narrow. Some 34 per cent of the respondents said that they currently pay $80 per ton for purchased concentrates while 54 per cent of the respondents said they pay $85 per ton.

Specifications for Replacements, Culls and Calves

The respondents were asked to determine the quality (in terms of yearly mature-equivalent production capacity) of replacements they might reasonably expect if they were to raise them from calves from their own herds. The results indicate that the average respondent in group II has slightly higher expectations than the average farmer in group I (Table 42). The results also indicate that the spread of quality replacements expected by the average respondent is wider for group II than for group I. These estimates are consistent with the

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[27]Yearly average price for feed oats was $0.92 per bushel (Canadian Wheat Board Price, basis in store Fort Williams - Port Arthur in 1968 or approximately $57.50 per ton). Assuming that the regional dairy farmers can buy it at this price (delivered to his farm) in his community --which is plausible in view of the Canadian Feed Freight Assitance Policy (see pp. 84-85)-- this would imply that transportation and landing costs from local suppliers to farmers amounts to about $12.50 per ton. These figures seem realistic. The fact is that most regional farmers produce their own feed oats, which is consistent with the figures presented herein.

previously specified herd characteristics (Table 39).

An important economic factor which must be considered in the farmer's decision relative to the replacement of the cows presently in his herd is the cost of either raising or buying the replacements. Since it was not possible to obtain relevant information on the costs of raising heifers in the region, the decision was made to use the market value of 2 to 3-year old culled cows as a proxy variable for cost of raising replacements in the region. This figure was obtained by asking the respondents how much they received last year for the sale of the 2 to 3-year old cows that were culled because their milk production capacity was considered unsatisfactory. Eleven respondents reported having sold such animals for an average price of $165.[28]

Since no information on the apparent production performance of cows raised on the proposed specialized dairy stock farms is yet available, there is no alternative but to assume a probability distribution for the expected quality of these animals. The results of simulated experiments involving a buying-replacement-strategy are therefore predicted under the assumption that, out of 100 heifers bought from the specialized dairy stock raising farms, 25, 50 and 25 might be

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[28]Various studies done in the United States indicate that feed and non-feed costs might respectively account for about 60 to 70 and 40 to 30 per cent of total costs involved in raising dairy heifers to first lactation. Assuming that a typical heifer is fed 1,300 pounds of concentrate, 4 tons of hay equivalent and 400 pounds of milk in the region before reaching her first lactation period, then the feed costs alone would be approximately $106 whenever feed inputs are valued at their market price (that is $4.20 per cwt. for milk, $45 per ton for oats and $15 per ton of hay). The ratio of 106/165 is equal to .64.

TABLE 42. Expected Production Capacity of Heifers Raised from Respondents' Own Herds for Farm Groups I and II, Eastern Quebec.

Yearly level of production class[a]	Percentage of replacements expected to be in specified class	
(pounds)	Group I herds[b] (per cent)	Group II herds[c] (per cent)
less than 5,000	6.5	8.0
5,000 - 5,999	26.1	22.0
6,000 - 6,999	32.3	28.8
7,000 - 7,999	29.3	24.8
8,000 - 8,999	5.8	13.2
9,000 - 9,999	-	1.6
10,000 or more	-	1.6
	100.0	100.0

Source: Eastern Quebec Dairy Farms Survey, 1969.

[a]Mature-equivalent basis.

[b]The average heifers in this distribution would produce approximately 6,500 pounds of milk per year.

[c]The average heifers in this distribution would produce approximately 6,800 pounds of milk per year.

expected to respectively fall within 7,000-7,999, 8,000-8,999 and 9,000-9,999 mature-equivalent production classes.[29] The average annual price

[29]The range of this hypothetical distribution may look narrow when compared to the variations in dairy breeding performances reported by the respondents (Table 42). This specification is purposedly introduced herein to reflect the fact that improved breeding efficiency might contribute not only to raise average production capacity of cows but also to standardize their expected performances. For instance, it is common knowledge among dairy scientists that the season of calving has a marked effect on total production of milk during a lactation. Cows calving in the fall tend to achieve greater production performances than cows calving in the spring. For this reason among others, 100 heifers raised on the specialized dairy stock raising farms (where fall calving will be practiced) and more likely to achieve comparable production performances than 100 heifers raised on farms where calving periods might differ to some extent.

for purchased replacements falling within this production capacity range is set at the level suggested by the planners ($250). This price will alternatively be set at $200 to analyse the impact that a $50-subsidy per head might have on the profitability of the two synthesized farms.

The final breeding strategy which is considered in this study consists of using artificial insemination (A.I.) on the two synthesized farms. Respondents estimated that A.I. services cost $5 per cow in the region.

It was not possible to obtain relevant information on how much progeny testing and preferential use of superior sires might reasonably be expected to raise the merit of commercial dairy cattle in the region. There are valid reasons to believe that in many countries with advanced dairying the merit of dairy cattle has been raised by artificial insemination, but there are few firm calculations to show how much. Estimated milk production differences between artificially and naturally-sired herdmates vary considerably among the few studies which are available. Estimates ranging from 90 to 240 pounds of milk per year are reported by Kucker and Tucker for North Dakota, South Dakota and Nebraska whereas estimates as high as 500 pounds of milk per year have been reported concerning the superiority of artificially inseminated dairy stock in New Zealand.[30]

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[30] W.L. Kucker and W.L. Tucker, The Influence of Artificial Insemination in the Midwestern States, paper presented at the A.D.S.A. Meetings, Ithaca, New York, June 27, 1967, p. 5, and I. Michael Lerner and H.P. Donald, op. cit., p. 143

All experiments considered in this study that involve the use of artificial insemination as a means of improving the production capacity of regional dairy herds are simulated under the assumption that, on the average, heifers from artificially sired cows would be superior to naturally sired heifers by the equivalent of 200 pounds of milk per year. In view of the results presented in the New Zealand study, this assumption is conservative.[31]

Other Information on Prices and Herd Characteristics

Net milk prices received by individual producers in the region vary slightly depending on their seasonal production, their base quota, the relative prices for fluid and manufacturing milk.[32] The effective annual net price can thus be interpreted as an average blend price. The average net market price received by the respondents for the year ending in the spring of 1969 is $3.25 per cwt. (standard deviation = $0.075). The net subsidized price of 3.5 per cent FCM effectively received by the local producer is thus estimated to be (1) $3.25 plus $0.99 per cwt. (manufacturing milk subsidy) or $4.24 for deliveries to quota, and (2) $3.25 minus $0.52 per cwt. (hold back) or

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[31]Further discussion of this assumption will be presented in a section of the following chapter dealing with sensitivity analysis.

[32]Since the great majority of the regional milk producers sell their milk for manufacturing purposes, the influence of fluid milk price on the effective level of the blend price prevailing in the region can be considered marginal.

$2.73 for deliveries in excess of quota.[33] In this study, the weighted blend price (including the subsidy) received by a typical respondent is set at $4.20 per cwt. for the entire period simulated.[34]

The average fat content of the milk currently produced by the respondents is estimated to be 3.6 per cent. This information, combined with the estimated average length of lactation periods, can in turn be used to convert the previously specified levels of production of cows into standardized 4% FCM-305-day lactation annual production records. Standardization to 4% FCM is required for using Hutton's model. The conversion to 4% FCM does not need to be performed in this study since it turns out to be redundant.[35]

Other price variables which need to be specified in the model are the prices received from the sale of culled cows and less than two weeks-old calves. The net price received from the young calves is estimated to be $15. We also estimate that 87 per cent of the cows

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[33] See p. 113 for a brief discussion of the current Canadian milk pricing policy.

[34] There are basically two situations in which the total net price received by a typical regional milk producer might be expected not to deviate much from $4.20 in the foreseeable future. The first would correspond to a stable market price, gradual increases in quota allocations to local producers and subsidies remaining at the current level. The second instance would correspond to a gradual increase in market price (in the range of 3 to 5 per cent a year) with both quota allocations and manufacturing milk subsidies at the current levels. Other sets of circumstances might be expected to generate significant changes in the current total net price received by a typical milk producer in the region. What circumstances will effectively prevail is a matter of speculation since much hinges upon the future individual quota allocations and subsidies.

[35] Gaines' standard formula for converting actual dairy products records into standard 4% FCM-305-day lactation records happens to yield a conversion factor very close to 1 for the fat content percentage and the lactation lengths estimated in this study. See W.L. Gaines, The Energy Basis of Measuring Milk Yields in Dairy Cows, Illinois Agricultural Experiment Station, Bulletin 308, 1928, for a discussion of his conversion formula.

in the respondents' herd normally drop a living calf during a calendar year. The net price received from the sale of cow culled because of her low production record is estimated to be $135. In a real world situation, if a cow fails--that is if she must be removed from the herd for sickness, physical injury or death--she can either be sold for beef or removed from the herd because of death. The value of a cow culled because of death is assumed to be zero in this study. The value of a cow failing for any other reason is presumed to be $135.

Information on the percentage of cows yearly removed from herds was directly obtained from the respondents (Table 43). There may be some valid reasons for arguing that the figures might vary somewhat if replacements were purchased instead of being raised from respondents' own herds but relevant information is not available for determining how much.[36] It is therefore presumed that culling rates for various reasons are not likely to differ significantly between replacement strategies in the foreseeable future.

Additional information was obtained from the respondents concerning certain managerial practices. For instance, we estimate, on the basis of the answer to the questionnaire, that the average respondent, a) requires only one year of production record on a cow before considering saving her daughter for a replacement but, b) must keep a cow for three years before forming a definite opinion as to her production capacity.

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[36]For instance a dairy scientist might argue that the failure of an animal in a given lactation is likely to be significantly correlated with the butterfat level of the animal.

It is also estimated that the average respondent--among those who intend to increase the size of their herds-- thinks he can add two cows per year to his current herd size during the nest five years.[37] This figure does not differ by size of herd.

Other Information on Costs

It was not possible to obtain adequate information on investments and nonfeed costs from the respondents. With regard to investments, the pre-test on the queationnaire itself led us to believe that many respondents were unwilling to report values for their land, buildings, farm machinery and equipment. It was therefore decided to adopt a gross margin approach. The basic ideas of the gross margin method are briefly as follows: The costs related to the operation of an agricultural enterprise are put into two groups--variable, or direct cash costs, which vary with the size of the enterprise or the practices used and are relatively easy to allocate to enterprises--and the fixed, or overhead costs, which are relatively constant or fixed, and are often difficult to allocate to individual enterprises. The total variable costs of an enterprise can then be subtracted from the total returns to obtain the gross margin. Thus the gross margin basically represents the contribution of the enterprise toward covering the fixed costs and

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[37]Of the respondents who answered this question, 70 per cent believe that they can achieve this objective even if they raise all their replacements themselves.

TABLE 43. Estimated Percentage of Cows Removed from the Respondents' Herds for Various Reasons, 68 Respondents, Eastern Quebec.

Reason for Removal	Proportion of Cows Removed for Specified Reasons
	(per cent)
Sickness	3.1
Death	2.7
Low producer and/or too old	16.4
Other reasons	2.8
Total culling rate	25.0

Source: Eastern Quebec Dairy Farms Survey, 1969.

producing a return for risk and management.[38] According to Wright, "The principal advantages of the gross margin method are that (1) the effects of different methods of inputs in an enterprise are readily apparent in the gross margin per acre or per head, and (2) the effects of changing the acres of crops or number of livestock are clearly shown by the total farm gross margin (unless there is a change that alters fixed costs, which usually can be determined).[39]

[38]This description of the gross margin approach is borrowed from K.T. Wright, "Gross Margin Methods of Planning," published in Michigan Farm Management Handbook, assembled by L.J. Connor, et als, Agricultural Economics Report No. 35, Michigan State University, East Lansing, October, 1967, p. 1.

[39]Idem., p. 1.

The nonfeed variable costs of a dairy enterprise include machinery operating costs, miscellaneous expenses, electricity, interest and taxes on cows and land costs. Labor is often assumed to be a variable cost. However, it is a common procedure in farm accounting to treat the value of labor contributed by the operator and his family as a fixed cost and the value of labor contributed by hired workers as a variable cost. This procedure is adopted in this study. The nonfeed variable costs per cow are estimated to be $50 per cow.[40]

The additional specifications necessary for simulating experiments with the model are related to the technical aspects of the model itself. An enterprise period in dairying may be defined as the time from the beginning of a lactation to the beginning of the next. Hence, for dairy cows it is essentially equivalent to a year. The analysis is intended to cover seven years, that is from 1969 to 1975.[41]

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[40]The only consistent estimates of costs of dairy farm enterprises in Quebec are those collected by the Groupes d'Etude en Rentabilité Agricole. Recent estimates from this source for dairy farming enterprises located in the region of Nicolet are reported by Jacques Brossier, Décisions de Production et Offre de Lait au Québec: Analyse du Comportement des Producteurs Laitiers de la Région Agricole de Nicolet et Prévisions, Ministère de l'Agriculture et de la Colonisation, Service de la Production et de l'Aménagement, Bureau Régional No. 4, Nicolet, Unpublished Study, Nicolet, Quebec, Canada, December, 1969. He estimated that the average nonfeed variable costs per cow in the region of Nicolet was $58 per cow. Since the costs associated with agricultural land ownerships is smaller in Eastern Quebec than in Nicolet, this figure cannot be directly used in this study as a proxy variable without being adjusted downward. The adjustment is made according to the following formula.

$$D = I\,(P_{L_N} - P_{L_E})S$$

where:

Summary

This chapter described a simulation technique for estimating future milk production and gross margins of individual farms in Eastern Quebec under varying conditions. For the purposes of this study, computer simulation was defined as a system analysis tool which utilizes subject matter theory, certain mathematical structures, programming logic, and empirical analysis to condense a complex system into a mathematical formulation duplicating the essence of the real system.

Although the model used in this analysis is capable of producing information on many aspects of a dairy farming enterprise, special emphasis was laid upon simulating the operation of two representative regional dairy farms under various feeding and breeding practices. A certain number of assumptions were thus made in order to restrict the scope of the analysis. The most crucial assumption was that dairy input and output prices now prevailing in the region will remain at their current levels in the foreseeable future. Each experiment to be performed with the model was set up to determine what increases in gross margins and milk production per cow may reasonably be expected,

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D = difference in land costs per cow between the region of Nicolet and Eastern Quebec;
I = interest rate
P_{L_N} = price of agricultural land used for dairy farming in Nicolet;
P_{L_E} = price of agricultural land used for dairy farming in Eastern Quebec;
S = total acreage under crop per cow.
With P_{L_N} = \$90, P_{L_E} = \$50, S = 3 and I = 6 per cent, D is equal to \$ 7.20.

41This corresponds to the first planning horizon proposed by the gional planners, except for the starting year which is considered herein the current milk year commencing in April, 1969.

TABLE 44. Summary of Simulated Experiments.

Experiments		Description of Practices Identifying Experiments	
Farm I	Farm II	Feeding Practices	Replacement Practices
1	7	- current feeding rates retained	All replacements raised on own farm by natural service;
2	8	- increased feeding rates without silage	
-[a]	9	- increased feeding rates with silage	
3	10	- current feeding rates retained	All replacements raised on own farm by using artificial insemination;
4	11	- increased feeding rates without silage	
-[a]	12	- increased feeding rates without silage	
5	13	- current feeding rates retained	All replacements purchased from specialized dairy stock raising farms;
6	14	- increased feeding rates without silage	
-[a]	15	- increased feeding rates without silage	

[a]These experiments are simulated only for farm II. It is thus implicitly assumed that the current dairy herd size on synthesized farm I is too small to justify the investments needed for appropriate silage storing capacity.

over time, by a typical regional dairyman if he were attempting to increase his dairy herd size at a rate of two cows a year by following various practices for improving the production capacity of his cows and/or improving his feeding program. This is a growth objective which

was expressed by a large proportion of the respondents who intend to increase their herd sizes.[42]

Each experiment is intended to correspond to a plausible course of action that a regional dairyman might follow if certain combinations of regional dairy development strategies were implemented. Each experiment to be simulated with the model can therefore be identified by a combination of dairy feeding and replacement practices. Each combination of these practices can readily be read from Table 44.

It is now possible to summarize the data specifications for (1) each experiment considered, and (2) each one of the two synthesized farms simulated, by determining the input variables which were fed into the computer in each simulation run (Appendix E). Each synthesized dairy enterprise was simulated over the seven year period extending from 1969 to 1975. The results are discussed in the following chapter.

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[42]See chapter V, p. 139.

CHAPTER VII

Micro and Macro Implications of Alternative Strategies

Criteria for evaluating alternative dairy development strategies are discussed in this chapter. The simulated micro results are then presented as one basis upon which to evaluate the relative merit of alternative dairy development strategies. Sensitivity analysis of changes in key parameters or input variables is also explored, and attention is concentrated upon the strengths and weaknesses of the model. Finally the micro results are discussed in relation to the use of benefit-cost analysis for appraising alternative dairy program strategies.

Criteria for Evaluating Alternative Regional Dairy Development Strategies

In theory, the consequences of alternative regional dairy development strategies could be evaluated on the basis of several criteria. To decide among the available alternatives, the following questions need to be answered;

1) Which groups of dairy development programs might induce the most rapid rates of increase in profitability of dairy farming enterprises in Eastern Quebec?
2) Which group of programs has the highest benefit-cost ratio?
3) What is the ranking of the various alternatives in terms of total employment opportunities in regional agriculture?
4) What effects will alternative strategies have on the milk supply

and demand balance in Eastern Quebec?

5) What segment of the regional dairy farming industry is likely to benefit the most from the set of strategies selected?

Since the stated objective of the agricultural development programs proposed by the regional planners is to provide regional farmers with incentives to "set up profitable farming operations"[1], it is necessary to evaluate the consequences of some alternative programs with regard to the first question suggested above. This study is oriented towards that purpose.

The other questions which are raised above are not directly answered in this study. It is thought, however, that they must be considered by the policy decision-makers. For this reason the information generated in this study is used to raise issues related to those questions. It is hoped that the seriousness of these issues will encourage other researchers to explore their implications also.

The Farm Level Results of Alternative Strategies

The consequences of alternative strategies on the two simulated dairy enterprises are measured by three characteristics in each of the years over which the various projections are made. These are the dairy herd size, the net cash income to the herd and the average production per cow in the herd. In addition, the present value of the discounted net cash income to the herd for each experiment simulated with the model is estimated. This latter measure is used for ranking alternative strategies from the farmer's viewpoint.

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[1]Development Plan for the Pilot Region, op. cit., p. 40.

It must be emphasized at the outset that the projections of net cash income over the simulated period are not adjusted for changes in capital invested in new buildings, facilities and equipment. As pointed out earlier, it was not possible to obtain relevant information on anticipated capital needs to allow expansion in herd sizes.

The main objective of the various regional dairy development strategies considered in this study was to induce more rapid rates of increase in profitability and productivity of dairy farming enterprises than those which might otherwise be achieved by the regional dairymen. It is necessary therefore, to make a comparative evaluation of alternative means for promoting this objective by first examining the plausible performance levels that representative dairymen might reach without the new programs.

Trend Projections

The first experiments simulated can be interpreted as attempts to estimate the growth potentials of the two synthesized dairy enterprises under current conditions. Hence, table 45 presents the output of the experiments simulated when it is assumed that each farmer (1) raises all heifers from his own herd for replacements, (2) feeds his cows at current feeding rates, and (3) attempts to expand his herd size at a rate of two cows a year.

Farm I

The analysis shows a potential for increasing the number of cows from 18 in 1969 to 28 in 1975 while raising replacements on own farm by natural service. Milk production per cow could be increased from 5,774 pounds the

first year to 6,254 the seventh year through selective culling. These estimates are based on feeding the low feeding rate specified earlier in the study. The net cash income of the dairy enterprise would increase from $1,008 to $1,846 during the same period due to the increase in the herd size and the slight gains in milk production per cow. Taking into account the capital investments which would probably be necessary to achieve the projected increase in herd size (barn, milking facilities, equipment for dairy-related crop enterprises) it appears safe to conclude that the increase in the cost of additional capital funds would at least offset the increase in net cash income over the simulated period, leaving very little room for increase in net profitability. This is partly due to the facts that the average production per cow in the initial herd was very low and that very limited gains in productivity are possible under current management practices followed by the operator.

TABLE 45. Projected Outcomes for Farms I and II under Trend Conditions, (Experiments I and 7).

Year	Farm I			Farm II		
	Net Cash income[a]	Average production per cow	Herd size	Net cash income[a]	Average production per cow	Herd size
	($)	(pounds)	(cows)	($)	(pounds)	(cows)
1969	1,008	5,774	18	2,106	6,775	25
1970	1,253	5,986	19	2,368	6,902	27
1971	1,387	5,942	21	2,737	7,031	29
1972	1,477	6,129	23	2,903	7,122	31
1973	1,544	6,098	24	3,184	7,209	32
1974	1,723	6,075	26	3,272	7,199	34
1975	1,846	6,254	28	3,634	7,390	35

[a]This estimate is not adjusted for replacement of equipment and additional facilities which might be required on a given farm.

Farm II

The simulated results show a potential for increasing the size of the herd from 25 cows in 1969 to 35 cows in 1975 by raising replacements on own farm. Milk production per cow could be increased from 6,775 pounds the first year to 7,390 the seventh year. The net cash income of the dairy enterprise would increase from $2,106 in 1969 to $3,634 in 1975 due to herd expansion and increases in production per cow. These estimates are based on feeding the medium quality ration specified earlier in this study. Additional capital costs related to the projected increase in herd size could not be measured due to lack of data. If these costs were likely to exceed $200 per year -- that is the equivalent of $2,000 of additional capital investment per year depreciated at a 10 per cent rate -- net profitability of this dairy enterprise would not increase.

In these instances, at least, intuitive analysis of the evidence is relatively easy. The evidence generated by the model indicates that there is little hope for increases in the profitability of either one of the two representative dairy enterprises considered in this study by increasing herd size alone under current management practices. These results help to explain why so many dairy farmers in Eastern Quebec have found milk production unprofitable and have liquidated their dairy operations. The simulated projections are also consistent with recent Quebec experience in other depressed areas where dairying is an important source of agricultural income.

The question which naturally arises at this stage is whether or not

the various regional dairy development strategies considered in this study can induce larger increases in profitability than those which appear likely if present trends continue.

Projections Under New Program Strategies

The simulated model is used to estimate projected net cash income for two representative herds under alternative dairy development strategies. These include policies for promoting herd improvements and changes in feeding rates. The simulated results for Farm I and Farm II are discussed in the following pages.

Farm I

Five experiments are simulated for Farm I. Each experiment is identified by specific replacement and feeding practices. Each of the replacement practices is appraised by using different qualities of rations as determined by characteristics of the feed. The results are presented in Table 46 and discussed hereafter:

Experiment 2: increased feeding only

The purpose of this experiment is to determine the extent to which the small dairy farmer might increase the profitability of his dairy enterprise and the productivity of this cows by expanding herd size and by increasing the quantity of feeds fed. The estimates are therefore based on feeding the high ration (without silage) specified earlier in the study.

This simulated experiment shows a potential for increasing the number of cows from 18 in 1969 to 28 in 1975 by raising replacements through natural

TABLE 46. Projected Outcomes for Farm I Under Alternative Program Strategies, 1969 and 1975.[a]

Estimated outcomes	Year	Simulated Experiments					
		All replacements raised on own farm				All replacements bought	
		Natural service		Artificial insemination			
		Current feeding rates	Increased feeding, no silage	Current feeding rates	Increased feeding, no silage	Current feeding rates	Increased feeding rates, no silage
Experiment number		1	2	3	4	5	6
Net cash income per year[b] . . .	1969	1,008	1,391	976	1,448	1,271	1,354
		(136)	(109)	(104)	(144)	(51)	(151)
	1975	1,846	2,563	1,970	3,848	846	3,087
		(191)	(220)	(229)	(260)	(80)	(169)
		- -		dollars	- -		
Average production per year[b] . . .	1969	5,774	6,122	5,845	5,978	6,331	6,212
		(259)	(102)	(302)	(144)	(71)	(26)
	1975	6,254	6,627	6,602	7,691	4,267	7,422
		(188)	(249)	(134)	(271)	(401)	(122)
		- -		pounds of milk	- -		
Herd size . . .	1969	18	18	17	18	15	18
	1975	28	28	28	29	10	30
		- -		number of cows	- -		

[a]Projected outcomes for each year can be found in Appendix F, Appendix Table 4.

[b]The numbers enclosed in parentheses are standard deviations about the means. Each experiment was run ten times.

service. Milk production per cow could be increased from 6,122 pounds the first year to 6,627 the seventh year. Net cash income would increase from $1,391 to $2,563 during the same period. Gains in milk production per cow appear to be limited by the poor quality of cows in the initial herd and by the poor quality of feeds fed.

Experiments 3 and 4: use of artificial insemination

Using artificial insemination to raise his own heifers for replacement and expansion, the small dairy farmer continuing on current feeding rates (experiment 3) would increase his herd size from 17 cows in 1969 to 28 in 1975. Annual net cash income and annual milk production per cow would respectively increase from $976 to $1,970, and from 5,845 to 6,602 pounds during the same period. It is interesting to note that production per cow in this simulated experiment is no higher than without A.I.. This indicates that low feeding rate is an important limiting factor. The estimates based on increased feeding rates without silage (experiment 4) in turn indicate that herd size could be increased from 18 cows in 1969 to 29 cows in 1975. In this instance, annual net cash income and annual milk production per cow would respectively increase from $1,448 to $3,848, and from 5,978 to 7,691 during the same period

Results of experiment 3 are a strong testimonial that limited availability of good-quality feed is one of the most important factors accounting for the poor performance of some dairy enterprises in the region. Artificial insemination without increased feeding rates is not likely to

have any payoff at all on Farm I. However, artificial insemination with increased feeding rates might contribute to increase the profitability of Farm I. The extent to which net profit could be increased would depend upon the amount of additional investment needed to achieve the herd expansion projected. Assuming that additional dairy equipment and buildings totalling $10,000 in new investment would be required to increase herd size from 18 1969 to 28 in 1975, the increase in profit over the seven year span would be approximately $ 1,400.[2]

Experiments 5 and 6: all replacements bought

The purpose of these experiments was to determine whether or not the small dairy farmer might increase the profitability of his dairy enterprise and the production of his cows by purchasing all his new heifers for replacement and expansion.

The estimates based on current feeding rates (experiment 5) indicate that, under such conditions, culled cows would not be replaced. In this case, low quality forage and other constraints limiting total feeding rates appear to place an upper limit on the ability of this farmer to fully take advantage of the higher production capacity of his purchased replacements.

The estimates based on increased feeding rates without silage (experiment 6) show a potential for increasing herd size with purchased replacements from 18 in 1969 to 30 in 1975. Annual net cash income and annual milk production per cow would respectively increase from $1,534 to $3,087, and from 6,212 to 7,422 pounds during the same period. Again, the

[2]That is, $3,848 for net cash income in 1975 minus $1,448 for net cash income in 1969, minus $1,000 for additional costs of capital, assuming that additional capital is discounted at a 10 per cent rate.

magnitude of the increase in net profits would depend upon the additional capital costs which dairy herd expansion might entail on individual farms.

Farm II

Eight experiments were simulated for Farm II (Table 47). Each of the replacement practices were appraised by using different feeding rates. The maximum feed intake per 100 pounds of body weight is varied from 2.6 pounds of dry matter for current feeding rates to 2.8 for improved feeding rates with or without silage. The composition of the rations feed with or without silage was specified earlier in the study.

Experiments 8 and 9: all replacements raised on own farm by natural service

The two series of results simulated under these conditions are quite similar in many respects. This was expected since only the composition of the rations fed varies from one simulated experiment to the other. It is interesting to note, however, that annual net cash income increases from $2,304 in the first year to $4,080 in the seventh for increased feeding rates without silage, and from $2,845 to $4,748 for increased feeding rates with silage during the same period. Since herd size and production per cow are almost identical in the two simulated runs, the differences in annual net cash income between the two projections must be attributed to lower costs of feeding when oats is harvested as silage. Additional information on the annual capital costs associated with investments in adequate silage storing capacity for this individual farm would be needed, however, to determine whether such investments have a high payoff.

TABLE 47. Projected Outcomes for Farm II Under Alternative Program Strategies, 1969 and 1975 [a]

Estimated outcomes	Year	All replacements raised on own farm						All replacements bought		
		Natural service			Artificial insemination				Increased feeding	
		Current feeding rates	Increased feeding with silage	Increased feeding no silage	Current feeding rates	Increased feeding with silage	Increased feeding no silage	Current feeding rates	with silage	no silage
Experiment number		7	8	9	10	11	12	13	14	15
Net cash income per year[b]					(dollars)					
	1969	2,106	2,304	2,845	1,938	2,158	2,685	1,992	2,191	2,681
		(128)	(127)	(109)	(125)	(119)	(134)	(101)	(101)	(103)
	1975	3,634	4,080	4,748	3,420	4,910	5,690	4,069	4,558	5,120
		(375)	(298)	(411)	(166)	(273)	(186)	(263)	(364)	(326)
Average production per cow[b]					(pounds of milk)					
	1969	6,775	6,822	6,772	6,836	6,935	6,825	6,863	6,840	6,766
		(134)	(122)	(70)	(75)	(62)	(95)	(65)	(69)	(92)
	1975	7,390	7,490	7,419	7,442	8,687	8,667	8,109	8,309	8,106
		(255)	(232)	(266)	(115)	(151)	(111)	(163)	(323)	(274)
Herd size					(number of cows)					
	1969	25	25	25	25	25	25	25	25	25
	1975	35	36	35	37	37	37	36	36	35

[a]Projected outcomes for each year can be found in Appendix F, Appendix Table 5.

[b]The numbers enclosed in parentheses are standard deviations about the means. Each experiment was run ten times.

Experiments 10, 11 and 12: use of artificial insemination

Three series of results were simulated under these conditions namely one for current feeding rates, one for increased feeding rates without silage and finally one for increased feeding rates with silage. The estimates based on current feeding rates (experiment 10) show a potential for increasing herd size from 25 cows in 1969 to 37 in 1975. However, annual net cash income and annual production per cow would increase only from $1,938 to $3,420, and from 6,836 to 7,442 pounds of milk during the same period. This again suggests that low quality forage and other constraints limiting total feeding rates appear to place an upper limit on the ability of this farmer to improve the actual production performance of his cows by using artificial insemination. The estimates based on increased feeding rates with or without silage (experiments 11 and 12) are again quite similar in many respects. Herd size and herd production per cow are almost identical for each year but annual net cash income differs from one series to the other. Annual net cash income would increase from $2,158 in the first year to $4,910 in the seventh year with increased feeding rates without silage, and from $2,685 to $5,690 with increased feeding rates with silage during the same period.

Experiments 13, 14 and 15: all replacements bought

Three series of results were simulated under these conditions. The estimates based on current feeding (experiment 13) show a potential for increasing herd size from 25 in 1969 to 36 in 1975. Annual net cash income and milk production per cow respectively increase from $1,992 to $4,069, and from 6,863 to 8,109 pounds of milk during the same period. The estimates

based on increased feeding rates with or without silage (experiments 14 and 15) both indicate that milk production per cow might go up by about 1,400 pounds of milk between 1969 and 1975. However, annual net cash income would increase from $2,191 in the first year to $4,558 in the seventh year for increased feeding rates without silage, and from $2,681 to $5,120 for increased feeding rates with silage.

The Ranking of Alternative Strategies

To sharpen the comparison of the various strategies from the farmer's point of view, a computation was made of the present value of each year's net cash income discounted at some specified rate for each experiment simulated in the study. This provides a convenient way of indexing the various monetary streams generated by the model. The model used in this study is capable of reducing the net cash income, distributed by years, and the change in capital funds from year to year to a single value for each experiment. It must be pointed out that the result thereby obtained is the discounted cash flow and not the present value of net benefits. This is due to the fact that the information available allows estimation of gross margin earned by each dairy enterprise under various experimental conditions but is not sufficient to permit computation of net profit, that is gross margin minus fixed costs.

A single interest rate of 6 per cent is used in this study. It must therefore be pointed out that the ranking of the various alternatives considered in the study has limited meaning since the ranking may itself

be dependant upon the interest rate used.[3] It must also be emphasized that the period over which the outcome is projected is itself too limited to fully appraise the consequences of each combination of dairy development strategies especially those having to do with breeding programs. The preceding remarks should therefore be kept in mind before reaching definite conclusions as to the relative merit of each alternative.

From the point of view of the farmer operating a dairy enterprise with characteristics similar to synthesized Farm II, it would appear that increased feeding rates with silage (experiment 12) is to be favored (Table 48).

Increased feeding rates with silage would apparently be the most profitable regardless of whether he chooses to continue to raise all his replacements on his own farm by natural service, buy all replacements from specialized stock raising farms or raise all his replacements on his own farm by using artificial insemination. It is interesting to note that there are very little differences in the present value of discounted cash flows for each of the experiments (12, 15 and 9) involving these strategies. The same remark applies to the next three experiments which all involve increasing feeding rates without silage (experiments 11, 14 and 8). Estimates of fixed costs associated with silage harvesting and storage facilities

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[3]This proposition could be tested by computing the present value of yearly earnings for each simulation run discounted at various interest rates. Computed estimates could then be reported for each discount rate specified and could be used to determine whether or not the ranking of the various monetary flows depends upon the interest rate considered.

would be needed to determine which strategy would have the highest returns on capital invested.

From the point of view of the farmer operating a dairy enterprise with characteristics similar to synthesized Farm I, it appears that increasing feeding rates (without silage) in combination with a strategy of raising all his replacements on own farm by using artificial insemination (experiment 6) offers the greatest possibilities for making his enterprise more profitable (Table 48). The other combination of strategies which would apparently constitute improvements over current practices appear less attractive. This is especially true for the combination of strategies involving purchased replacement and current feeding rates (experiment 5).

TABLE 48. Ranking of Simulated Experiments on Basis of Present Value of Cash Flows Discounted at 6 per cent.

Ranking	Farm I		Farm II	
	Simulated experiments[a]	Present value of discounted cash flow	Simulated experiments[a]	Present value of discounted cash flow
		($)		($)
1	6	2,881	12	3,560
2	2	1,921	15	3,516
3	4	1,836	9	3,500
4	3	1,541	11	3,065
5	1	1,442	14	2,990
6	5	1,281	8	2,876
7			10	2,806
8			7	2,728
9			13	2,386

[a]The practices identifying each experiment are presented in table 44.

Effects of Various Strategies on Capital Requirements

The foregoing discussion leads to the conclusion that the combined effects of improved feeding rations and of artificial insemination might be the most appropriate course of action to follow in order to increase profitability of regional dairy farming enterprises. Buying replacements may have another disavantage as far as capital requirements are concerned.

With small herds buying cows for replacement to increase herd size may provide a quicker and more profitable means of growth than raising replacements. This may be particularly true for small herds with very low production cows. The people holding these beliefs, however, often forget to consider the fact that the practice of buying replacements requires a larger capital fund than the practice of raising replacements. The results of this analysis indicate that the buying practice might rapidly deplete the capital stocks of those regional farmers who follow it systematically (Table 49).[4] These findings point to the serious possibility that many regional dairy farmers may not have access to enough capital funds and outside credit to finance both an increase in herd size through a buying replacement practice and other investments which might be needed to operate with larger herds. One of the major shortcomings of this research consists in the fact that other investment requirements for the various herd sizes and the various practices considered in the study are not taken into account. We decided to refrain from making

[4]The market price for purchased replacements appears to be significantly higher than the cost of raising replacements in the region. One of the reasons accounting for this difference might be the value of the quotas (needed to qualify for the subsidies) which are partly capitalized into the price of replacements.

arbitrary charges against gross income for fixed assets since no data were available on either their salvage values, their worth in present employment or their replacement costs. It must therefore be pointed out that additional information would be needed to convert the gross margin figures presented above, which can correctly be interpreted to represent returns to management, fixed investment and the operator's labor, into a more sophisticated measure of net farm income. Assuming that such information could be collected, it would then be possible to use the basic data provided by this study to develop an economic appraisal of the alternative dairy development strategies.

TABLE 49. Projected Net Change in Farm Capital Invested in Cows for Various Simulated Experiments.[a]

Simulated experiments[b]		Change in farm capital fund for the simulated period (7 years)	
Farm I	Farm II	Farm I	Farm II
		(dollars)	(dollars)
1	7	+ 451	+ 1,369
2	8	+ 941	+ 1,624
-	9		+ 2,019
3	10	+ 1,068	- 897
4	11	- 1,191	- 1,465
-	12		- 486
5	13	+ 2,061	+ 1,423
6	14	+ 7,043	+ 1,534
-	15		+ 1,877

[a]Only the capital stock outlays for investments in cattle are included in this calculation. Depletion of the capital fund is therefore assumed to occur with investments in cattle and when the gross margin is less than the amount of money necessary for yearly family expenses.

[b]See Table 44 for the practices identifying each experiment.

It appears safe to conclude that the interests of the regional dairymen who intend to further commit themselves to dairy farming might best be served by promoting artificial insemination as a means of increasing productive efficiency of dairy cattle and by inducing improvements in the performance of dairy-related crop enterprises on the farms. The analysis indicates that improved feeding practices might be a necessary but not sufficient means for improving the performance of the regional dairy enterprises.

Validity of the Model and Its Results

Since a simulation model is an attempt to represent a real system, it is desirable to do some sort of checking to see if the analytical procedure used is a reasonably valid representation within the context of the problem at hand. The most usual procedure for testing the validity of a simulation model is to have the computer program simulate a situation about which prior knowledge is available. The necessary degree of correspondence between the simulated and the known results is then used as a basis for determining whether or not the model accurately represents the real system under consideration.

The first question which must be raised at this juncture is whether or not the milk production function assumed in this study can predict current levels of production associated with the various levels of feeding reported in the survey.[5] A comparison of the results of this study with levels of production per cow reported by the respondents shows similar results (Table 50).

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[5]The assumed production function was discussed on p. 168.

TABLE 50. Levels of Milk Production Associated with Various Feeding Rates, Simulated and Measured in Survey.

Feeding rate	Estimated average milk production per cow in herd		
	Simulated		Survey
	Farm I	Farm II	
	(pounds of milk)		
Low[a]	6,160	-----[d]	6,130
Medium[b]	-----[d]	6,775	6,540
High[c]	6,331	6,822	6,630

Source: Simulated Projections for year 1969 and results of survey presented in Appendix D.

[a]Simulated trend experiment for farm I.
[b]Simulated trend experiment for farm II.
[c]Simulated farms I and II under high feeding rates without silage and current breeding practices.
[d]These feeding rates were not analysed for both farms.

However, since the estimates of feeding rates obtained from the survey were rather crude, this limited evidence is no guarantee that the function used was the most appropriate one to choose. The only conclusion which can be drawn is the following. The input-output relationships expressed in this function may adequately represent those of regional dairy farming enterprises within the range of feeding rates considered in the study.

Another means of checking the validity of the model is to determine whether or not the projected results are consistent with the respondents' opinions concerning the comparative merit of alternative strategies.[6]

[6]This test is implicitly based upon the assumption that the people on whose shoulders the implementation of a chosen strategy is to rest are capable of making rational decisions and of detecting courses of action with high payoffs.

Let it be sufficient to recall that the respondents' expressed preferences for alternative strategies showed that there was substantial disagreement among them as to what would constitute the most appropriate course of action to follow. If the respondents are at all capable of forming a reasonable opinion concerning the consequences of alternative courses of action, this would suggest that the range of favorable consequences is likely to be narrow. The simulated results are consistent with this proposition. For example, let us consider the various simulated experiments for farm II. On a discounted cash flow basis for the seven year period, the first ranked outcome resulted in only $754 more than the seventh ranked outcome (Table 48).[7]

The results generated by the model support the following generalizations. There are some limited possibilities for increasing porfitability of reagional dairy farming enterprises either through increases in herd sizes, improved production capacity of dairy herds and/or improved feeding rates. The greatest possibilities appear to be those that would result from artificial insemination and improved feeding rates. The quality and quantity of feed fed is shown to be a major importance with respect to production and income from dairying. Feeding poor rations would apparently result in milk production lower than the cows' potential if higher production capacity cows were introduced in the region without concomitant improvements in feeding rates. This conclusion is consistent with the respondents' opinion that

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[7]This difference would have been smaller if a higher discounting rate had been used.

more adequate feeding rates is one important means for improving the production capacity of their herds (Table 30).

Strengths and Weaknesses of the Model

It is easy to exaggerate the degree of assistance that a simulation model can offer policy makers. At most, an adequately specified model can help him to understand relevant alternatives and key interactions by providing some estimates of important consequences and the time-span associated with various courses of action. It may sharpen his intuition and broaden his basis for judgment, thus helping him make a more rational decision. But unavoidable value judgments, imprecise knwoledge and uncertainties about individuals' behavior mean that such a study can do little more than assess some of the most relevant implications of choosing one alternative over another.

The purpose of the following discussion is to explore the most apparent strengths and weaknesses of the model used in this analysis. A related objective is to suggest how the model could be improved to cover a wider range of problems.

Strengths of the Model

The simulation model used in this study is capable of projecting the consequences of following various management practices in dairy farming. The consequences are described by five characteristics. These are the size of the herd, the gross margin to the herd, and the average milk production per cow. In addition to this information, the model can generate results

concerning changes in capital stock, the present value of monetary flows, and culling rates.

The wealth of information provided reflects favorably on this simulation model. For instance the results simulated in this study indicate that the strategy of purchasing replacements has a major disadvantage of high capital cost. This type of information is likely to be useful to the regional planners. Indeed, promoting the strategy of purchasing replacements to improve production capacity of regional dairy herds might fail if enough attention was not devoted to the need for supplying additional credit.

An additional advantage of the model is that it stresses the considerable influence of the initial quantity and quality of resources upon the growth possibilities of the dairy enterprise. It also constitutes a convenient method for incorporating a wide range of data that can be brought to bear on the solution of a particular problem.

Finally, the model allows one to analyse the dairy enterprise with respect to various planning periods, namely a short period analysis in which feed is the only variable, a medium period in which both feed and herd size are variable and finally a long run analysis in which all factors of production are variable. It is not certain, however, that the model used is preferable to other technique such as recursive linear programming for analysing problems related to growth of dairy enterprises over time. It is thought none the less that the information produced by the simulation model used in this study is relevant to the decision-makers' final decision concerning the choice of a dairy development strategy in Eastern Quebec.

Weaknesses of the Model

The first major weakness of the model is that it is restricted to the analysis of the dairy enterprise and the dairy-related crop enterprises. Since few regional dairy farms are completly specialized, this model gives only a partial picture of their resource allocation problems. Most of the commercial farms in Eastern Quebec are small family-sized businesses producing two to maybe five kinds of crops, and/or one to three types of livestock in order to use resources fully in an attempt to equate marginal returns approximately with marginal factor costs for all enteprises. On such small farms multiple enterprises may be a necessity, if the operator and his family expect to live on the returns from such small-size farming. The farmers who will further commit themselves to dairying will likely have to curtail a few enterprises in order to expand the dairy enterprise. The model used in this study does not help determine which enterprises should be curtailed and what the net increment to total farm revenue is.

Second, the model considers the price of milk as a deterministic variable. The structure of the model could be modified to incorporate a function of the following type:

$$P_t = f\ (t,\ q_{i_t})$$

where P_t = net farm price for milk at time t;

t = a given year; and

q_{i_t} = a dummy variable taking into consideration quantity of milk produced within quota allocation and that in excess of quota during a given year.

The routine which would be needed to incorporate this function into the computer program might be fairly complex but the gains in accuracy of the projected results might be worth the additional effort.

Third, land was assumed to be available if and when needed. It may be argued that the size of the farm with respect to land available for feed production is an important consideration in the dairy farmer's decisions concerning size of herd and replacement practices. This is especially true in Eastern Quebec where land fragmentation is considered a serious problem. It is particularly difficult to make plausible generalizations on the relationships between herd size and land available for feed production since increases in yields might prove to be a high priority solution in the region. In order to put the results obtained in this analysis into a more realistic perspective, it would be necessary to collect additional information from the farmers themselves. Such information would serve to determine the proportion of regional dairymen who (1) need to expand their acreage in order to increase the size of their dairy herds and to improve their feeding rates, and (2) might qualify for financial assistance - by way of special credit and/or limited capital grants - to purchase or lease neighboring units. This information could be incorporated into the model.

Fourth, the market value of feed was used to estimate feed costs. Since the market value of feed probably represents the upper limit of feed costs, there is a serious possibility that the simulated results underestimate the profitability of the two enterprises considered. Feed production costs are not easily determined, however, especially because of the

complexity of allocating joint costs and the problems of estimating fixed assets used in the production and storage of feed. Until further information becomes available, this problem cannot be easily avoided.

Fifth, the costs of owning sires were not taken into account in the simulated experiments involving raising replacements on own farm through natural service. If the relevant information on such costs were available, this conceptual weakness could be avoided by adding a simple routine to the computer program which would account for them. However, this conceptual problem does not affect the consequences generated for the other simulated situations since artificial insemination and buying replacements practices eliminate much of the overhead cost of owning sires of milking stock. Another important weakness, as pointed out earlier, is that annual costs of new investments such as silos and extra harvesting equipment for the oat silage, are not taken into consideration because of the absence of relevant information.

Sensitivity Analysis

Sensitivity analysis can be used to analyse the impacts of uncertainty on likely micro consequences of each dairy development strategy. This involves using several plausible values for those parameters about which the analyst is uncertain in an attempt to determine how sensitive the projected results are to variations in the uncertain parameters.

The purpose of the following discussion is to present some evidence on the likely consequences of varying a few parameters about which question-

able assumptions might have been made in this study and to seek further information on a few possible program alternatives. The variations considered are with respect to (1) the price of agricultural land, (2) the price and quality range of purchased replacements. Other parameters which could submitted to sensitivity analysis are also discussed.

The Price of Land

The future trend in the price of agricultural land in Eastern Quebec is an issue over which opinions may diverge. There are about as many reasons to believe that it might go up as there are reasons to believe that it might remain stable in the foreseeable future, but very few people seem to think it might go down as a result of government intervention in the regional agricultural land market.

The analysis carried so far has been undertaken under the assumption that the price of agricultural land in the region would remain at current levels. Suppose, however that increases in the price of regional agricultural land will occur in the foreseeable future. Suppose further that these increases in the price of regional agricultural land would be accompanied by significant increases in the costs of hay, oats and pasturage. The consequences resulting from such circumstances can be predicted by the model used in this study.simply by changing the parameters identifying the costs of various feed items. A case in point is presented in Table 51. The results simulated under these conditions indicate that a large increase in the cost of feed (20 per cent increase assumed) without any increase in the price of

TABLE 51. Projected Outcomes for Farm II with Increased Costs of Feed.[a]

Year	Estimated gross margin	Estimated average production per cow in herd	Estimated herd size
	(dollars)	(pounds of milk)	(number cows)
1969	1,493	6,796	21
1970	1,406	6,925	22
1971	1,434	6,820	23
1972	1,569	6,843	22
1973	1,536	6,574	22
1974	1,367	6,094	22
1975	1,467	5,948	23

[a]Same conditions as for "trend" projections for farm II, expect for cost of harvested forage per ton of hay equivalent, cost of pasturage per ton and cost of concentrated mix which were arbitrarily set at $18, $19 and $54 respectively as compared to $15, $16 and $45 in the "trend" experiment.

milk would likely make it unprofitable to further invest in dairying. This points out a serious possibility that the increased cost of feeds might contribute to further depress the profitability of many regional dairy farming enterprises if improved management practices were not adopted.

Price and Quality Range of Purchased Replacements

One of the crucial issues concerning the strategy of promoting specialized dairy stock raising farms in Eastern Quebec has to do with the price and quality range of replacements which could be raised on such farms. It is generally recognized that quality of dairy animals is a very important factor determining productive efficiency and rate of profitability of dairy enterprises. The quality of dairy animals that a farmer finds desirable to keep

largely depends upon the cost of such animals, among other things.

All situations previously considered in this study that involved the strategy of buying all replacements from the specialized dairy stock raising farms were simulated under the assumptions (1) that out of 100 heifers bought from the specialized dairy stock raising farms, 25, 50 and 25 might be expected to respectively fall within 7,000-7,999, 8,000-8,999 and 9,000-9,999 mature-equivalent production classes, and (2) that these heifers would sell for about $ 250. There are a certain number of questions which can be answered in this study by considering other plausible assumptions.

Suppose the regional planners are convinced that very few regional dairy farmers might shift to a buying replacement strategy if the cost of purchasing such animals is not subsidized. Suppose further the decision-makers have reached the decision that a government agency would subsidize the purchase of such animals in the region so that the net price paid by the regional dairymen would not exceed $200. It is possible to predict the consequences of such a policy by changing the value of the variable identifying the cost of purchased replacements from $250 to $200. Two cases in point are presented in Table 52. The results generated indicate that the combinations of strategies involving this policy rank lower than those involving the use of artificial insemination (Table 48) when each situation is ranked exclusively in terms of the present value of the discounted cash flow. An interesting implication of the subsidy, however, is that buying replacements at the subsidized price would involve a much smaller drain on capital funds than buying replacements at the market price, thereby leaving more funds to invest in other facilities required to increase herd size.

TABLE 52. Projected Outcomes for Farm I and Farm II with Price of Purchased Replacements Set at $200 per Head.

Year	Farm I			Farm II		
	Net cash income ($)	Average Production per cow (pounds)	Herd size (cows)	Net cash income ($)	Average Production per cow (pounds)	Herd size (cows)
1969	1,402	6,157	18	1,968	6,939	25
1970	1,807	6,523	20	2,321	7,293	27
1971	2,100	6,673	22	2,803	7,621	29
1972	2,430	6,854	24	3,207	7,875	31
1973	2,726	6,992	26	3,624	8,077	33
1974	3,176	7,143	28	4,006	8,266	35
1975	3,502	7,267	30	4,398	8,412	37

The estimated net change in capital fund is +$5,915 for farm I and +$517 for farm II. The present value of the discounted cash flow (at 6 per cent discounting rate) is $2,707 for farm I and $2,864 for farm II. High feeding rates without silage were assumed in both simulated projections.

The strategy of using a subsidy as an additional incentive for regional dairymen could be analysed with benefit-cost analysis. However, it must be pointed out that the total amount of the subsidy would have to be imputed as a cost for promoting such a program. This cost might be fairly high. For instance, the simulated results presented in Table 52 imply that farm II would buy approximately 65 heifers from the specialized dairy stock raising farms over the seven year period considered. The cost of the subsidy would therefore be about $3,250 for farm II alone.

A possible area of discontent with the regional planners' recommendations concerning the specialized dairy stock raising farm strategy lies in their specifications of the quality range of cows which might be produced on such farms. This issue can be expressed in the following terms. If there are reasons to believe that this strategy is the most appropriate one to follow from the community's point of view, why not attempt to get the most out of it by raising very high quality cows? Suppose for instance (1) that out of 100 heifers bought from the specialized dairy stock raising farms, 25, 50 and 25 might be expected to respectively fall within 8,000-8,999, 9,000-9,999 and 10,000-10,999 mature-equivalent production classes, and (2) that these heifers would sell for about $300. It is possible to predict the consequences of such a policy by changing the expected distribution of purchased replacements and the value of the variable identifying the cost of purchased replacements (Table 53).

TABLE 53. Projected Outcomes for Farm II Associated with a Higher Quality Range of Purchased Replacements.

Year	Net cash income	Average production per cow in herd	Herd size	Change in capital fund	Present value of cash flow discounted at 6 per cent
	(dollars)	(pounds of milk)	(number of cows)	(dollars)	(dollars)
1969	2,475	6,808	25		
1970	2,747	7,175	27		
1971	3,192	7,581	29		
1972	3,654	7,981	31		
1973	4,193	8,263	33		
1974	4,745	8,493	34		
1975	5,188	8,677	36	-3,405	2,916

As expected, the results generated indicate that fairly quick improvement in herd productivity could be achieved under such conditions. However, the relatively high cost of such animals would impose a heavy drain on the regional farmer's capital stock.

Further Research Needs

It is not possible to reconsider all the parameters about wich questionable assumptions might have been made. It is possible, however, to suggest some key parameters, the values of which might affect the ranking of the alternatives under consideration.

First, all experiments considered in this study that dealt with the use of artificial breeding as a means of improving the productive efficiency of regional dairy herds were simulated under the assumption that, on the average, heifers from artificial sired cows would be superior to natural sired heifers by the equivalent of 200 pounds of milk per year. Since this assumption is conservative, it might be appropriate to reconsider the consequences of promoting that strategy under a more liberal assumption while taking into account its cumulative effect over time.

Second, the initial capital fund available was assumed to be $3,000 for farm I and $4,000 for farm II for all experiments simulated. The projected outcomes of various situations were not apparently affected by this assumption but they might have been affected if lower values had been assumed. For this reason, it would be interesting to consider several values for that parameter.

Third, it was assumed that annual withdrawals of income for family living expenses were zero. This assumption was made because it allowed

the analysis to determine the net change in capital fund ascribable to given replacement practice. The scope of this research could be extended by collecting information on living expenses of regional farm families. The estimate could then be subtracted from farm net income to determine what portion of it, if any, is available for reinvestment in the dairy enterprise. Incorporation of family living expenses in the analysis would probably affect the consequences of all combinations of strategies involving the buying replacement practice. Considering a regional dairyman who has very limited sources of capital, there is a serious possibility that family living expenses could not even be maintained at current levels if a buying replacement strategy were pursued because this strategy would impose a heavy drain on his limited capital funds mostly at first.

Standard Deviations of Projected Results.

In addition to making projections over time, the simulation model used herein can provide measures of the standard deviations of projected outcomes over time. In order to obtain such measures, however, each simulated experiment must be replicated many times. The fewer times the simulation is replicated, the shorter the computer's running time and the smaller the certainty of accurately measuring differences.

Because each cow in the simulated dairy herds is exposed to a probability culling because of hazards and each cow that calves to an equal probability of a bull or heifer calf, the computed milk production and income will likely vary somewhat each time a simulated experiment is replicated. In this analysis, each simulated experiment was replicated ten times mainly to illustrate how

the model can be used to measure uncertainties. The results presented in Table 54 are for simulated farm II under the conditions specified in the table. The number of times each situation is replicated is probably not sufficient to derive firm conclusions concerning the variability of consequences implied by various dairy development strategies at the farm level. The results indicate, however, that the practice of purchasing replacements might slightly contribute to reduce yearly income variability in regional dairy farming in the foreseeable future. Further evidence would be needed, however, to adequately substantiate this tentative proposition.

TABLE 54. Estimated Variability in Returns and in Average Production per Cow for Farm II Under Three Experimental Conditions.[a]

	Standard deviation in gross margin[b]			Standard deviation in average production[b]		
Year	Natural Service	Replacements purchased	Artificial insemination	Natural Service	Replacements purchased	Artificial insemination
	(dollars)			(pounds of milk)		
1969	109	134	103	70	95	92
1970	144	193	161	194	199	127
1971	153	222	134	191	157	176
1972	243	185	184	214	106	208
1973	167	204	248	202	115	252
1974	197	120	241	217	98	290
1975	411	186	326	266	111	294

[a]All three experiments were simulated under the assumption of high feeding rates with silage.

[b]Standard deviation from mean estimates.

Issues in The Economic Appraisal of Alternative Strategies

In order to compare the relative merit of alternative regional dairy development strategies, it is necessary to consider the strategies from three points of view, namely those of the farm (considered in this study), the financing agency and the community as a whole. The difference in each point of view are discussed by E.M. Ojala in following terms:

> The impact of a project on the pattern of farm income and expenditure and on net farm income is crucial to its success, but it does not give the whole picture. The financial appraisal goes further. In the light of the economic changes brought about by the project on the farms benefiting, it would assess the increase in rates or taxes that the farmers might be asked to pay as reimbursement to the financing agency . . . This approach is in turn narrower than the economic appraisal, which tries to assess the costs and benefits of the project in terms of the public interest. Economic appraisal is thus concerned with opportunity costs as well as direct costs, and benefits that accrue to the general public revenue as well as the money receipts of the financing agency. This is therefore the correct approach to apply in appraising agricultural investment projects financed from the public funds. The farm and financial appraisals are nevertheless essential, to provide basic data for the wider analysis.[8]

From the community's point of view, the macro economic problem is that of maximizing welfare by efficiently allocating scarce resources. Ideally a community should then choose that course of action which, with the available resources, maximizes the well-being of the whole community. If possible, the community should like to ascertain the total amount of this magnitude under various alternative courses of action. Then it would pick the alternative that yielded the most community well-being. This prescription,

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[8]E.M. Ojala, "The Programming of Agricultural Development", Published in Herman M. Southworth and Bruce F. Johnston, Agricultural Development and Economic Growth, (Ithaca, New York: Cornell University Press), 1967, p. 573.

however, helps little more than saying that the community wants the best course of action. Nobody knows precisely how the well-being of the Eastern Quebec population is related to the observable or projected outcomes of various dairy development strategies because the analytical tools and the relevant data to translate the outcomes into such terms are not available. In practical problem solving, therefore, researchers choose to look at some proximate criteria which serve to reflect what might happen to community well-being under various courses of action. Actual criteria are thus essentially practicable substitutes for the maximization of whatever a society would ultimately like to maximize.

Cost-benefit analysis is the only approach to economic appraisal of public projects that is at all well established. Conceptually cost-benefit analysis sets out to evaluate alternative courses of public action on the basis of their effects on national income. As a general rule, an alternative is said to be economically justified when total assessed benefits exceed total assessed costs, that is when the benefit-cost ratio is above unity.[9]

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[9]The two main types of criteria used by benefit-cost analysts are (1) the ratio of the present value of the time-stream of net benefits to the present value of the time-stream of costs, and (2) the internal rate of return of a given course of action, which is the discount rate that reduces the present value of the stream of net benefits to zero, or in other words, that brings the present value of benefits to equality with the present value of costs. When the present value procedure is followed, the alternative with the higher present value is said to be preferable. When the internal rate of return criterion is applied, any alternative that has a rate of return higher than that at which the funds can be borrowed is said to be economically justified.

The following discussion is intended to show that the data generated in this study could be used to set up a thorough benefit-cost analysis of alternative regional dairy development programs. Emphasis is laid upon the basic problem of aggregation, the problems raised by the evaluation of labor and the need to explore the problem of redistribution of income. Serious questions concerning future milk supply and demand balance in Eastern Quebec are also raised.

Aggregation Issues

A recurrent problem faced by cost-benefit analysts of agricultural development programs is that of finding out the rate at which farmers are likely to respond to alternative strategies. It hardly needs to be mentioned that direct benefits of any development program are the sum total of the direct benefits realized on each farm making a positive response.

Evidence presented in this study shows that the regional dairy farmers with relatively large herds (20 cows or more) would probably respond more rapidly than others to alternative programs because they would apparently benefit the most from them. This suggests that a realistic appraisal of the direct benefits generated by alternative dairy development strategies in Eastern Quebec might require additional information on potential rate of response among various classes of regional dairymen.[10] This information could in turn be used to predict the number and the type of dairy farmers who might

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[10]The information presented in this study on the likely response of regional farmers cannot be used for that purpose because of the limited coverage of the survey.

respond immediately to a specific program if it were implemented, those who would probably take action in later years and finally those who might make no positive response at all.

It is of crucial importance that a realistic view be taken on the aggregation problem concerning the direct and indirect benefits of various dairy development programs in Eastern Quebec. This importance stems from the fact that one strategy would lead to the establishment of specialized stock raising farms while the other might necessitate the development of artificial breeding facilities in the region. Promoting either one of these strategies might not be economically justifiable if there were insufficient demand from the regional dairymen for these commodities and services. Otherwise these activities would have to be subsidized, which would add to the costs of promoting increases in the profitability of dairy farming in the region. It is suggested, in relation to this issue, that changes in cost and benefit be compared for different possible scales on which either one of the above programs might be undertaken.

Benefit-cost analysts of dairy development programs in Eastern Quebec would also need to investigate the elements of uncertainty which characterize various relevant strategies. Since most of the potential beneficiaries are low income people, there may be a considerable fall off in the affected marginal utility functions within the range of possible benefits distribution over time. If this were true, there might be valid reasons for either penalizing high-risk alternatives in the decision process or using a high discount rate which would automatically deflate the present value of alter-

natives the consequences of which might be late to manifest themselves. For instance, it is possible that some regional dairymen might prefer a buying replacement practice over the use of artificial insemination because the former could provide a quicker means of improving the productive efficiency of their dairy herds than the latter. Such an attitude would reflect a high value on present gains as compared to future gains.

It is not the purpose of this study to show how a benefit-cost analysis should be set up for appraising the various alternatives to promote improvements in regional dairy farming. It is thought, however, that the micro data generated in this study could be used as a basis for determining the magnitude of the direct benefits which might be generated by various alternatives over a limited period of time. The projections presented could be easily extended over time to suit the needs of benefit-cost analysts.

Problems Related to the Evaluation of Labor

A serious problem in benefit-cost analysis lies in pricing labor in areas of seasonal unemployment such as Eastern Quebec. For instance, it may be foreseen that promoting the establishment of private specialized dairy stock raising farms might contribute more to create jobs in the region than favoring dairy herd improvements through artificial breeding. In order to determine the real costs of either strategy, it would be necessary to reckon with the fact that the wages paid to individuals who might otherwise be unemployed do not measure the usual definition of cost, which is the value of these labor services in alternative use. That is shadow prices would

have to be used to evaluate the labor value of these individuals.

The issue is complicated by the fact that labor services would probably have to be bought at a wage rate prescribed by the current minimum wage laws. Under these circumstances, the wages paid to the hired workers would partly represent a transfer payment and would probably substitute for current public assistance already being provided to such individuals. Under such conditions, it appears that a safe rule of thumb in reckoning the labor costs implied by various publicly sponsored programs to improve dairy herds in the region would be to count only the prior level of earnings as the cost of hiring individuals seasonally unemployed. According to such a rule, the previous level of earnings of such individuals would be used as the estimated value of their labor services in alternative use or their contribution to regional income during the periods they were employed.

The Income Distribution Problem

One of the major limitations of benefit-cost analysis is that it ranks public projects in terms only of economic efficiency.[11] There is no basis for assuming that a combination of regional dairy development strategies which might maximize efficiency in regional dairy farming would also necessarily achieve a high level of income redistribution. Thus planners responsible for developing program strategies intended to serve both purposes might need to attach relative weights to efficiency and income redistribution.

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[11]An interesting discussion on some of the limitations of benefit-cost analysis can be found in Arthur Maas, "Benefit-Cost Analysis: Its Relevance to Public Investment Decisions," published in Planning, Programming, Budgeting: A Systems Approach to Management, edited by Fremont J. Lyden, and Ernest G. Miller, (Chicago,Markam Publishing Company), 1968, pp. 221-240.

The projected consequences of various program strategies can be used to illustrate the complexities involved in trying to reconciliate the objective of economic efficiency with that of income redistribution. Suppose that public decision makers have decided to promote artificial insemination in the region and to lend capital funds at low cost to regional dairymen eager to invest in silage storing facilities. Suppose further that most of the regional dairymen with relatively large herds (20 cows or more) decide to take advantage of these programs. Under these conditions, the total increase in milk supply in the region would probably lead to significant decreases in the market price for milk. Those who would probably suffer the most from adverse price effects are the small and inefficient milk producers. It might very well happen that such circumstances result in improving the well-being of some regional dairymen while leading to a deterioration in the well-being of others. These are consequences that planners must attempt to predict.

The foregoing discussion should not leave the impression that economic efficiency is not an important objective in promoting economic development. Maximizing the level of living in the framework of a group of development programs means maximizing the impact of a unit of resources used on the level of well-being generated. This concept implies a rejection of the practice of taking increase in productivity as the exclusive and final criterion. It does not mean that the increase in productivity effect should be forgotten. It means only that it should be put in a broader perspective as an intermediate but important achievement.

A proper system of weights to compare various achievements resulting from a group of development programs might be one that reflects the national priorities. This study cannot enter into a discussion of how this could be done with regard to alternative dairy development strategies in Eastern Quebec. Let it be sufficient to emphasize that most of major planning decisions are finally resolved primarily on the basis of intuition and judgment.

Regional Milk Supply and Demand Balance

One of the crucial issues which remains to be explored has to do with the plausible effect of the dairy development strategies on the regional milk supply and demand balance in the foreseeable future. In order to show how serious this issue might be, let us consider the changes in milk supply from Farms I and II over the simulated period, based on the practices of artificial insemination and on high feeding rates (Table 55). Estimates of production potentials from the two synthesized dairy herds based on these conditions indicate a possibility of increasing supply by as much as 10 per cent per year. The results indicate that, in 1975, 1,040 dairy enterprises with characteristics similar to those projected for Farm II could supply the same total quantity of milk as that which was produced on all the regional farms in 1963 (approximately 335 million pounds according to the planners' estimates). It is important to recall at this juncture that 5,269 regional census farms reported sales of milk in 1966.

TABLE 55. Projected Milk Production of Farms I and II.[a]

Year	Farm I		Farm II	
	Estimated Milk Production	Rate of Increase Per Year	Estimated Milk Production	Rate of Increase Per Year
	('000 pounds)	(percent)	('000 pounds)	(percent)
1969	108		174	
1970	124	17.8	193	10.9
1971	143	15.3	218	13.0
1972	165	15.4	245	12.4
1973	180	9.1	271	10.6
1974	199	10.6	297	9.6
1975	223	12.1	321	8.1

[a]Based on high feeding rates and the use of artificial insemination as a breeding practice.

These results point out the serious needs for a well-documented milk demand analysis before any dicision is taken as to what set of strategies is the most appropriate one to implement. The most appropriate combination of regional dairy development strategies might not be that which will increase productive efficiency the most but rather that which will increase productive efficiency at a rate compatible with (1) the existing prospects for a larger market, and (2) the expected rate of decrease in the number of regional farms with dairy enterprises.

The results simulated in this study indicate that this issue is one that should not be treated casually by the policy makers.

Summary

Empirical evidence presented in this chapter was used as a basis for evaluating the comparative merit of alternative dairy development strategies in Eastern Quebec. The likely consequences of various alternatives considered on the pattern of farm income were simulated for two representative herds in Eastern Quebec. Four major characteristics were used to measure these consequences. They are the net cash income to the dairy herd, the average milk production per cow, the present value of the discounted cash flows and the changes in capital stock associated with various dairy stock replacement practices.

The most pertinent conclusions which can be drawn from the micro analysis are the following:

1) The major criterion used to rank alternative strategies was the present value of the discounted cash flows. This criterion ranked the various policy alternatives in terms of the pay off accruing to the two simulated dairy enterprises. On the basis of this criterion, the estimates generated for each enterprise indicated that artificial insemination with improved feeding rates has the highest present value when the cash flows are discounted at a 6 percent rate. However, simulated results for the larger enterprise (Farm II) indicated very little differences between the net present value of the discounted cash flow for this alternative and those estimated for the practices of either buying replacements from the specialized stock farms or raising all replacements on own farm by natural service (based on the same feeding rate as the first ranked strategy). Furthermore, it was found that all

simulated experiments involving current feeding practices had the lowest present value of discounted cash flows.

2) The simulated results were found to be consistent with the respondents' opinions concerning the most appropriate course of action for them to follow. The respondents seemed to recognize that they must improve their feeding practices in order to increase income from dairying but there was disagreement among them as to what strategy would be the most appropriate for increasing the inherent production capacity of their herds. According to the simulated results, the various stock replacement practices considered in this study had about the same present value of discounted cash flows for any feeding rate analysed but all low ranked alternatives were identified by current feeding rates.
3) Additional information generated by the model pointed out the following interesting aspect of the problem. The strategy of buying replacements would quickly deplete farmers' capital stock. It might therefore act as a serious deterrent on the pursuit of that strategy mostly at the start of the program. If current availability of capital funds and borrowing capacity are at all related to the current levels of profitability of various regional dairy enterprises, it may be expected that the small dairy farmers will have the most difficulties to take advantage of that program.

It was argued, however, that the impact of a set of regional dairy development programs on farm income does not give the whole picture. We therefore suggested that benefit-cost analysis might be a convenient method for extending the scope of this research. The results generated in this

study, with a limited number of modifications, could be used to evaluate the total direct benefits of alternative regional strategies for dairying. Special care would need to be taken, however, in aggregating the simulated results. Such a study would also need to explore the distribution over time of both the expected indirect benefits and the expected costs of implementing each alternative. Such a study could substantially contribute to sharpen the policy makers' judgment concerning the relative merit of alternative strategies from the community's point of view. It would take into account program administrative feasibility and costs.

Finally, it would be necessary to consider the plausible consequences of promoting various strategies on the distribution of benefits among the regional farm families. This would involve an exploration of the effects of various strategies on changes in total regional milk supply, on price of milk at the farm level and finally on the possible adverse effects of price decreases on the farms failing to increase resource productivity. The simulated results indicated that the regional milk supply and demand balance might be seriously disturbed by increased supply on farms responding to the planners' incentives without larger prospects of market expansion.

PART III

General Summary and Policy Implications

CHAPTER VIII

SUMMARY AND CONCLUSIONS

The amount of public funds used for financing regional development research in Canada increased quite rapidly during the last decade. Yet the economic returns of individual projects and particular phases of publicly financed programs continues to be questioned by various sources. This is aside from general criticisms concerning the consistency of various project investments with respect to broader regional and national objectives.

With this situation in mind, this thesis chose to focus on the regional development planning research recently conducted in Eastern Quebec. The scope of the study was further restricted to analysing the consequences of alternative dairy development strategies on local dairy farming enterprises. One of the major objectives pursued was to present careful estimates of the economic results of alternative regional dairy development programs.

The first part of the study dealt with planning issues in the regional economy of Eastern Quebec, with special emphasis on the agricultural problem situation. Evidence presented indicated that dairy farming is the mainstay of agriculture in the region. It was found that a series of factors combine to create a serious low income problem in the regional activity. These factors were identified as (1) limited supply of highly productive resources, (2) lack of growth of effective demand for milk in the region, (3) limited job opportunities outside of farming in the region itself,

and (4) poor performance of both the dairy processing industry and the regional dairy input suppliers which face difficulties of their own in the area.

The existence and continuance of dairy farming in the region was explained in terms of low factor costs. The low returns accruing to these factors were shown to be supplemented by government subsidies, especially with respect to manufacturing milk. Increases in resource productivity were therefore singled out as the major possible source of improvement in the profitability of regional dairy farming. However, since lack of growth of effective demand will probably continue to be a serious problem for the regional dairy subsector, it was concluded that large quantities of resources now committed to dairy farming will be forced to shift to other uses if increases in resources productivity are to be achieved in the foreseeable future.

From the standpoint of agricultural planning in Eastern Quebec, the area where existing knowledge most seriously falls short of the need was shown to be with respect to milk demand projections. It was therefore suggested that funds devoted to seeking and analysing the relevant information on this issue were crucially needed before any regional development strategy is implemented.

The second part of the study analysed alternative strategies for increasing profitability and technical efficiency in regional dairy farming. The three basic strategies analysed were those suggested by the regional planners, namely (1) specialized dairy stock raising farms for increasing regional supply of more productive cows, (2) improved feeding practices,

and (3) farm consolidation and community pasture programs to facilitate increases in herd sizes on farms facing serious difficulties in acquiring additional agricultural land. In addition, two additional alternatives for increasing regional supply of more productive cows were considered. They were artificial insemination and specialized dairy stock raising farms selling heifers at a subsidized price of $200 per head.

On the premise that it was appropriate to base aggregate estimates of direct project benefits on estimates of their consequences at the farm level, this part of the study set out to compare the relative merit of alternative dairy development strategies from the farmers' point of view. This was done in two steps. First, information was presented on local dairymen's intentions with respect to the alternatives considered in this study. Second, a simulation model was used to project the changes in profitability (net cash income from dairying) and productivity (milk production per cow) of two representative dairy enterprises under various growth conditions. The estimated parameters were based on primary data from a survey conducted in three rural communities located within the two major regional milksheds. These farmers may be regarded as being representative of the group most likely to successively achieve the growth objectives stated in the analysis.

The analysis of the respondents' intentions indicated that the regional dairymen with large herds (20 cows or more) were the most likely to further commit themselves to dairy farming in the foreseeable future. Most of these respondents tended to recognize that limited availability of good quality

feed was a serious problem confronting the regional dairy farming industry and that improving feeding practices was one of their major concerns. A majority of the respondents also expressed the opinion that improving the production capacity of their dairy herds was one of their major concerns. There was disagreement among them, however, as to what might be the most appropriate set of policies to increase supply of more productive cows in the region. Some said they would prefer artificial insemination, others seemed to prefer buying their new replacements while the others appeared to favor raising all their replacements from their own herds by natural service.

With regard to the results of the various simulated experiments, those based on low feeding rates provided a strong testimonial that limited availability of good quality feed is one of the most important factors accounting for the poor performance of some dairy enterprises in the region. These simulated results indicated that any one of the three dairy stock improvement programs considered will contribute very little to increase the productivity and profitability of those farms where poor feeding practices will persist in the future.

The various experiments simulated under increased feeding rate conditions, to the contrary, showed potentials for increasing productive efficiency and profitability of regional dairy enterprises. The present value of projected cash flows was then used as a criterion for determining which dairy stock improvement strategy might bave the highest payoff from the farmer's point of view. On the basis of this criterion, artificial insemination ranked first for both simulated enterprises, but only by a slight

margin over purchased replacements for the larger farm. However, the practice of buying replacements would apparently require more capital funds than other herd improvement practices, especially in the initial stages. This might constitute a major obstacle for the implementation of the stock raising farms project. Regional dairymen with limited access to capital funds might therefore be expected to refrain from following this practice to improve their dairy herds.

Although the simulation model used was most useful for analysing resource allocation decisions for individual fairy farms, results of the analysis can also be extended to provide basic information for macro analysis of alternative strategies. Benefit-cost analysis was suggested in this study as an appropriate method for determining which alternative has the highest payoff from the community's point of view.

Policy Implications

Despite the limited coverage of the study, a few policy implications emerged. For example, the following consequences might be expected if the policy makers chose to promote the development of specialized dairy stock raising farms and improvements in feeding practices. On the one hand, the dairy farmers' demand for credit might increase considerably. If regional supply of agricultural credit failed to increase, the adoption of this dairy stock replacement practice might proceed at a very slow pace. On the other hand, since regional dairymen appear to have strong preferences for raising their own replacements, additional incentives might be needed

to make them shift to a buying replacement practice. These might involve additional extension personnel and services, and/or subsidies to reduce the cost of purchasing replacements. Either case would contribute to increase the costs of the original programs.

If, instead, the policy makers decided to promote the use of artificial insemination, they would have to consider various alternatives. The technique of deep freezing of semen might make it possible in practice to supply the thinly populated area of Eastern Quebec with semen imported from the other areas of the Province where artificial insemination centers already exist. However, because of the widely scattered and relatively small herd sizes, cost of inseminating cows would be high compared to other regions of Quebec where cows population is concentrated. Even if this alternative were retained, however, there would still remain a need for improving regional supply facilities and for training local artificial inseminators. Determining how large a payoff these programs might have would probably engage agricultural economists for some time.

Further Research Needs

From the standpoint of national efficiency in resource use, adjustments between regions must be made as rapidly as possible when changes in productivity, supply, or demand contribute to alter the returns on labor and capital. An important problem worthy of attention by agricultural planners in the Province of Quebec would be to determine where dairy programs financed by the tax payers are likely to have the highest payoff. The specific

goals which are deemed proper and appropriate for the policy decision-makers to be seeking in Eastern Quebec will somehow have to be selected in the light of a comprehensive evaluation of national priorities regarding the dairy farming industry. Without exploring all the ramifications of this proposition, it is appropriate to suggest that much attention should be given to the following issues.

First, the main areas of Canada with advanced dairying tend to rely more and more on corn as a feed input. Apparently, this adjustment is taking place because it may reduce the costs of producing milk, depending on relative costs. The question then arises whether the decision-makers should devote public funds to promoting increased supply of corn rather than to help dairy farmers in marginal areas such as Eastern Quebec where this crop cannot be produced. There is no simple answer to this question but the issue itself is worthy of attention by agricultural planners in Canada.

Second, with policy emphasis on rationalization of the Canadian dairy industry at the farm level and on price stabilization of dairy products on the domestic market, the question arises whether supply restrictions through withdrawal of quotas from small producers will have significant adverse effects on marginal dairy areas. Different situations might result, depending upon the government's objectives concerning the regional distribution of quotas. There is a serious possibility that disincentives due to quota restrictions might offset the incentives created by regional dairy development programs in Eastern Quebec. Further research must be brought to bear in this issue.

Third, there is a need to investigate the likely consequences of collective bargaining on the future performance of the regional dairy subsector. There are reasons to believe that the regional dairy processing industry might be capable of reducing its costs of production through plant consolidation. But there are also reasons to believe that the regional dairymen will seek price increases for their milk in the foreseeable future. These changes in the organization of the regional dairy subsector will probably have important consequences for the distribution of the rewards of increased productivity among the various participants.

Fourth, there is a crucial need for investigating the likely effects of various regional dairy development strategies on the regional milk supply and demand balance. The results of this study indicate that the expanding farms could increase their milk supply at a rate of about 10 percent per year during the next seven years. The question as to whether or not this consequence is likely to create a serious disequilibrium situation in the regional dairy farming industry must be answered before any strategy is implemented.

Fifth, there is a real need for a benefit-cost analysis of alternative dairy development strategies in Eastern Quebec. The farm net cash incomes projected in this study would prove useful but further research based on these estimates would need to incorporate changes in capital requirements on individual farms.

In conclusion, results of this study could be extended to provide basic information for benefit-cost analysis of alternative regional dairy

development strategies. Such an ambituous task could not be undertaken in this study but it is hoped that other research workers will. It might be a measure of the success of our effort if, indeed, it encouraged other researchers to undertake that task. The findings presented in this study might then contribute to sharpen policy makers' judgment concerning the consequences of alternative courses of action.

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Appendices

APPENDIX A

METHODOLOGICAL CONSIDERATIONS ON SURVEY DESIGN

The population for which the survey was designed consisted of dairy farmers of Eastern Quebec who (1) milked 10 cows or more between June 23rd and July 26th 1969, and (2) whose farms were located within the two major regional milksheds. According to the 1966 Canadian Census of Agriculture, some 72,000 out of a total of 87,000 cows reported in the region were milked on farms located within the boundaries of these two milksheds.

A two-stage sampling method was used in designing the survey. Since no lists of dairy farmers with the number of cows milked were available, the number of farms having the characteristics mentioned above was unknown. Given this limitation, the only feasible alternative was to proceed on a community basis.

The first step consisted in choosing the communities to be surveyed. This choice was made according to the following rules. First it was required that a rural community comprise 100 farms or more (not necessarily dairy farms). Second, it was required that at least 60 per cent of the farm operations in a given community be commercial farms (1966 Census definition).[1] Third, the communities which were not eliminated according to the first two criteria were required not to have contiguous geographical boundaries. Under the third criterion, preference between contiguous communities was given to the one having the highest percentage ratio of commercial farms to all farms.

The 1966 Canadian Agricultural Census data were used in choosing the communities surveyed.[2] Out of 19 communities which satisfied the first requirement, 11 were eliminated on the basis of the second requirement. Finally, of the remaining 8 communities 7 were found to form two distinct nuclei made up of contiguous municipalities. On the basis of the third requirement, three communities were retained. They were: St-Benoit-Joseph-Labre (Matapédia County), Ste-Cécile-du-Bic (Rimouski County) and St-Arsène (Rivière-du-Loup County).

It must be pointed out that the choice of the communities was not made at random. Since this choice could not be made at random, the rules of selection mentioned above were imposed in order to obtain a very high probability that the dairy farmers located there were milking 10 cows or more. It was presumed that the proportion of commercial farms to all farms in a given community might reflect the presence of relatively large dairy farms. This presumption was substantiated by the survey results. As a matter of fact, 76 out of the 78 dairy farmers who answered the questionnaire reported milking 10 cows or more at the time the field survey was conducted.

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[1] See p. 64 for this definition.

[2] 1966 Census of Canada Agriculture, Special Bulletin, Number and area of Census-Farms and Commercial Farms for Counties and Census Subdivisions, Catalogue No. 96-632.

In the second step, a list of dairy farmers reporting sales of milk in 1968 was obtained for each one of the three communities. The list included the names and addresses of 179 dairy farmers. A sample of 100 was drawn at random from the lists. Out of the 100 farmers who were visited for an interview, 78 accepted to answer the questionnaire.

Some methodological limitations must be ascribed to the procedure according to which the communities were selected. It is thought that statistical inferences can be drawn from the survey which can be applied to the total population. These inferences, however, might entail slight biases in the estimation of some population parameters. The magnitude of the biases cannot be estimated because of lack of data. The direction of the biases is likely to be positive for some important variables considered in this study. For instance, it may be suspected that the average production of dairy herds reported on the surveyed farms is slightly higher than that of all dairy farms with 10 cows or more in the two milksheds. The prices of inputs (especially land) might also be slightly higher for the average surveyed farm than for the average population farm.

Financial restraints on the survey were especially responsible for limiting the number of communities surveyed. Since there were at most 2,600 relatively large (10 cows or more) dairy farms in the two milksheds, the ratio of sample size to total population was 0.03.

APPENDIX B

FACTORS AFFECTING YIELDS OF DAIRY COWS

Suppose that the level of production of a cow in a given period to can be expressed as the dependent variable in the following functional relationship:

$$Q_{t_o} = f\,(q_{t_o}\ ,\ q_{t_{o-i}}\ ,\ C_{t_o}\ ,\ C_{t_{o-j}},\ I_{t_o}\ ,\ E_{t_o}\ ,\ B_k\ ,\ B_m\ )$$

where,

Q_{t_o} = production (lbs. of milk) of a cow in period t_o;
q_{t_o} = quantity of feed fed to the cow in period t_o;
$q_{t_{o-i}}$ = quantity of feed fed to the cow in periods t_{o-i}, where $i = 1, 2, \ldots\ldots, n$ and $t_{o-i} > 0$;
C_{t_o} = composition of the ration fed in period t_o;
$C_{t_{o-j}}$ = composition of rations fed in periods t_{o-j}; where $j = 1, 2, \ldots\ldots, r$ and $t_{o-j} > 0$;
I_{t_o} = index of inherited factors of the cow identifiable in period t_o;
E_{t_o} = index of environmental factors affecting the production of the cow at time t_o;
B_k = breed of cow, where $k = 1, 2, \ldots, p$;
B_m = breeding practice followed, where $m = 1, 2, \ldots, s$.

This functional relationship states that the production of a cow during a period t_o may depend upon (1) the quantity and the composition of rations fed during period t_o, (2) the quantity and the composition of rations fed in periods preceding t_o, (3) the inheritance factors peculiar to the type of cow, (4) the environmental factors (weather, housing and milking arrangements, handling of cow by farmer, number of milking daily, and other factors) believed to affect the yields of cows, (5) the breed of cows considered, and (6) the breeding practices followed.

Since neither the functional form nor the parameters of this relationship can be specified because of absence of data on most of these variables, we propose an alternative method for comparing the production capacity of dairy cows in Eastern Quebec with that of dairy cows in other parts of Canada. The effects of the levels of feeding (q_{t_o}) and of the composition of rations (C_{t_o}) can be neutralized -- at least partially -- by choosing a period t_o such that q_{t_o} and C_{t_o} do not significantly diverge from region to region. For instance, the 1966 Canadian Census of Agriculture data allow one to compare the daily milk production per cow (as of July 1rst of that year) on a countywise basis. Since most cows in Quebec and Ontario are on pasture at that time of the year, it might reasonably expected that feed ration levels and composition do not diverge too much from cow to cow, from farm to farm, and from region to region. To the extent that this presumption is valid, Appendix Table 1 indicates that dairy cows in Eastern Quebec are relatively less productive than those found in other regions of Quebec, which in turn appear to be relatively less productive than those found in Ontario.

Assuming that the influence of q_{t_o} and C_{t_o} are neutralized by this method of comparison, low levels of cows' yields in Eastern Quebec would have to be attributed to some of or all of the following causes; predominance of low producing dairy breeds, poor management practices and/or difficult environment for dairying. Unfortunately, the importance of these factors cannot be isolated due to the absence of data. It appears safe to conclude that a typical dairy farmer in Eastern Quebec milks cows of lower production capacity than the average dairyman in Quebec and Ontario, while recognizing that our estimates of these differences may not be particularly accurate. The major bias involved in using this method has to do with the differences in quality of roughage from farm to farm and from region to region. The production capacity of Eastern Quebec dairy cows might be significantly underestimated in Appendix Table 1 if it happened that they are fed rather low quality roughage in comparison to other regions.

APPENDIX TABLE 1. Daily Production per Cow in Quebec, Ontario and by County of Eastern Quebec, July 1rst, 1966.

Area	Daily production per cow
	(pounds of milk)
a) Counties of Eastern Quebec	
Bonaventure	27.17
Gaspé-East	26.01
Gaspé-West	27.47
Matane	24.04
Matapédia	26.96
Rimouski	26.70
Rivière-du-Loup	26.90
Témiscouata	26.78
b) Province of Quebec	
All counties	30.55
c) Province of Ontario	
All counties	35.53

Source: 1966 Census of Agriculture, Ottawa, Canada, Catalogue no. 96-606.

APPENDIX C

QUESTIONNAIRE

NUMERO _____, NOM_____

1. Combien de vaches trayez-vous actuellement? No._____

2. De quelle race(s) sont ces vaches? (1) Jersey; No._____
   (2) Ayrshire; No. _____
   (3) Guernsay; No. _____
   (4) Autres; No. _____
   (5) Spécifiez la race: _____

3. Considérant chacune de vos vaches individuellement, pourriez-vous indiquer combien de ces vaches sont dans les classes d'âge suivantes et combien de livres de lait ces vaches ont produites approximativement au cours de l'année 1968?

Classe d'âge		Nombre de vaches dans chaque classe d'âge		Production annuelle (1968) de ces vaches
2 à 4 ans	(1)	_____	(5)	_____
5 à 7 ans	(2)	_____	(6)	_____
8 à 10 ans	(3)	_____	(7)	_____
10 ans et plus	(4)	_____	(8)	_____

4. Durant combien de jours ou de mois par année trayez-vous ces vaches en moyenne?
   (1) _____jours ou (2) _____ mois

5. Quel est ordinairement le pourcentage de gras dans le lait que ces vaches produisent?
   _____%

6. Quel est le poids de vos vaches qui ont entre 6 et 8 ans?
   _____lbs.

7. Combien aviez-vous de vaches dans votre troupeau il y a un an?
   No. _____

8. Au cours de l'année dernière, avez-vous vendu des vaches que vous ne vouliez plus traire parce qu'elles ne produisaient pas assez de lait? (1) oui _____ (2) non _____
   Si oui, pourriez-vous indiquer le poids approximatif de ces vaches que vous avez vendues ainsi que leur âge et le prix net que vous avez reçu pour chacune d'elles?

Vache no.	Age	Poids	Prix
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____
-	_____	_____	_____
	_____	_____	_____

9. Au cours de l'année dernière, avez-vous vendu des génisses que vous avez élevées?
   (1) oui _____ (2) non _____
   si oui, pourriez-vous indiquer le poids approximatif de ces génisses, ainsi que leur âge et le prix net que vous avez reçu pour chacune d'elles?

Génisse No.	Age	Poids	Prix
1			
2			
3			
4			
5			

10. Avez-vous vendu des jeunes veaux (moins de 2 semaines) au cours de l'année dernière?
    (1) oui _____ (2) non _____
    si oui, à quel prix avez-vous vendu ces jeunes veaux?(3) $_____

11. Combien de vos vaches ont donné naissance à un veau vivant l'année dernière?
    (1) No. _____ de (2) _____ au total

12. Avez-vous l'intention d'augmenter la taille de votre troupeau laitier au cours des 5 prochaines années?
    (1) oui _____ (2) non _____
    si non, qu'allez-vous faire? (3) traire le même nombre de vaches_____
    (4) vendre votre ferme . . . . . _____
    (5) réduire le nombre de vaches _____
    si oui, combien de vaches par année croyez-vous être capable d'ajouter à votre troupeau au cours des 5 prochaines années?
    (6) No. _____
    (Si la réponse est non à la question 12, passez immédiatement à la question 15).

13. Si vous avez l'intention d'augmenter la taille de votre troupeau laitier, de quelle façon entendez-vous procéder?
    (1) Elever toutes vos nouvelles vaches vous-même?_____
    (2) Acheter toutes vos nouvelles vaches? _____
    (3) Elever et acheter vos nouvelles vaches? _____

14. Si vous avez l'intention d'acheter toutes ou seulement quelques-unes de vos nouvelles vaches au cours des 5 prochaines années, combien en achèteriez-vous si ces vaches produisaient 8,000 livres de lait et se vendaient aux prix suivants?
    (1) $250 _____
    (2) $200 _____
    (3) $100 _____

15. Combien devriez-vous payer actuellement si vous vouliez acheter une tonne de foin dans votre localité?
    $ _____par tonne

16. Combien devriez-vous payer actuellement pour louer un acre de pâturage dans votre localité?

$ _____ par acre

17. Considérant chacun des items suivants, pourriez-vous indiquer combien vous en avez présentement ainsi que leur valeur approximative?

Items	Nombre	Valeur
(1) acres en pâturage;	_____	(2) _____
(3) acres en foin;	_____	(4) _____
(5) acres en maïs;	_____	(6) _____
(7) tracteur(s);	_____	(8) _____
(9) trayeuse(s) électrique (s);	_____	(10) _____
(11) séparateur (s);	_____	(12) _____
(13) charrue(s) à tracteur;	_____	(14) _____
(15) semoir(s);	_____	(16) _____
(17) batteuse(s);	_____	(18) _____
(19) lieuse(s);	_____	(20) _____
(21) étable (s) avec équipement;	_____	(22) _____
(23) camionnette(s) et camion(s);	_____	(24) _____
(25) silo(s);	_____	(26) _____
(27) sécheuse(s) à foin;	_____	(28) _____

18. Quel type d'étable avez-vous présentement?

(1) étable(s) avec stalles;_____
(2) étable(s) sans stalles;_____

19. Si vous songiez à augmenter la taille de votre troupeau de 10 vaches (10 vaches de plus) au cours des 5 prochaines années, combien de capital pensez-vous que vous devriez investir sur votre ferme, excluant le coût des vaches?

$_____

20. Combien de tonnes de foin par acre récoltez-vous sur votre ferme au cours d'une année normale?

_____ tonnes

21. Combien de coupes de foin obtenez-vous sur votre ferme au cours d'une année normale?

_____ coupes

22. Quel est le coût moyen ou le prix (si vous l'achetez) d'une tonne de moulées concentrées avec lesquelles vous nourrissez vos vaches?

$_____par tonne

23. Durant combien d'années devez-vous observer le niveau de production de lait d'une vache avant de décider de garder sa génisse pour la production de lait?

_____ années

24. Parmi les critères suivants, lequel utilisez-vous le plus souvent pour décider de garder une génisse produite par une de vos vaches?

(1) la vache qui a eu cette génisse donne au moins 300 livres de lait de plus que vos autres vaches, par année _____
(2) la vache ayant cette génisse donne un peu plus de lait (entre 0 et 300 livres de plus)que vos autres vaches _____
(3) la vache ayant cette génisse donne à peu près la même quantité de lait que vos autres bonnes vaches _____

25. Jusqu'à quel âge devez-vous garder une vache avant de vous faire une opinion définitive sur sa qualité?

_____années

26. Avez-vous un ou des boeuf(s)(ou taureau) que vous utilisez pour la reproduction?

(1) oui _____ (2) non _____

si oui, êtez-vous satisfait de la qualité de ce ou ces boeufs que vous utilisez pour la reproduction?

(3) oui _____ (4) non _____

27. Si vous n'avez pas vos ou votre propre(s) boeuf(s) pour la reproduction, louez-vous les services d'un boeuf appartenant à quelqu'un d'autre?

(1) oui _____ (2) non _____

si oui, combien devez-vous payer à chaque fois que vous en louez un?

(3) $ _____

28. Avez-vous l'intention d'améliorer la qualité de votre troupeau laitier durant les 5 prochaines années?

(1) oui _____ (2) non _____

si oui, lesquelles des méthodes suivantes avez-vous l'intention d'employer?

(3) améliorer la qualité des boeufs de reproduction; _____
(4) donner seulement plus de foin; _____
(5) donner seulement plus de moulées concentrées; _____
(6) donner plus de foin et de moulées; _____
(7) acheter des génisses de meilleure qualité; _____
(8) produire vous-même des génisses de meilleure qualité; _____

29. Avez-vous déjà eu recours à l'insémination artificielle pour fertiliser vos vaches dans le passé?

(1) oui_____ (2) non _____

si oui, combien vous en a-t-il coûté par vache? (3) $_____

30. Si l'insémination coûtait moins cher, seriez-vous prêt à utiliser cette méthode pour améliorer la qualité de votre troupeau?

(1) oui _____ (2) non _____

si oui, quel prix seriez-vous prêt à payer par vache fertilisée?

(3) $ _____

31. Combien de livres de lait pensez-vous que vos propres génisses donneront à leur maturité (7 à 10 ans)? Par exemple, si vous considérez 10 de vos génisses, combien d'entre elles, à votre avis, pourraient se situer dans les classes suivantes de production annuelle?

(1) moins de 5,000 livres de lait_____
(2) 5,000 à 5,999 " _____
(3) 6,000 à 6,999 " _____
(4) 7,000 à 7,999 " _____
(5) 8,000 à 8,999 " _____
(6) 9,000 à 9,999 " _____
(7) 10,000 et plus " _____

32. Quel prix recevez-vous présentement pour la vente de 100 livres de lait?

$_____

33. Combien devez-vous payer présentement dans votre localité pour acheter une génisse qui porte son premier veau?

$_____

34. Combien de vaches avez-vous retirées de votre troupeau l'année dernière pour les raisons suivantes?

(1) maladie _____
(2) mortalité _____
(3) ne produit pas assez _____
(4) autres raisons _____

35. Pourriez-vous indiquer, approximativement, combien des aliments suivants tout votre troupeau laitier a consommés au cours de l'année dernière?

(1) foin: _____ tonnes
(2) pâturage: nombre de vaches _____ par acre;
(3) ensilage; _____ tonnes;
(4) moulées concentrées; _____ tonnes.

APPENDIX D

SUMMARY OF SURVEY RESULTS ON FEEDING RATES

APPENDIX TABLE 2. Annual Forage and Grain Fed, and Milk Production per Cow: Dairy Herds of Mixed Breeds, Eastern Quebec, 1969.[a]

Quantity of grains fed[b]	Number of farms in group	Forage fed[c]		Milk production per cow	
		Mean	Standard deviation[d]	Mean	Standard deviation[d]
(pounds)		(tons)	(tons)	(pounds)	(pounds)
0 -1,499	19	6.0[e]	1.45	6.130	710
1,500-1,999	15	6.3[e]	0.87	6.340	920
2,000-2,499	19	6.5[e]	0.79	6.540	830
2,500 or more	15	6.7[e]	0.86	6.630	1,040

Source: Eastern Quebec Dairy Farms Survey, 1969.

[a]These estimates were obtained through the following steps. First, the quantities of hay and grain mixtures the respondents reported to have fed their dairy herds in 1968 were divided by the number of dairy cows in their herds at the end of that year. This computation was carried out only for dairy farms reporting mixed-bred herds of 10 cows or more (68 respondents). The estimated quantities of grains fed per farm per cow were then used to classify the respondents in the grain categories specified in the left hand-side column of the above table. Second, the quantities of hay apparently fed per cow per farm were added up for all farms classified in a specific grain feeding rate category and divided by the number of farms in this category. The result might be conveniently labelled the mean quantity of hay fed annually. In this step, each mean quantity of hay fed annually was increased by 1.8 tons of pasture per cow to obtain the mean quantities of forage fed which appear in the table above. In other words, it was assumed that all cows in each respondent's herd have access to the equivalent of one acre of pasture-land yielding about 1.8 tons of eatable forage per acre. It was also assumed that the respondents do not harvest significant quantities of oats as silage. The same steps were followed to compute the quantities of milk produced per cow in 1968.

[b]The composition of grain mixtures reported by the respondents does not differ much from farm to farm. The mixtures are largely based on locally grown oats fed as grains.

[c]It is common knowledge among dairy scientists that the quality and/or

palatibility of forage fed determine, to a significant extent, the percentage of a forage ration that a cow will effectively consume. With the exception of alfalfa which is sporadically grown in Eastern Quebec (Alfalfa and alfalfa mixtures accounted for less than 5 per cent of the total regional cropland devoted to the production of hay in the region in 1966), it appears that the types of hay grown in the region range from poor hay (relatively small proportion of legumes) to medium quality hay rather than from medium-quality hay to excellent hay (large proportion of legumes harvested at an early bloom stage). For several reasons, it was not possible to obtain accurate estimates of the percentage of forage rations fed which are effectively consumed by these herds. Crude estimates obtained by multiplying the mean quantities of forage fed annually per farm per cow (third column of table) by .9 might come close to describe actual forage feeding rates.

[d]The relatively high standard deviations of these estimates clearly indicate that there are substantial variations in feeding rates and milk yields from farm to farm.

[e]The fact that both the grain feeding and the forage feeding rates are shown to increase simultaneously does not imply that these estimates are inconsistent. Apparently, two factors have contributed to this rather unorthodox result. First, it was found that the lowest grain-fed category (0-1,499) includes a large proportion of respondents with small herds and/or with no apparent interests in further investing in dairying whereas the uppermost grain-fed category (2,500 or more) mostly included respondents with relatively large herds and/or with expressed interests in further committing themselves to dairying. Second, farmers with low dairy feeding rates tended to raise more animal units (other than dairy cows) per dairy cow than dairy farmers with high feeding rates.

APPENDIX E

SUMMARY OF DATA USED IN VARIOUS SIMULATED RUNS

APPENDIX TABLE 3. Values Assigned to Variables in Simulated Experiments

Variable name	Farm I: Simulated Experiment						Farm II: Simulated Experiments								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Number of milking cows in initial herd;[a] (number of cows)	18	-	-	-	-	-	25	-	-	-	-	-	-	-	-
2. Amount of capital available for improvement and/or increase in herd size;[b] ($'000)	3	-	-	-	-	-	4	-	-	-	-	-	-	-	-
3. Herd size growth objective; (number of cows/year)	2	-	-	-	-	-	2	-	-	-	-	-	-	-	-
4. Cost of raising replacements;[c] ($/head)	165	-	-	-	-	-	165	-	-	-	-	-	-	-	-
5. Cost of purchased replacements;[d] ($/head)			250	250						250	250	250			
6. Average length of lactation: (number of days/year)	280	-	-	-	-	-	290	-	-	-	-	-	-	-	-
7. Average body-weitht of mature cows in the herd; (pounds/head)	1,050	-	-	-	-	-	1,080	-	-	-	-	-	-	-	-
8. Cost of hay; ($/ton)	15	-	-	-	-	-	15	-	-	-	-	-	-	-	-

APPENDIX E (continued)

Variable name	Farm I: Simulated Experiments						Farm II: Simulated Experiments								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10. Smallest intake of forage per 100 pounds of body weight;[e] (pounds/day)	1.0	-	-	-	-	-	1.0	-	-	-	-	-	-	-	-
11. Total feeding ration: pounds of dry matter per 100 pounds of body weight per day;[f] (pounds)	2.4	2.8	2.4	2.8	2.4	2.8	2.6	2.8.	2.8	2.6	2.8	2.8	2.6	2.8	2.8
12. % of forage TDN fed as pasture (per cent)	15	-	-	-	-	-	15	-	-	-	-	-	-	-	-
13. TDN analysis of common forages fed; (% of fed weight)	35	-	-	-	-	-	35	35	30	35	35	30	35	35	30
14. % dry matter in forage; (% of fed weight)	85	-	-	-	-	-	85	85	60	85	85	60	85	85	60
15. Value of harvested forage per ton of hay-equivalent;[g]	15	-	-	-	-	-	15	15	12	15	15	12	15	15	12
16. TDN analysis of concentrate: (% of fed weight)	70	-	-	-	-	-	70	-	-	-	-	-	-	-	-
17. % of dry matter in concentrate; (% of fed weight)	85	-	-	-	-	-	85	-	-	-	-	-	-	-	-
18. Average cost of concentrate;[h] ($/ton)	45	-	-	-	-	-	45	-	-	-	-	-	-	-	-
19. Quality index of sire: average production of daughter;[i] ('000 pounds of milk/year)	6.7	6.7	8.0	8.0	8.0	8.0	7.0	7.0	7.0	8.0	8.0	8.0	8.0	8.0	8.0
20. Quality index of purchased replacements' dam;[j] ('000 pounds of milk/year)			8.0	8.0						8.0	8.0	8.0			

APPENDIX E (continued)

Variable name	Farm I: Simulated Experiments						Farm II: Simulated Experiments								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
21. Expected increase in production capacity of A.I. heifers;[k] (pounds of milk/year)					200	200							200	200	200
22. Value of less than two week old calves; ($'head)	15	-	-	-	-	-	15	-	-	-	-	-	-	-	-
23. Value of cows culled because of low production records; ($/head)	135	-	-	-	-	-	135	-	-	-	-	-	-	-	-
24. Net price received for milk; ($/ cwt.)	4.20	-	-	-	-	-	4.20	-	-	-	-	-	-	-	-
25. Cash costs per cow, excluding feed and replacements;[l]	50	50	50	50	55	55	50	50	50	50	50	50	55	55	55
26. % of cows calving each year; (%)	87	-	-	-	-	-	87	-	-	-	-	-	-	-	-
27. Years in herd before daughter saved for replacement; (years)	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-
28. % of herd average production before calf saved for repl.;[m] (%)	75	-	-	-	-	-	75	-	-	-	-	-	-	-	-
29. Heifer preference factor;[n] (%)	75	-	-	-	-	-	75	-	-	-	-	-	-	-	-
30. Opportunity cost of capital;[o] (%)	6	-	-	-	-	-	6	-	-	-	-	-	-	-	-

APPENDIX E (continued)

Variable name	Farm I: Simulated experiments						Farm II: Simulated Experiments								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
31. Annual withdrawal of income;[p] ($/year)	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-
32. % of gross margin to be reinvested in dairying;[q] (%)	10	-	-	-	-	-	10	-	-	-	-	-	-	-	-
33. Number of lactation needed to evaluate cows' production capacity; (number of lactation)	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Source: Sources of specifications, unless otherwise specified, are from Eastern Quebec Dairy Farms Survey, 1969.

Symbol: - indicates that the value at which the variable is set in run1 for Farm I and in run 7 for Farm II remains the same in other simulated runs for the particular farm considered.

[a]Lactation number and production (mature-equivalent) must be specidied for each cow in initial herd. This information can be generated directly from Table 39A from Farm I and Table 39B for Farm II.

[b]Assumed.

[c]Does not include cost of breeding services which are considered elsewhere.

[d]All replacements assumed bought from specialized dairy stock raising farms. All of them are presumed to be purchased prior to their first calving. Their expected production capacity is randomly determined according to the probability density function given on p. 183.

[e]Assumed.

[f]It is assumed (1) that farm I is currently in the low feed quality range (Table 41) and, (2) that it

can shift to the high feeding rate without silage (simulation runs 2,4 and 6) It also assumes that the operator of Farm II is currently in the medium feeding range and that he can shift to either the high feeding rate without silage (simulation runs 8,11 and 14) or to the "hypothetical" feed quality range (simulation runs 9, 12 and 15). Specifications for the various feeding rates are presented in Table 41.

[g]Value of harvested forage per ton of hay-equivalent is low in simulation runs 9,12 and 15. This is intended to reflect the fact that production of TDN can be increased for oats when they are harvested as silage rather than as grain. The value of a ton of oats silage in terms of income foregone in oats grain is about $6 ($45/ 7.5 tons) in the region. Since the TDN of a ton of hay is about twice as much as that of a ton of oats silage in the region, a ton of oats silage costs about $12 in terms of a ton of hay-equivalent in the region. We believe that this estimate is high.

[h]All runs are simulated under the assumption that the farmer's own crop enterprises supply whatever amount of oats grain is needed to feed the dairy herd.

[i]In simulation runs 1, 2, 7, 8 and 9, the quality index of sires is set at the annual level of milk production per cow reported by the respondents. In all other simulation runs, it is set equal to the expected production capacity (mature-equivalent) of cows raised on the specialized dairy stock raising farms.

[j]Expected value of distribution function described on page 184.

[k]Conservative 200 pounds of milk assumed (see p. 186).

[l]Includes breeding service costs per cow for experiments 5, 6, 13, 14 and 15.

[m]This variable specifies that a cow must reach at least 75 per cent of herd average production (mature-equivalent basis) before the farmer might consider saving her calf for a replacement. This specification is slightly less stringent than that which was reported on most of the surveyed farms.

[n]This is the standard age conversion factor for a heifer. Thus a heifer that produces more than 75 per cent of the current production of mature cows is probably more productive than cows already in the herd.

[o]Rate of earnings on long-term government bonds in periods of mild inflation in Canada.

[p]Annual withdrawal of income for family expenses is treated as a residual in this study.

[q]Family expenses and dairy enterprises needs for investments funds are viewed as competing for their shares of the residual income. In this study, it is assumed that 10 per cent of the gross margin earned by the dairy enterprise is available for reinvestment in dairying each year. This specification therefore allows for increases in family expenses as the contribution of the dairy enterprise to total family disposable income goes up.

APPENDIX F

SUMMARY OF PROJECTED
OUTCOMES FOR FARMS I AND II

APPENDIX TABLE 4. Projected Outcomes for Farm I Under Alternative Program Strategies

Estimated Outcomes	Year	Simulated Experiments[a] 2	3	4	5	6
		--		(dollars)		--
Net cash income per year	1969	1,391	976	1,448	1,271	1,534
	1970	1,672	1,005	1,728	1,345	1,570
	1971	1,854	1,197	2,043	1,273	1,856
	1972	2,100	1,409	2,469	1,209	2,230
	1973	2,207	1,599	2,955	1,069	2,430
	1974	2,347	1,672	3,326	966	2,809
	1975	2,563	1,970	3,848	846	3,087
		--		(pounds of milk)		--
Average production per cow per year	1969	6,122	5,845	5,978	6,331	6,212
	1970	6,261	5,991	6,190	6,407	6,597
	1971	6,355	6,187	6,494	6,425	6,804
	1972	6,502	6,289	6,885	6,082	6,996
	1973	6,466	6,363	7,202	5,660	7,191
	1974	6,536	6,435	7,390	5,267	7,332
	1975	6,627	6,602	7,691	4,267	7,422
		--		(number of cows in herd)		--
Herd size	1969	18	17	18	15	18
	1970	20	19	20	14	20
	1971	22	21	22	13	22
	1972	23	23	24	12	24
	1973	24	24	25	11	26
	1974	26	26	27	11	28
	1975	28	28	29	10	30

[a]See p. 193 for a description of practices identifying experiments.

APPENDIX TABLE 5, Projected Outcomes for Farm II under Alternative Program Strategies.

Estimated Outcomes	Year	8	9	10	11	12	13	14	15
			--		(dollars)		--		
Net cash income per year	1969	2,304	2,845	1,938	2,158	2,685	1,992	2,191	2,681
	1970	2,654	3,238	2,336	2,544	3,133	2,360	2,557	3,128
	1971	2,939	3,522	2,525	2,963	3,609	2,602	2,877	3,526
	1972	3,247	3,850	2,821	3,376	4,093	2,957	3,295	3,975
	1973	3,478	4,089	2,989	3,840	4,629	3,338	3,670	4,638
	1974	3,646	4,379	3,155	4,425	5,102	3,678	4,116	4,832
	1975	4,080	4,748	3,420	4,910	5,690	4,069	4,558	5,120
Average production			--		(pounds of milk)		--		
per cow	1969	6,822	6,772	6,836	6,935	6,825	6,863	6,840	6,766
	1970	6,916	6,926	6,969	7,168	7,180	7,037	7,053	7,037
	1971	7,056	7,009	7,118	7,531	7,570	7,258	7,278	7,248
	1972	7,186	7,107	7,192	7,896	7,889	7,446	7,497	7,467
	1973	7,250	7,189	7,249	8,199	8,185	7,667	7,749	7,608
	1974	7,291	7,262	7,321	8,484	8,454	7,865	8,042	7,852
	1975	7,490	7,419	7,442	8,687	8,667	8,109	8,309	8,106
			--		(number of cows)		--		
Herd size	1969	25	25	25	25	25	25	25	25
	1970	27	27	27	27	27	27	27	27
	1971	29	29	29	29	29	29	29	29
	1972	31	30	31	31	31	31	31	31
	1973	32	32	33	33	33	32	32	33
	1974	34	34	35	35	35	34	34	34
	1975	36	35	37	37	37	36	36	35

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