THE UNIVERSITY OF MANITOBA

REGIONAL OUTPUT AND FACTOR USE IN CANADIAN AGRICULTURE, 1950-1974

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR

THE DEGREE OF

MASTER OF SCIENCE

Department of Agricultural Economics

May
1979

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ABSTRACT

A knowledge of the gains in agricultural productivity is of importance because it has implications for farmers in terms of income effects, for farm administrators in terms of policy measures, for suppliers of farm inputs in terms of demand, and for the general public in terms of food costs. The present study is concerned with regional productivity performance in Canadian agriculture.

A review of relevant statistics reveals that Canadian agriculture has made dramatic gains in productivity since World War II. It is hypothesized that these gains have been brought about mainly by adjustments in the farm labor force, increased capital inputs, and other technological progress.

The study attempts to demonstrate the extent to which adjustments in the farm labor force, increased use of capital inputs, and other technological progress, have contributed to gains in agricultural labor productivity in Canada and the five different statistical regions of the Atlantic, Quebec, Ontario, the Prairies and British Columbia during the period of 1950-1974. Agricultural labor productivity has been defined as either gross value of output per worker or net value of output per worker, in constant dollars.

Many studies have been conducted to measure productivity in Canadian agriculture. The majority of these works were national in scope, and relied mainly on the use of an index number technique to measure growth in productivity.

The primary objective of this study is to measure and to compare regional labor productivity growth rates, and the contributions of the major sources of productivity gains in the different regions using methods other than the traditional index technique.

The index number approach, which does not involve the use of formal mathematical functions, makes it difficult to incorporate technological progress explicitly, and even more difficult to conceptualize and to accommodate contributions of interactions among resource inputs to growth in productivity.

In terms of methods, therefore, the current study departs from the traditional index technique, and employs a production function framework in which technological progress is explicitly incorporated and interactions among resource inputs are accommodated. A Cobb-Douglas-type production function is specified and fitted to data to estimate output per worker for each region. Using these estimates, which compare quite favourably with actual output per worker, annual growth rates for Canada and the regions are computed. To estimate the contribution each resource input makes to this annual overall growth rate in labor productivity, the study assumes that farmers attempt to maximize their return and allocate resources so that the marginal cost of each resource input is equal to its marginal return. This assumption combined with data on farmers' operating expenditures, investment in land and buildings, machinery, and labor use, provide the basis for computing the contribution these resources make to gains in labor productivity. Growth in output per worker is attributed to growth in expenditures on inputs per worker, each weighted by its factor share in gross value of output. To illustrate this procedure, let us assume, for example, that the share of machinery costs is one-tenth of the current value of farm production, and that machinery operating costs change at an annual rate of, say, 6 percent. Then the annual gain in labor productivity attributed to the annual change in machinery is estimated at .6 percent. Assuming an annual labor productivity growth rate of, say, 3 percent, it implies that one-fifth of the overall growth in labor productivity is imputed to growth in machinery expenditures. In general, the same procedure is applicable to all resource inputs which are identified as sources of improvements in labor productivity. The sources are categorized as labor input (effect of outmigration), land and buildings, mechanization, crop yield inputs, livestock yield inputs, and miscellaneous operating expenses. Land and buildings, crop yield inputs, and livestock yield inputs, are further broken down into specific items or categories. For changes in the labor input, however, a reduction in the farm labor force with less than proportionate reduction in output makes a positive contribution to growth in output per worker. Some indirect inputs which are difficult to quantify, such as increased education, skill of the labor force, and agricultural research, all of which bring about quality improvements in resource inputs, are estimated in a residual of "all other changes" as the contribution of technological progress to growth in labor productivity. To take account of interactions among resource inputs, Taylor's expansion is employed to estimate the contribution each resource makes to overall growth in labor productivity.

The results of the study indicated that labor productivity in regional agriculture performed quite well, and that in general, different regions owe their gains in productivity to different input categories. According to the estimates, labor productivity in Canadian agriculture increased at an annual rate of about 6 percent at the national level, and ranged between 5.5 percent in Quebec to about 9 percent in British Columbia during 1950-1974. The results reveal some interesting regional differences in terms of the major components of growth in agricultural labor productivity. While in the Atlantic region, the effect of labor outmigration, and other technological progress, were dominant contributors to gains in labor productivity, in Quebec it was growth in livestock technology and to a lesser extent outmigration and crop yield technology, which contributed the bulk of the growth in labor productivity. Ontario achieved superior performance in livestock yield technology, as well as in land and buildings, and at the same time performed well in outmigration and crop yield technology. Although the effect of outmigration was lowest in the Prairie region, growth in labor productivity performed creditably well as a result of the remarkable performance recorded in land and buildings, mechanization and to a lesser extent, crop yield technology. In the British Columbia region, the much superior performance in land and buildings, coupled with reasonably high growth rates in livestock technology, and the effect of outmigration, were responsible for the achievement of the highest overall growth in labor productivity in this region.

Compared with the Atlantic and Quebec regions, the three regions of Ontario, the Prairies, and British Columbia achieved superior performance in labor productivity during the period under consideration. The estimates demonstrate the importance of capital formation as a necessary source of growth. The Quebec and Atlantic regions appear to have lagged behind the rest of Canada in expenditures per worker in capital inputs related to land and buildings, and mechanization. In Canada as a whole, as well as in Ontario, the Prairies, and British Columbia, capital and material inputs contributed nearly half of the overall growth in labor productivity. However this dominant role of capital and material inputs in contributing to growth in productivity was apparently absent in the Atlantic and Quebec regions, where technological progress and the effect of outmigration were the dominant contributors to growth in productivity.

The estimates also indicated, in general, that at both the national and regional levels, the contribution of crop yield technology was the lowest in comparison to the contributions of mechanization, and livestock yield technology to a lesser extent.

If the results of this study are any guide then the analysis has isolated sources for achieving continued gains in Canadian agricultural productivity, namely the improvements in yield technology in all regions, increased developments in land and buildings, especially in the Atlantic and Quebec regions, and increased outmigration of labor from farms, especially in the Prairies where the developments of more farm processing industries will help to speed up movement of labor from farms.

It must be stated, however, that increased gains in agricultural productivity must be matched by effective market development, and market organization for farm products, to ensure that such gains in productivity serve to provide the necessary conditions for improvements in farm incomes rather than the depressant of farm incomes.

In conclusion, a few remarks about the major limitations of this study is in order. The procedure employed in this study, although conceptually attractive, has its share of drawbacks.

The principal shortcoming of the approach is the assumption of equilibrium conditions, which enables the substitution of factor shares for production elasticities. Such an assumption ignores the more realistic gradual adjustment lags in resource allocation. The use of factor shares as production elasticities in a Cobb-Douglas production function framework, means that returns to scale are freely determined statistically. Greater factor shares, therefore, implies greater returns to scale, greater contribution is imputed to individual resource inputs, and consequently a smaller residual is imputed to "all other changes", as the contribution of other technological progress.

The second major problem, although by no means unique to this approach, is the problem of the existence of non-market transactions in agriculture. These non-market transactions pose data problems when it comes to estimating the factor income share of farm labor and capital inputs directly from labor earnings and capital expenditures. Indirect methods adopted to circumvent this data problem are at best approximations.

Throughout the analysis gross output per worker has been employed to measure labor productivity. The use of net output per worker as a measure of labor productivity would provide results different from those of the current study.

ACKNOWLEDGEMENTS

Although the preparation of this thesis was a personal assignment, it would have been an impossible task to accomplish without the valuable assistance of a number of people and institutions to whom the writer wishes to extend his appreciation.

I wish to extend my greatest thanks to Dr. Martin H. Yeh, my senior program advisor, under whose direct supervision this thesis was written, for his constructive criticisms and continuous encouragement, during the preparation of this study and throughout the course of my entire academic program.

My thanks also go to Dr. C. F. Framingham for reading and criticizing earlier drafts of this study.

I am equally grateful to Dr. I. Lipnowski, of the Department of Economics, for suggesting valuable additions to the study.

My greatest appreciation and indebtedness are extended to the Food and Agricultural Organization (U.N., Rome) for making it financially possible for me to study in Canada, and to the Economic Research and Planning Service of the Ministry of Agriculture, Ghana, for granting me leave of absence.

I also wish to extend my sincere thanks to, P. F. Ellis for moral support, members of my family for their constant prayers, Miss Helen Slater of the Department of Agricultural Economics, for her motherly understanding and encouragement during the course of my study, and to all my colleagues and friends who made graduate school enjoyable and a rewarding experience.

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CHAPTER 1

INTRODUCTION

A. Historic Trends in Labor Productivity:

Canadian agriculture has achieved dramatic gains in agricultural productivity[1] since World War II. There has been dramatic change in resource use, in technology and in labor productivity over the period 1950-1974. Historic labor productivity ratios[2] reveal that the average value of gross output per worker in Canadian agriculture, measured in 1961 dollars, was greater than $3000 during the five year period 1950-1954. This annual average figure rose to over $4000 during the period 1960-1964, and during the period 1970-1974 it stood at nearly three times its 1950-1954 level. Changes in real net[3] labor productivity values followed a similar pattern as the gross measure discussed above (Table I).

Annual comparisons of regional agricultural labor productivity show the existence of significant regional differences in labor productivity regardless of whether labor productivity is

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[1]Agricultural productivity as used in this context is defined as output per unit of total farm input measured in constant dollars. See I-F Furniss "Productivity Trends in Canadian Agriculture, 1935 to 1964," Canadian Farm Economics; Vol. 1, No. 1; April 1966; p. 18.

[2]Labor productivity ratios measure labor productivity in terms of output per worker either as: a) the gross value of production per worker, or b) the net value of production per worker.

[3]Labor productivity is real and net in the sense that it is estimated in 1961 dollars and net of purchases from non-agricultural sectors, which are used in the process of production.

TABLE I

LABOR PRODUCTIVITIES, SELECTED PERIODS, FIVE YEAR ANNUAL AVERAGES: CANADA & REGIONS, 1950-1974 (1961 DOLLARS)*

PERIOD	CANADA	ATLANTIC	QUEBEC	ONTARIO	PRAIRIES	B.C.
			GROSS OUTPUT PER WORKER			
1950-1954	3164	2212	1914	3460	3785	4897
1960-1964	4352	2350	3894	6257	5870	6973
1970-1974	8789	6138	5943	10188	9312	10538
			NET OUTPUT PER WORKER			
1950-1954	1729	1127	999	1647	2270	2606
1960-1964	1902	960	1298	2168	3160	3470
1970-1974	3293	1969	1973	3348	4306	3815

Source: Based on data from Statistics Canada (See Appendix, Tables 8 (A-F)).

measured as gross, or net, value of production per worker. The estimates showed that there have been substantial gains in agricultural labor productivity in all regions during the period 1950-1974.

In terms of gross output per worker, British Columbia consistently achieved the highest labor productivity values in all three selected periods. The Prairie region had the second largest productivity value during the period 1950-1954, followed by Ontario, the Atlantic region, and Quebec, in descending order of magnitude. This ranking was slightly altered during the sub-period of 1960-1964, when the second highest productivity value was recorded by Ontario, the Prairie region ranking third, followed by Quebec, with the Atlantic region achieving the lowest labor productivity. The ranking of the labor productivity values for the sub-period 1970-1974 was the same as that of the sub-period 1960-1964, with the Atlantic region once again achieving the lowest agricultural labor productivity value. The estimates also revealed that the labor productivity values of British Columbia, the Prairie region, and the Ontario region, were always above the national average in all selected periods, while those of the Quebec and Atlantic regions were below the national average for Canada.

Measured in terms of net value of production per worker, the British Columbia region topped the labor productivity rankings for the sub-period 1950-1954, the Prairie region was second, followed by Ontario, the Atlantic region, and Quebec, in that order. This ordering of magnitude was similar to that of the sub-period 1960-1964, with the exception that the lowest labor productivity value was recorded in the Atlantic region. However, during the sub-period 1970-1974, the highest labor productivity estimate was achieved by the Prairie region, with the rest of the regions achieving the same ranking position as for the sub-period 1960-1964. In all the selected periods the net productivity values for the Prairie and British Columbia regions were constantly above the national average, while those of Quebec and the Atlantic were below the national average, with those of Ontario more or less at par with the national average values. Regional average growth rate in labor productivity ranged from a low of about 5.5 percent per annum in Quebec to a high of about 9 percent in British Columbia. There is some evidence from the above review that part of the productivity differences among regions can be explained by the fact that farmers in some regions purchase and utilize more inputs from the non-agricultural sector than their counterparts in other regions. One may therefore be tempted to hypothesize that agriculture in some regions is more efficient than agriculture in other regions because it is more highly mechanized. Estimates of resource inputs per worker in agriculture in the various regions may throw some light on the validity of such a hypothesis. But before then an analysis of changes in the agricultural labor force will be attempted.

B. Labor Inputs and Labor Productivity:

An important observation to be made concerning employment in agriculture during the period under study is the rapid decline in the farm labor force in all regions of Canada. During the period, the Atlantic region experienced the highest annual rate of decline in agricultural employment, about 3.5 percent. The lowest annual rate of decline occurred in the Prairie region, about 1.5 percent. The rates of decline in the agricultural labor force for the other regions fell within this range. The significant decline of the farm labor force in the majority of the regions may be explained by the availability of non-farm job opportunities, such as logging and fishing in the Atlantic region, trade, finance and manufacturing in Ontario and Quebec and industrial development and tourism in British Columbia. Lack of non-farm job opportunities might have been the major contributory factor to the slow rate of decline in the Prairie region. These rapid rates of decline in agricultural employment are related to the significant changes in labor productivity in the various regions which were discussed earlier.

C. Resource Inputs Per Worker:

Given the considerable achievements in absolute labor productivity levels, which were most significant in the British Columbia, the Prairie, and Ontario regions, one may be tempted to hypothesize that the productivity gains in these regions are the result of efficiency from a more highly mechanized agriculture than that present in the rest of Canada. A comparison of resource inputs per worker partially explains the major differences in the intensity of input utilization among regions during the period 1950-1974, (Table II).

TABLE II

RESOURCE INPUTS PER WORKER: CANADA & REGIONS, 1950-1974 (1961 CONSTANT DOLLARS)

Resource Description*	Canada	Atlantic	Quebec	Ontario	Prairie	B.C.
Land and buildings	1437	750	1043	1730	1608	1920
Labor	....	....	....	....	....	....
Capital Inputs Related to:	2850	2089	1932	3506	2879	3188
Mechanization	1483	825	457	1308	2061	1195
Crop yield technology	305	389	221	455	252	334
Livestock yield technology	882	757	1060	1474	411	1438
Miscellaneous operating expenses	180	118	194	269	155	221

Source: Based on data from Dominion Bureau of Statistics, (See Appendix, Tables 5 (A-F)).

* These categories of resource inputs will be defined later in the study.

Resource inputs have been stratified by type of input into land and buildings, capital inputs related to mechanization, crop yield inputs, livestock yield inputs, and miscellaneous operating expenses. The results show that more significant differences exist among regions in capital inputs related to mechanization, and livestock yield technology, than is the case in land and buildings (except the Atlantic region), and crop yield technology. Table II shows that in British Columbia, expenditure per capita of labor employed in agriculture was highest in land and buildings, followed by livestock yield inputs, and mechanization. In the Prairie region, however, expenditure per worker in mechanization was highest, followed by land and buildings, with expenditure per worker in crop-yield technology being comparatively low. Ontario's expenditure per capita pattern was similar to that of British Columbia with land and buildings being the highest, followed by livestock-yield technology, before mechanization. In the Quebec region expenditure per worker in livestock-yield technology predominated slightly over land and buildings, with mechanization, and crop-yield technology being relatively low. Expenditures per worker on resource inputs in the Atlantic region were comparatively low in all cases, although one of the highest values of expenditure per worker on crop-yield technology occurred there.

On the basis of this preliminary analysis alone, a partial explanation of the higher labor productivity values achieved by British Columbia, the Prairie region, and Ontario, can be attempted. British Columbia's higher productivity values may be due primarily to more intensive capital inputs related to land and buildings, livestock-yield technology, and mechanization. The Prairie region achieved higher productivity in agriculture mainly due to capital inputs related to mechanization, land and buildings, while labor productivity increases in Ontario may be attributed mainly to capital inputs related to land and buildings, livestock-yield technology, and mechanization. In the Quebec region expenditure per worker in livestock-yield technology, and land and buildings may be the major contributors to increases in labor productivity. Mechanization, livestock-yield technology, and land and buildings might have contributed to growth in labor productivity. At the national level, expenditure per worker was more intensive in mechanization and land and buildings. The similarity between the national estimates and the Prairie region show the predominant position occupied by the Prairie economy in Canadian agriculture.

The analysis so far has attempted to demonstrate that increases in farm labor productivity were not only affected by the rate of growth in total farm capital, but also by changes in the composition and most probably the quality of farm capital inputs during the period. Apart from the capital inputs other non-readily quantifiable changes might have contributed very significantly to labor productivity. Such factors may include crop variety and livestock improvements achieved through research; they may cover farm management practices, regional specialization, farm size distribution, farmer education, and other items which are difficult to measure quantitatively. Given the state of technology, the fact that fewer farmers today produce more than was produced twenty-five years ago shows that by far the most significant contribution to growth in labor productivity has come through adjustments of the farm labor force itself. Even if a constant volume of production is assumed, the mere fact that fewer farmers are able to produce that volume of output reflects increased productivity, ceteris paribus. It can be hypothesized, therefore, that the fast growth, and changes in Canadian agricultural labor productivity were influenced not only by various types of variations in farm capital inputs, but also to a considerable extent by changes in, and the efficiency of resource utilization, commonly referred to as technological change.

D. Statement of the Problem:

The above analytical review clearly demonstrates that significant regional differences exist in Canadian agricultural labor productivity, and that productivity in Canadian agriculture is influenced not only by changes in farm capital but even more so by technological progress.

Although considerable research and discussion has been conducted on the topic of agricultural labor productivity, the majority of these works and discussions were limited to the national level.[4] Agricultural labor productivity has not received ample attention at the regional level. Little research has been conducted on labor productivity associated with both

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[4]This observation will be substantiated in the next chapter.

physical inputs and technological change in the past, probably due to the lack of a suitable conceptual framework for the quantitative measurement of technological change and the components of agricultural labor productivity. Some of these conceptual problems have been removed, at least partially, with the recent development of a conceptual framework for the empirical analysis of agricultural labor productivity and technological change by Ludwig Auer.[5] The present study will employ the techniques and one of the concepts developed by Auer for the quantitative analysis of Canadian agricultural labor productivity and technological change at the regional level.[6]

Quantitative estimates of the contributions to gains in agricultural labor productivity by adjustments in the farm labor force, increased capital inputs, and technological change, will serve as a lead to indicate how further gains in labor productivity may be achieved. As in other sectors of the economy, high productivity gains in agriculture are essential to the achievement of higher levels of income in the longer run. They serve as a necessary, although not sufficient, condition for improved farm incomes. It is therefore important to explore and evaluate all possible avenues for potential further improvements in agricultural productivity, and especially those that contribute to farm income. It must be emphasized, however, that the

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[5]See, L. Auer, "Canadian Agricultural Productivity," Economic Council of Canada, Staff Study No. 24, Queens Printer, Ottawa, 1970.

[6]*Ibid*.

present study focuses on regional productivity performance issues rather than farm income and cost-price relationships.

E. Objectives of the Study:

There has been remarkable growth in Canadian agricultural labor productivity. Compared to 1950-1954 productivity levels, the productivity values in 1970-1974 were two to three times higher in Canada and Canada's regions. This study is designed to investigate the nature of agricultural labor productivity and technological change in Canada, and the five statistical reporting regions of Canada, during the period 1950-1974. The study attempts to demonstrate the extent to which adjustments of the agricultural labor force, increased capital inputs, and other technological progress have contributed to gains in agricultural productivity. The major objective of the study is to carry out a comparison of regional productivity performance and to measure the major components of productivity in each region during the period, using data stratified by type of inputs. Specifically, the study attempts to achieve the following objectives:

1) to determine the annual growth rates in agricultural labor productivity and technological change in different regions,

2) to determine the contribution of individual resources, and technological change to growth in agricultural labor productivity, and

3) to examine how further gains in agricultural labor productivity may be achieved in different regions.

As a secondary objective, the study will also examine to what extent, using the methodology and data employed, a Cobb-Douglas-type 'labor productivity' production function approximates actual agricultural production per worker.

F. Organization of the Study:

The geographical scope of the study is Canada and the five statistical reporting regions of British Columbia, the Prairies (Alberta, Saskatchewan, Manitoba), Ontario, Quebec, and the Maritimes* (Prince Edward Island, Nova Scotia, New Brunswick).

Chapter II deals with a review of some previous related studies and further attempts to justify the present study. Various basic theoretical concepts which are pertinent to the measurement of technological change and agricultural labor productivity are discussed in Chapter III. The model for the empirical analysis of labor productivity and technological change is specified and developed in Chapter IV, followed by a presentation and discussion of the empirical results of the study and their implications for resource allocation at the regional level, in Chapter V. Finally, a discussion of the limitations of the study, summary and conclusions, is presented.

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* Newfoundland is not included.

CHAPTER II

REVIEW OF RELATED STUDIES

Agricultural productivity analysis has been the subject of considerable interest to several Canadian economists for some time. This is demonstrated by the sizeable number of studies which have been conducted on it and other related topics, especially since World War II. Some of these studies have attempted to identify the major sources of productivity while others focused on depicting the role of technology in Canadian agriculture. This chapter of the present study provides a review of studies related to Canadian agricultural productivity. The emphasis here is on the techniques used for measuring agricultural productivity, the period, and geographical scope covered by each study.

A comparative study of the productivity of labor in Canadian agriculture within regions and between the agricultural and non-agricultural sectors of the economy, covering the period 1945-1953, was undertaken by Anderson.[1] The measure of productivity used was the net product[2] per unit of labor, in dollar and index forms, based on an approach he called the "residual method". This method which does not require the use

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[1]W. J. Anderson, "Productivity of Labor in Canadian Agriculture," The Canadian Journal of Economics and Political Science, Vol. 21, No. 2,(May 195), pp. 228-236.

[2]Net product in this case refers to the residual of farm income after accounting for the value of land and other farm capital, as well as purchased inputs from the non-agricultural sector, used in the production process. It refers to labor's share in total outputs.

of formal mathematical functions, derives its name from the manner in which the return to labor is computed. The return to labor is the remainder from net farm income after deducting the contribution of land and other capital inputs. Farm production was also adjusted for changes in inventories held by the Canadian Wheat Board. The agricultural labor force was then adjusted for differences in sex and composition and length of the working year to make it more comparable to the non-agricultural labor force. After obtaining the "residual" (return to labor input) it was divided by the adjusted labor force to obtain an annual value of labor productivity in dollar or absolute terms. This type of productivity measure is sometimes referred to as a 'partial' productivity measure. Each productivity value was then converted into a form of index number by taking the national productivity figure as a normalization base. There are two basic assumptions underlying the use of the "residual" method. Firstly, it assumes that market prices correctly reflect the productivity of some of the factors. This implies that all inputs, with the exception of labor, are valued at market prices. Secondly, the method also must assume that the sum of the marginal productivities of the factors multiplied by their prices equals the total value of the product. If this second assumption, that returns to factors account for the total product, is wrong, then the residual return to labor will be higher than the true value of the marginal production of labor, and the labor productivity estimate would be biased upwards.

Anderson's analysis showed wide regional variations in Canadian agricultural labor productivity. Eastern Canada (especially the Maritimes and Quebec) achieved lower productivity in comparison to the Western regions of British Columbia and the Prairies. Compared with the non-agricultural sector, the author indicated that variability between regions in productivity was much greater in agriculture than in other occupations, and that agricultural productivity was considerably lower than non-agricultural productivity during the period.

The partial productivity measure was also used by Hood and Scott in their productivity analysis covering the period 1926-1955.[3] Gross domestic product (G.D.P.) in agriculture was estimated in constant 1949 dollars. The agricultural labor force was measured in man-hours. The productivity of agricultural labor was then measured in terms of dollars of output per man-hour. The rate of growth in productivity for selected periods ranged from a low of .60 percent in 1926-1947 to a high of over 11 percent in 1959-1953. The authors noted that figures of productivity in agriculture are extremely sensitive to variations in crop yields. They observed that part, at least, of the phenomenal rate of increase in the G.D.P. per man-hour achieved in Canadian agriculture during the post-war period must be attributed to good crop yields, coupled with increased mechanization, which progressed at a rapid rate during the period.

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[3]W. C. Hood and A. Scott, "Output, Labor and Capital in the Canadian Economy," (Ottawa, Royal Commission on Canada's Economic Prospects, 1955), pp. 214-215.

In subsequent research, MacEachern and MacFarlane up-dated the earlier work of Hood and Scott for the 1960-1964 period.[4] This latter work also employed labor productivity measured in terms of gross domestic product (in 1949 dollars) per man-hour, with the results showing continued but less dramatic gains in productivity. Like its predecessor, the second study was also national in scope.

A study was undertaken by Lok to test the hypothesis that rising productivity in the farm sector has been detrimental to farm income.[5] The author chose a constant dollar method to measure input and output and decided to use the Laspeyres formula with four different weight periods along with the Paasche formula and a chain index formula (i.e.: he created six index number time series of productivity, of output, of gross income and of real net income).

The actual procedure of calculating the four constant weight series was as follows. The current outlay on each input taken from Statistics Canada farm income statistics was divided by its own price for each of the four weight periods selected.

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[4]G. A. MacEachern and D. L. MacFarlane, "The Relative Position of Canadian Agriculture in World Trade," Report on the Conference on International Trade and Canadian Agriculture, Banff, 1966, (Ottawa, Economic Council of Canada and Agricultural Economics Research Council of Canada, 1966).

[5]S. H. Lok, "An Enquiry into the Relationships Between Changes in Over-all Productivity and Real Net Return per Farm, and Between Changes in Total Output and Real Gross Return, Canadian Agriculture 1926-1957." Technical Publications, (Ottawa, Economics Division, Dept. of Agriculture, 1961).

The values so derived for individual inputs were then added to give total input. This aggregate was then converted into an index number series based on the first year (1926 = 100). The method, therefore, produced a quantity index of aggregate input weighted by relative prices of the selected periods.

The same procedure was followed to obtain indices of gross physical output which, when divided by the indices of total inputs, gave the overall productivity indices required in the study.

Using the annual percentage changes in overall productivity and real net return per farm, the working hypothesis was tested by a simple linear regression. On the basis of the data and method used, the hypothesis was not substantiated and no evidence was found for the belief that Canadian agricultural productivity and real net return per farm are inversely related. Instead, as far as Canadian agriculture is concerned, the evidence suggested that with every percentage increase (decrease) in overall productivity, net return per farm increased (decreased) by about 1.5 to 2 percent.

As the author did not intend to describe and interpret fully the changes in the overall productive capacity of inputs, the productivity indices included weather and other extraneous but important effects. He did not separate resource saving technology from the exogenous sources of changes in overall productivity. Therefore, the results do not provide a quantitative measure of the contribution of technological progress to rising productivity.

In 1961, MacKenzie, as a means of examining the net productivity of agriculture for the period 1926-1958, measured the physical productivity per person employed in agriculture using three base periods, 1926, 1935-39 and 1946, for selected periods.[6] The net productivity during each period was calculated by estimating the constant dollar gross volume of agricultural production and subtracting from it the constant dollar volume of purchased inputs. This was done with valuations of both gross output and purchased inputs in 1926, 1935-39 and 1946 prices. Net agricultural productivity was measured as net value added per man, and taking the value of each base period, the results were then converted to index form. The results of the study indicated that agricultural productivity relatively lost ground during the period 1944-48, but recovered effectively by 1949-53 and continued to improve during 1954-58. The author attributed the low relative position of productivity in the 1944-48 period to possibly the effects of shortages of men and materials (particularly machines) coupled with the effects of output fluctuations due to poor crop yields. However, the author concluded that agricultural productivity improved considerably in the post-1949 period.

Later in 1962, in an attempt to measure the impact of technological change in Canadian agriculture as a whole and by regions, MacKenzie determined an index of net output per unit

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[6]W. MacKenzie, "The Terms of Trade, Productivity and Income of Canadian Agriculture," Canadian Journal of Agricultural Economics, Vol. IX, No. 2, (1961), pp. 1-13.

of factor input as an indicator of technological change within agriculture.[7] The basic theoretical assumption underlying the approach adopted in this study is that purchased inputs are paid for at prices equated with their marginal productivity and that a rise in net output comes about as a result of internal productive efficiency.[8] The study which covered the period 1944-1958, used 1944-1948 as a base period for constructing the index of net output and total inputs. Output and inputs were valued at 1926 and 1946 price levels.

The constant dollar gross volume of agricultural production was estimated first, by deflating the total gross income of agriculture by the official index of farm product prices on a 1935-39 base. It was then revalued at 1926 and 1946 prices. The purchased inputs were individually deflated by the relevant indices and then added to represent a constant dollar total of purchased inputs. The constant dollar totals were subtracted from the constant dollar totals of gross output to yield a constant dollar measure of net output. This was done at each of the three price levels for each of the regions of Canada. Then the five year average value of net output for the period 1944-1948, was used as a base period to construct an index of net output up to 1958. Productive efficiency was then measured as net output per unit of factor input.

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[7]W. MacKenzie, "The Impact of Technological Change and the Efficiency of Production in Canadian Agriculture," Canadian Journal of Agricultural Economics, Vol. X, No. 1, (1962), pp. 41-53

[8]The term productive (or physical) efficiency has the same meaning as overall productivity in agriculture. It is expressed as the ratio of net output to weighted sum of total factor inputs, all measured in constant dollars.

The author indicated that productive efficiency increased in Canadian agriculture in all regions. However, the Maritime region showed the largest rate of gain followed by the Prairie region. The lowest rise occurred in the British Columbia region and Ontario was substantially behind the other regions in the rate of rise. In both the Maritimes and Quebec the rise in the second five year period was more or less as high as the first five years, whereas in British Columbia, the rate of gain was greater in the last five years than the first five. In Ontario the rate of change between periods was more gradual.

Analyzing these increases in efficiency, the author noted that the most striking relationship was between the rate of gain in efficiency and the rate of decline in the labor force. In the Maritimes and Quebec, where the largest relative gains occurred, labor had left agriculture relatively faster than elsewhere in Canada. On the other hand, he indicated that the replacement of man with machine, land with fertilizer and weed sprays, better cultivation practices, all partially contributed to the rise in net product per unit of factor input.

In yet another productivity study covering the period 1944-1958, MacKenzie employed the index technique as described above to measure changes in overall productivity (i.e. productivity per unit of factor input) and productivity per man.[9]

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[9] W. MacKenzie, "Regional Changes in Income, Terms of Trade and Productivity Within Canadian Agriculture," Canadian Journal of Agricultural Economics, Vol. XI, No. 2, (1963), pp. 41-51.

In this third study, which was regional in nature, the author indicated his preference for the total productivity measure (i.e. output per unit of factor inputs), with the explanation that net value added per man in constant dollars has the disadvantage of measuring physical productivity per unit of only one factor of production. However, he indicated that it is worthwhile to bring out the differences in rates of change when productivity is measured by the partial ratio of net value added per man and the more complete ratio of net value added per unit of factor input. His results revealed that the former measure of productivity has a tendency to be biased upwards, compared with the latter. Thus, on a per man unit basis, all regions showed a much more substantial rate of gain than on an output per unit of factor input basis.

Productivity was measured as the total output/total input ratio using the constant dollar method to measure both output and inputs by Furniss.[10] The study analyzed the changes in total output, total inputs and productivity in Canadian agriculture for the period 1935 to 1960. Furniss defined productivity as the ratio of the index of the volume of output to the index of the volume of all relative tangible inputs, with both indices based on 1935-39 constant dollars. Laspeyres' weighted aggregative formula is used to calculate index numbers of inputs and outputs. The procedure involves weighting the inputs and outputs in the time series by their prices for a particular base period. Annual

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[10] I. F. Furniss, "Productivity of Canadian Agriculture, 1935 to 1960: a Quarter Century of Change." Canadian Journal of Agricultural Economics, Vol. Xii, No. 2, (1964), pp. 41-53.

total input and total output measures are obtained by adding the resultant constant dollar values, for all items for each year. The constant dollar values are then taken as a measure of the changes in physical quantities during the period. The annual total output per unit of total input measures changes in overall productivity of the inputs.

The author estimated that the productivity of Canadian agriculture increased at an average annual rate of 2.6 percent during the period. He attributed this increase in productivity to an average increase in farm output of 2.3 percent annually and a corresponding decline in total inputs of 0.3 percent. A breakdown of the total input mix indicated a decreasing proportion of labor, little change in real estate, and a substantial increase in capital. Labor on farms decreased at an annual rate of 2.4 percent; the increase of capital inputs, especially machinery and fertilizer, was 3.7 percent annually; farm real estate showed a fractional decrease (of less than 0.1 percent) each year of the period considered.

Later, in a second study using the same procedures, Furniss extended his period of observation to 1964 and used 1949 as a new price weight.[11] The author's estimates showed that agricultural productivity in Canada increased at an annual rate of about 2.2 percent from 1935 to 1964. This was the result of 1.9 percent increase in output coupled with a fractional decline

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[11] I. F. Furniss, "Productivity Trends in Canadian Agriculture, 1935 to 1964," Canadian Farm Economics, (Ottawa, Canada Department of Agriculture Economics Branch), Vol. 1, No. 1, April, 1966.

in total inputs. Furniss also measured the gross deomestic product per man in agriculture, which showed an increase of about 4.3 percent annually during the period 1935 to 1964.

These earlier studies by Furniss were concerned with productivity measures at the national level. Therefore, in a third study Furniss applied the same index techniques and method to measure regional agricultural productivity.[12] This regional study covered the period 1946 to 1965. The results showed that agricultural productivity growth rates ranged from a high of 3.6 percent in Quebec to a low of 1.7 percent in B.C. In Quebec, the increase in productivity was the result of an annual increase of 1.9 percent in farm output coupled with a decline of 1.7 percent in total inputs. Although the Maritime region showed a fractional decrease of 0.1 percent in output, the rate of decrease in inputs was 2.4 percent per year, with the result that productivity increased by 2.6 percent per annum.

On the Prairies, farm output rose from 1946 at a rate of 1.8 percent a year while inputs declined fractionally. Consequently, agricultural productivity in the region increased at 2.0 percent per year. The heavy weight which Prairie agriculture carries in the all-Canada indices is reflected in the close correspondence between the growth rate for the region and for Canadian agriculture as a whole, 2.3 percent per year since 1946.

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[12] I. F. Furniss, "Trends in Agricultural Productivity," Canadian Farm Economics, Vol. 2, No. 1, (April, 1967).

British Columbia agriculture showed the highest rate of growth in farm output, 2.6 percent per year. However, production inputs also rose by almost 1 percent annually, with the result that the rate of productivity growth was comparatively lower than in other regions, 1.7 percent per annum.

The author attempted to explain the regional differences in terms of the shifts which have occurred in the composition of farm inputs since 1946. Contrasted with the Maritime region where real estate inputs declined by 1.5 percent per year, British Columbia achieved an estimated 2.2 percent per year increase in farm real estate. Labor inputs declined in all regions, with the highest rate of decrease, 4.7 percent, being in Quebec, followed by the Maritimes with a decrease of 4.2 percent per year. Furniss indicated that the high rate of decline in the Quebec farm labor force was the main contributory factor to the overall productivity growth rate in that region.

The annual rate of growth in capital inputs in Quebec was higher than that in Ontario, but below the rates for the Prairies and British Columbia. British Columbia had the highest rate of growth in capital inputs, 2.5 percent per year. This was the principal factor which contributed to the productivity growth rate shown by that region.

In terms of the three main input categories of production discussed above, the decline in the farm labor force appears to have been the most important single factor contributing to productivity since 1946.

The latest study on productivity by Furniss dealt with productivity at the national level.[13] The study covered the period 1950-1969. Once again the productivity measure was computed from an index of farm output and an index of total farm inputs. During the period under consideration the rate of growth in agricultural productivity is estimated to have been almost 2.0 percent. The increase was the net effect of a rise of more than two percent a year in farm output and an annual growth in the volume of farm inputs of less than half a percent a year.

Furniss indicated that since 1960, the rate of growth in farm productivity increased because of an increased rate of growth in output which more than offset an increase of one percent in farm inputs, with the result that productivity improved at a rate of 2.5 percent annually. The study also went on to isolate the major factors in the input mix contributing to the growth in productivity. It was observed that farm real estate inputs in Canadian agriculture were relatively stable during the period both in terms of volume and share of total inputs. Labor employed in agriculture showed a continually declining trend throughout the 1950's and 1960's, averaging about 3 percent per year rate of decline during the period. Regarding capital inputs, which the author broke down into machinery and equipment, purchased feed, fertilizer and lime, and other capital, the results

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[13] I. F. Furniss, "Agricultural Productivity in Canada: Two Decades of Gains," Canadian Farm Economics, (Ottawa, Canada Department of Agriculture, Economics Branch), Vol. 5, No. 5, 1970.

indicated minimal increases in the total capital input category, although high rates of growth were recorded by individual capital inputs, during the period studied. For example, feed and seed purchased by farmers from the non-farm sector rose by almost 5 percent per year; fertilizer and limestone by almost 9 percent a year; other capital inputs by about 35 percent, while machinery and equipment increased by almost 2.0 percent per year.

With regard to farm labor productivity, which was measured by real gross domestic product (value added) per man in agriculture, Furniss observed an annual growth rate of more than 5 percent for the period 1950-1969, and an even faster rate of 6 percent a year for the decade 1960-1969. The author indicated that these rates of growth in agricultural labor productivity exceeded by a considerable margin the growth rates in labor productivity in the rest of the economy.

The 1950-1969 study by Furniss has been up-dated in a recent study by Shute.[14] Applying the same index number technique as Furniss, the author analyzed total productivity in agriculture at the national level, for the period 1961 to 1973. In a follow up study Shute extended the period of analysis to 1974 and the geographical scope to include the regions. According to this second study by Shute,[15] the growth rate of Canadian

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[14]D. M. Shute, "Input Substitution and Productivity of Canadian Agriculture, 1961 to 1973," Canadian Farm Economics, (Ottawa, Canada Department of Agriculture, Economics Branch), Vol. 10, No. 1, Feb., 1975.

[15]D. M. Shute, "National and Regional Productivity of Canadian Agriculture, 1971 to 1974," Canadian Farm Economics, Ottawa, (Canadian Department of Agriculture, Economics Branch), Vol. 10, No. 6, December, 1975.

agricultural productivity was in the order of about 0.9 percent a year. Annual productivity growth rates at the regional level indicated that the Maritimes, Quebec and Ontario recorded increases of less than 1 percent while the Prairies and British Columbia experienced decreases in agricultural productivity. The negative agricultural productivity growth rates in western Canada are attributed to lower growth rates in farm outputs which were not enough to offset the higher growth rates of farm inputs. Shute also disaggregated the farm input mix and analyzed the annual growth rates of the various input items in an effort to try and explain regional productivity performance.

Farm real estate at the national level increased about 1.78 percent a year from 1962 to 1974. At the regional level, British Columbia achieved the highest rate of growth in farm real estate (over 6 percent per year), followed by the Prairies with a little over 2 percent per year; Ontario and Quebec recorded annual growth rates of 0.24 percent and 0.09 percent respectively. The Maritimes region showed an annual rate of decline in farm real estate of 0.84 percent per year.

Labor in Canadian agriculture decreased at about 3 percent per year from 1962 to 1974. The rate of decline was highest in the Maritimes region, some 6 percent annually. Quebec showed a decrease in the farm labor force of 3 percent per year, while in Ontario and the Prairie region the annual rate of decline was about 2.7 percent. British Columbia had a decline of less than 1 percent per year in the labor force during the period.

The highest growth rate in capital inputs, about 5 percent a year, occurred in British Columbia, while the lowest rate of 2.4 percent in capital inputs occurred in the Maritimes region. These estimates obtained by Shute appear to lend some support to the earlier observation by Furniss who indicated that the rate of decline in the labor force appears to be the single most important contributory factor to growth in agricultural productivity.[16]

In general Shute concluded that there appears to be a trend towards increasing agricultural productivity in eastern areas of the country, while the trend in the west has been towards decreasing agricultural productivity. In this connection Shute carried out yet another study which focused on changes in agricultural productivity for eastern Canada, namely Quebec, Ontario and the Maritimes.[17] As usual, the technique of indices was the tool applied to measure agricultural productivity. The results showed that agriculture in the Atlantic region achieved the highest rate of growth in productivity, about 1 percent per annum, between 1962 to 1974, while in Ontario and Quebec the corresponding rates were 0.7 percent and 0.4 percent per annum, respectively. Once again the author concluded that the high rate of decline in the labor force appears to be the major force behind the comparatively higher growth in agricultural productivity achieved in the Maritime region.

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[16]I. F. Furniss, op. cit.

[17]D. M. Shute, "Agricultural Productivity in Eastern Canada," Canadian Farm Economics, (Ottawa, Canada Department of Agriculture, Economics Branch), Vol. 11, No. 5, Oct. 1976.

Yeh and Li, in a study on supply and demand for farm labor in Canada, also applied the index technique to measure agricultural labor productivity for Canada and the regions.[18] The index was derived from the ratio of total output to all associated inputs in real terms, using 1935-39 as a base period. This study covered the period 1946-1962.

The estimates of the above study indicated that the average change in productivity in Canadian agriculture was 2.5 percent per year during the period 1946-1962. During the same period, the highest average increase in productivity was 2.6 percent per year in the Prairie region. The other regions experienced slight changes in productivity over the period but as these were low and offsetting in sign, the Prairie increase proved to be the major single influence in Canadian aggregate average productivity increase.

In a second study by the same authors which was concerned with an analysis of technological change in Canadian agriculture for the period 1946-1965, they attempted not only to measure increases in labor productivity, but also to attribute the increases in labor productivity to increases in capital intensity or to technological change.

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[18]M. H. Yeh and L. K. Li, "A Regional Analysis of the Supply and Demand for Farm Labor in Canada," Canadian Journal of Agricultural Economics, Vol. XIV, No. 2, (1966), pp. 15-31.

[19]M. H. Yeg and L. K. Li, "Technological Change in Canadian Agriculture," Research Report No. 15, Winnipeg, Department of Agricultural Economics, University of Manitoba, 1968.

Net output of farm production was computed as the difference between gross output and total inputs purchased from the non-agricultural sector, all measured in 1935-39 prices. This net value added was then divided by the labor force measured in man-equivalents.[20] Thus, productivity is measured as value added per man equivalent of the labor force employed in agriculture.

Solow's model was applied to Statistics Canada data to measure the geometric growth of net technological change in regional agriculture.[21] The results indicated that Canadian agriculture experienced considerable technological change during the period 1946-1965. Regional differences in the annual rate of growth were even more dramatic. The highest growth rate of 4.4 percent was registered in the Atlantic region; Ontario ranked second with 3.7 percent, and the Prairies achieved a growth rate of 3.5 percent. British Columbia and Quebec recorded growth rates of 2.8 percent and 2.0 percent respectively.

With respect to total increases in labor productivity over the period, the results ranged from a high of almost 200 percent in Ontario and the Atlantic regions, to a low of about 100 percent in Quebec and British Columbia. The authors divided this total increase in net productivity measure into two parts, one

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[20]Man-equivalent is a measure of the labor force in adult male units, by a special adjustment procedure which takes into account age, and sex composition of the labor force. For details of the procedure see Yeh and Li (Ibid.), page 17.

[21]Yeh and Li, Ibid., page 12.

measured by the shift of the aggregate production function which results from technological change, and the other by the movement along the production function attributable to the increased use of capital per man equivalent. Over the period, for Canada as a whole, net labor productivity increased by 176 percent for the period 1946-1965. Technological change accounted for about three quarters of this change with the other quarter being attributed to capital. Among regions, the share of technological change in increased net labor productivity varied from almost 85 percent in the Atlantic region to about 60 percent in Quebec, while the corresponding shares in British Columbia, the Prairie and Ontario regions, were over 80 percent, nearly 79 percent, and about 75 percent, respectively.

The authors established the annual rate of growth in net labor productivity for the whole period, and also for four sub-periods. The annual growth rates for the whole period of 1946-1964 ranged from a high of over 10 percent in the Atlantic and Ontario regions, to a low of over 5 percent in Quebec and British Columbia. The Prairie annual average rate of growth was 8 percent.

The analysis by sub-periods indicated that the growth rates of labor productivity were generally low or even negative in the first and third sub-periods (i.e. 1946-1950 and 1955-1960). This the authors suggested was probably caused by a rapid decline in total net output and a low off-farm migration due to a lack of job opportunities in non-agricultural sectors during the period immediately following World War II and the period of economic recession. In the second and fourth sub-periods (1950-1955, and 1960-1965) the authors indicated that the Korean War and the economic boom at the time called for great demand for farm products on both domestic and foreign markets. The above reason, accompanied by a rapid outmigration of farm labor, and increased farm capital use were the probable factors which made possible the significant increases in labor productivity in these two sub-periods.

The studies reviewed so far have almost invariably applied the index number technique for the measurement and analysis of productivity in agriculture (see Table III). In general, the technique involves the construction of indices -- an index number for total inputs, and an output index. The output index is then divided by the input index to obtain a measure of annual change in overall productivity.

To obtain the input index each input component is deflated by the appropriate price index based on a particular year's weights. Thus the input components are converted into constant "dollar values", which are aggregated into total inputs. These aggregated values are then expressed as a percentage of the first year of the series. A similar procedure is followed to obtain the output index. This is the procedure used by Lok and in fact most of the analysts who employed the technique.[22]

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[22]S. H. Lok, op. cit.

TABLE III

SUMMARY OF PREVIOUS PRODUCTIVITY STUDIES, SHOWING PERIOD OF STUDY, GEOGRAPHICAL SCOPE, AND TECHNIQUE USED

AUTHOR	PERIOD	GEOGRAPHICAL SCOPE	TECHNIQUE
Anderson	1945-1953	Canada	Index method
Hood & Scott	1926-1955	Canada	Index method
MacEachern & MacFarlane	1960-1964	Canada	Index method
Lok	1926-1957	Canada	Index method
MacKenzie	1926-1958	Canada	Index method
MacKenzie	1944-1958	Canada & Regions	Index method
Furniss	1935-1960	Canada	Index method
Furniss	1935-1964	Canada	Index method
Furniss	1946-1965	Canada & Regions	Index method
Furniss	1950-1969	Canada	Index method
Shute	1961-1973	Canada	Index method
Shute	1962-1974	Eastern Canada	Index method
Yeh & Li	1946-1962	Canada & Regions	C-D Production Function
Auer	1947-1965	Canada	Production Function Framework Labor Productivity Function

Perkins carried out a review of Lok's productivity indices to evaluate their economic meaning.[23] He expressed the procedure for constructing Lok's inputs index number (I) as described above in the following mathematical formula:

$$I = \frac{\sum_j \left[\sum P_n Q_n \cdot \frac{\sum P_o Q_o}{\sum P_n Q_o} \right]_j}{\sum_j \left[\sum P_1 Q_1 \cdot \frac{\sum P_o Q_o}{P_1 Q_o} \right]_j}$$

where,

n = given year

o = the base year for the price indexes used

1 = the first year of the series, and

P and Q are price and quantity, respectively.

Perkins indicated that the inputs index expressed in the above formula is a "weighted sum of Paasche indices of input components divided by a similarly weighted sum of (the first year) Paasche index values,"[24] and is therefore not based on constant weights. He observed that the "measurement of changes in productivity by comparison of ratios of output index numbers to input index numbers necessitates the use of fixed weight indices, otherwise such measurements will not separate changes in productivity from changes in relative price." Perkins concluded that little economic meaning can be attached to both the input and output indices computed as above as well as their quotient used as a measure of changes in overall productivity.

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[23] B. B. Perkins, "What Do Lok's Productivity Indices Measure?", Canadian Journal of Agricultural Economics, Vol. XII, No. 2, (1964), pp. 70-71.

[24] Ibid.

Added to the illusive fixed weights problem involved in computing such indices was one of aggregation. The method of aggregation employed in the index approach assumes a linear and homogenous production function, which enables an arithmetic (addition) aggregation of weighted inputs and output.[25] The index technique also attributes changes in productivity entirely to tangible inputs only. This is probably so because the technique does not require formal mathematical functions which express the functional relationships between output and resource inputs. It is, therefore, not easy to conceptualize changes in productivity brought about by technological progress, let alone incorporate such progress explicitly in that kind of framework.

Auer has developed a conceptual frame work which enables the formulation and measurement of productivity using formal mathematical functions.[26] The author used production function analysis as a conceptual framework for an analysis of labor productivity in Canadian agriculture. After formulating the general relation between the value of production of a particular industry and the resource inputs employed, he demonstrated that a change in output can be attributed to changes in each of the tangible resource inputs and technological progress. He then derived a labor productivity function from the formulated

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[25]This is an assumption which economists have debated for some time now. See Paul A. Samuelson, Foundations of Economic Analysis, Cambridge, Mass., (1947), pp. 83-89.

[26]L. Auer, "Canadian Agricultural Productivity," (Ottawa, Economic Council of Canada, Staff Study No. 24, 1969).

production function and attributed changes in labor productivity to changes in resource and technological progress.

Auer's study attempted to identify the sources of growth in agricultural productivity at the national level, and to demonstrate to what extent adjustments of the agricultural labor force, increased capital inputs, and technological progress have contributed to gains in agricultural labor productivity. The approach assumed that farmers attempt to maximize their return. This assumption combined with data on farmers operating expenditures, investment in real estate, machinery, and labor use, provided the basis for computing the contribution these resource inputs made to overall growth in labor productivity. In other words, growth in output per worker is attributed to growth in expenditures on inputs per worker. For changes in labor inputs, however, a reduction in the labor force makes a positive contribution to growth in output per worker. Some indirect inputs, such as increased education, skill of the labor force, agricultural research, etc. were estimated summarily in a residual of "all other changes". The analysis is, therefore, restricted to growth in labor productivity measured in terms of growth in volume of production per worker.[27]

The results of the analysis showed that Canadian agricultural labor productivity advanced at nearly 6 percent per year during the period 1947-1965. The movement of workers out of

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[27]The concepts, assumptions, and technical details underlying the approach are given further treatment in Chapter IV.

agriculture accounted for over one-third of this gain. Another third is attributable to increased capital and material inputs, and the balance to "all other changes" which contributed the residual to the growth in labor productivity.

The method employed by Auer for measuring productivity has a number of important advantages over the index approach. These advantages can be summarized as follows:

(i) the technique derives from a production function analytical framework which has a clear theoretical basis,

(ii) it allows the use of formal mathematical function to express a functional relation between labor productivity and resource inputs per unit of labor,

(iii) it does not attribute growth in productivity to tangible resource inputs only,

(iv) technological progress can be explicitly incorporated in this conceptual framework as a contributory factor to growth in productivity,

(v) the measure of changes in productivity obtained has a definite economic meaning, in terms of growth in overall labor productivity and in terms of the factors which contribute to that growth,

(vi) the technique neither assumes nor limits itself to a linear production function as does the index technique, and

(vii) the procedure is suitable for a disaggregated analysis.

It is in view of the above that this concept of a labor productivity function is preferable to the index number approach as the technique to be used in the present study. Auer used the technique for national agricultural productivity analysis. In the present study the technique will be applied to regional data to analyze regional labor productivity performance during the period 1950-1974.

The next chapter develops a conceptual analysis of labor productivity with particular reference to agriculture, and the theoretical relationship between gains in labor productivity and resource use. Leading from this conceptual framework, the analytical model is specified, and developed for the empircal measurement of annual changes in labor productivity and its components in Chapter IV.

CHAPTER III

BASIC CONCEPTS IN AGRICULTURAL LABOR PRODUCTIVITY ANALYSIS

The major concern of this chapter is to present a theoretical discussion of the basic concepts which are relevant to the analysis of labor productivity, with particular reference to agriculture. The relation between gains in labor productivity, resource use and technological change are the focus of this conceptual analysis.

A. Concepts of Labor Productivity:

The term 'labor productivity' may be used to mean one of several things.[1] Firstly, labor productivity may be used to refer to the gross value of output obtained from a given combination of labor with other factors, divided by the units of labor employed.[2] This is the concept of labor productivity employed in the current study. Secondly, the term may be used with an abstract meaning to refer to the inherent ability or willingness on the part of a person to contribute to his or her efforts. In a more technical sense, labor productivity may refer to the value of the incremental product resulting from the addition of one unit of labor to a fixed quantity of other factors, given the demand for the product, the inherent ability of the worker and the nature of the available technology. This third concept is what is generally referred to in economic theory as the marginal

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[1]Anderson, op. cit.

[2]Units of labor in this case, may be expressed in terms of number of workers employed, or as total number of man-hours utilized.

product of labor, which measures the marginal increment to the value of total output. It is this last concept which has meaning and implications to the problem of optimal resource allocation within an industry or among industries.

The first concept, rather than the third, is employed to measure labor productivity in this study because the kind of data required in order to obtain an estimate of productivity using the third concept is not available. For the purposes of the current study, the first concept will be used.

B. Contribution of Resource Inputs:

Output at any date depends on many determinants, and it is changes in these determinants that cause output to change. An analysis of the sources of growth in output over any time span identifies the determinants that have changed and the contribution that changes in each have made to the change in output. The size of the contribution of a determinant depends upon its importance and the amount by which it has changed.[3] The importance of each factor input is estimated by its marginal product at a particular point in time. Then its contribution to growth is measured by its rate of growth weighted by its marginal product. This procedure can be applied to analyze the contribution of the various resource inputs to growth in labor productivity.

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[3]E. F. Denison, "Accounting for United States Economic Growth, 1929-1969," The Brookings Institution, Washington, D.C., 1974.

Under certain conditions the importance of each factor input can be estimated by its factor share. The factor shares approach derives from marginal productivity analysis which requires that the value of output be divided among the earnings of the various factors of production. The factor shares provide accurate estimates of the importance of the inputs if the earnings (prices) of the various factors of production are proportional to their marginal products. The proportionality of factor earnings and marginal products is achieved if it is assumed that enterprises combine factors in such a way as to obtain minimum factor cost combinations. Production at minimum cost to an enterprise implies that given the price at which factors can be obtained, factors are combined in that proportion which makes the marginal product of each factor proportional to the cost of obtaining it.[4] This means that under such conditions there is a tendency in a particular industry toward an equilibrium position of the most efficient combination of factors. This tendency, although by no means a stable one, can nevertheless be a strong one especially in a competitive industry such as agriculture, if not in the short-run, at least over a number of years.

In the light of the above theory the basic assumption underlying the analysis of labor productivity in agriculture which is made in this study is that farmers attempt to allocate their expenditures rationally by investing their money so that

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[4]See E. F. Denison, "Why Growth Rates Differ," The Brookings Institution, Washington, D.C., 1967.

each extra dollar yields the highest return. In other words farmers attempt to maximize profits by using least cost factor combinations. Given this assumption and coupled with data on farmer's operating expenses, investment in land and buildings, machinery, and labor use, the contribution these resources have made to overall growth in labor productivity, during the period under consideration, can be computed.

C. Labor Productivity and Resource Use:

As indicated above the relative importance of the various changes in resource use is estimated by weighting each of the changes by the cost share of that resource in total farm production. To illustrate this procedure let us assume, for example, the share of land and buildings is one-tenth of the current value of farm production, and that land and building operating costs (in constant dollars) change at an annual rate of, say, 5 percent. Then, the annual gain in labor productivity attributed to these changes in farm real estate is estimated at 0.5 (.10 x 5) percent. Assuming an annual rate of growth in labor productivity of, say, 5 percent, this implies that one-tenth of the total growth is imputed to land and buildings. In general, the same procedure is applicable to all other resource inputs which are identified as sources of improvement in labor productivity. However, in the case of the labor input, a reduction in labor inputs with less than proportionate reductions in output will raise the level of labor productivity in terms of output per worker. The lower the level and/or the greater the reductions in labor inputs, the greater will be the imputed gains in labor productivity.

D. <u>Identifying Sources of Growth in Labor Productivity</u>:

Sources are defined to be the changes that are capable of causing labor productivity to increase from one year to the next year. Changes in output per worker can be attributed to a number of factors. For the purposes of this analysis, growth in output per worker is attributed to growth in expenditures on inputs per worker, which are used in production. For changes in labor inputs, a decline in the farm labor force makes a positive contribution to labor productivity. There are certain indirect inputs, such as increased education and skills of the agricultural labor force or agricultural research, which also contribute to growth in output per worker, but which are difficult to quantify. The analysis does not provide explicit estimates of the contribution to growth of these inputs. Instead this contribution is estimated in a residual of "all other changes", sometimes referred to as "factor productivity" or other technological change.[5] Thus, changes in agricultural productivity are attributed to changes in resource use and productivity improvements.

The basis for attributing changes in agricultural labor productivity to changes in resource (including labor) use and productivity improvements is exemplified by Auer.[6] The following three possible situations under which changes in labor productivity

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[5]Factor productivity measures improvements in the overall level of resource use due to technology.

[6]Auer, op. cit.

can occur are examined:

1) Labor inputs in agriculture remain constant while capital and factor productivity change,

2) Labor inputs in agriculture change while capital inputs and factor productivity remain constant, or

3) Labor inputs, capital inputs and factor productivity change simultaneously.

Under the first set of conditions there is no change in labor inputs, and all gains in labor productivity are attributed to changes in capital inputs and factor productivity. Such a situation can occur if, for example, a farmer expands his present cropland acreage by purchasing and clearing additional land, probably land used as wild pasture, and partly in bush and trees. The farmer intends to plant this newly developed land in grains and, to cope with the larger acreage, he replaces his small tractor-pulled combine harvester by a self-propelled combine with greater harvesting capacity. According to the estimation procedures applied later in this study, part of the gains in annual output per worker is imputed to greater capital inputs in land and machinery, and part of it is imputed to productivity improvements. Gains in labor productivity are imputed to capital inputs because purchases of new land and machinery enable the farmer to produce more output without change in his annual labor inputs.[7] The purchase of the self-propelled combine may also

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[7]The assumption here is that the clearing of the newly acquired land was "contracted out" and did not require hiring of additional labor on the farmer's part.

enable him to cut down his harvesting losses by greater timeliness of operations and add to his productivity. Such further productivity improvements are captured in residual factor productivity.

The second set of conditions assumes that labor productivity varies with changes in labor inputs while the levels of capital inputs and factor productivity remain constant. This situation can be illustrated with the case of two neighboring farmers. Let us assume for one reason or another the first farmer decided to cease farming and sells his land, machinery and equipment to the second farmer. With the exit of the first farmer labor inputs are cut in half, capital inputs remain unchanged and labor productivity of the second farmer is doubled, assuming he succeeds in doubling his annual output. This situation implies that after consolidation -- without change in machinery and equipment -- one farmer alone cultivates as much land as two farmers. In such a situation the estimation procedures impute all of the gains in labor productivity to labor adjustments. This is possibly a somewhat unrealistic outcome, since it suggests that before consolidation both farmers were grossly underemployed.

More realistically, changes in agricultural labor productivity are more likely to occur under the third set of conditions, where changes in labor inputs, capital inputs, and factor productivity occur simultaneously. This situation can be illustrated with a retiring farmer who sells land, livestock, machinery, and equipment. This may change resource use and cause changes in labor productivity in a number of ways. First, there is a positive effect on labor productivity if, after consolidation, total labor inputs are reduced. Secondly, there may be a slightly negative effect if some of the farm buildings go unused and abandoned. Thirdly, there is a positive effect if some of the small-scale depreciated machinery and equipment is placed by more efficient and more costly equipment. Fourthly, there are some additional gains in labor productivity if there are returns to scale from better use of farm machinery and equipment. And, finally, there could be some further productivity improvements due to better farm management. Thus labor productivity changes as a result of changes in both magnitude and proportion of both capital and labor inputs in the wake of technological progress. The analytical procedures adopted in this study, therefore, attribute changes in output per worker to changes in the magnitude and proportion of the labor force, capital inputs, and factor productivity or technological change.

Technological change and capital intensity are important concepts in the analysis of labor productivity. It is for this reason that a discussion of the various concepts of technological change, and their relation to labor productivity and capital inputs, is presented here.

E. Concepts of Technological Change:

Technological change has been defined by Solow as "any kind of shift in the production function".[8] Such a shift may

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[8]R. V. Solow, "Technical Change and the Aggregate Production Function," Review of Economics and Statistics, Vol. 39, p. 312, 1957.

originate from the adoption of improved seed varieties, regional specialization, acquisition of better skills and knowledge by the labor force, all of which make for better management of resources and result in more efficient production techniques. It is this change in the efficiency of resource use that is often referred to as technological change.

A simplified concept of technological change is to think of it in terms of increasing the level of output while holding the level of factor inputs constant. However, a more realistic concept of technological change postulates that the level of resource inputs does vary in both magnitude and proportion with advances in technology. This latter concept will be further elaborated later in a detailed discussion. Here a brief discussion of the types of technological change is presented.

F. Classification of Technological Change:

A number of conventions have been employed by economists to classify technological change. One such convention introduced by Hicks[9] has been to classify technological advances into:

1) 'labor-saving' changes (which facilitate the use of other labor substituting inputs), and

2) 'capital-saving' changes (which facilitate the use of other capital substituting inputs). According to this classification a shift in the production function can be either "neutral" or "non-neutral".[10] The technological change is said

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9 J. R. Hicks, "Distribution and Economic Progress," Review of Economic Studies, Vol. 4.

10 J. R. Hicks, The Theory of Wages, McMillan and Company, (2nd ed.), 1963.

to be neutral if the marginal productivity[11] of capital and labor increased in the same proportion. Put differently, a neutral change is said to have occurred when the marginal rate of substitution of capital for labor remains unchanged. A non-neutral type of technological change, on the other hand, is one which alters the marginal rate of substitution of capital for labor at each point on the production function. If the marginal productivity of capital increases more than the marginal productivity of labor, a non-neutral shift is said to be 'labor-saving' (or 'capital-using'), and 'capital-saving' (or 'labor-using') if the marginal productivity of labor increases more than the marginal productivity of capital.

The concept of neutrality is important in the evaluation of the relative contribution of capital intensity and technological change to labor productivity. This is because whether or not all or part of the increase in labor productivity is attributed to technological change depends on whether or not the change is neutral. In the case of a neutral production function shift, all of the increase in labor productivity could be attributed to technological change because the capital per unit of labor remained unchanged. However, if the shift was non-neutral, some of the increase in the labor productivity might be due to the interaction between capital or labor and technological change. In other words, if the shift was non-neutral, for example, as a

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[11]The marginal productivity of a factor input is the rate of change in total productivity with respect to a variation in quantity of that input.

result of interaction of an increase in capital per unit of labor and technological change then capital might have made a substantial contribution to the resulting increase in labor productivity.

A second convention for types of technological change was introduced by Solow, who classified it as either "embodied", or "disembodied" technological change.[12] Disembodied technological change is defined as an increase in productivity resulting from the use of productive techniques, such as improvements in seed varieties and crop rotations, innovations in mechanization, increased use of fertilizer and herbicides for weed control, better management and superior knowledge. This type of technical change applies equally to all factor items of capital and labor employed in the production process. Embodied technological chance is the increase in productivity due to improvements in quality of productive factors over time. Thus the utilization of the latest capital and its respective labor force leads to an embodied technological change. The embodied technological change concept implies that capital "produced" at different time periods have different quality contents and cannot therefore be treated as being homogeneous. Disembodied technological change upholds the homogeneity assumption for both labor and capital and allows their aggregation without a consideration of age differences.[13]

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[12]Solow, op. cit.

[13]R. G. D. Allen, "Macro-Economic Theory", MacMillan & Co., New York, L968.

In this study, assumptions relating to technological change will be made in the next chapter, when the research methodology is presented.

CHAPTER IV

RESEARCH METHODOLOGY

A great deal of research has been done using production function techniques for description and analysis of resource allocation in agriculture.[1] The production function approach is employed in this study for the analysis of labor productivity trends in agriculture. A discussion of some of the underlying assumptions and related concepts are presented here.

The general assumption underlying a production function is that there is a functional relationship between output (or value of production) of a particular industry and resource inputs. This concept can be expressed in a simplified mathematical form as in (1) below:

$$Y_t = f(X_{1t}, X_{2t}, \ldots\ldots\ldots\ldots, X_{nt}) \quad (1)$$

where

Y_t is output expressed as a function of resource inputs X_1, X_2, $\ldots X_n$ at time period (t).

To estimate the quantitative contribution of changes in resource use to output, the dynamic elements of production are taken into account by dating all changes in resource use. As

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[1]See E. O. Heady and J. L. Dillon, "Agricultural Production Functions," Ames, Iowa; Iowa State University Press, 1961. The approach adopted here follows that of Fred H. Tyner and Luther G. Tweeten, "A Methodology for Estimating Production Parameters," Journal of Farm Economics, Vol. 47, No. 5, December, 1965; p. 1462.

well, technological change is explicitly incorporated. No assumptions are made regarding returns to scale, neutral or non-neutral technological changes at this point. The only assumption made here is that the variables of function (1) have "finite and continuous derivatives of all orders which converge upon expansion".[2] Such changes in aggregate production can be described as shown in the following equation (2).

$$Y_{t+1} - Y_t = f(X_{1,\ t+1}, \ldots\ldots\ldots X_{n,\ t=1}) - f(X_{1t} \ldots\ldots X_{nt}) \quad (2)$$

Changes in annual output can be computed by the techniques of calculus. The conventional technique of imputing growth to particular resources is to differentiate the production function with respect to time. An alternative method for achieving the same goal is Taylor's expansion. Using this technique changes in output can be attributed to changes in resource use, their marginal productivities, and a series of interaction effects among resources. The principal advantage of using Taylor's expansion instead of time derivatives is that it is more accurate because the result of using time derivatives is equivalent to a first-term Taylor expansion. In this study a third-term Taylor expansion will be used to minimize further the error of estimation. The Taylor expansion technique has the added advantage of being programmable, thus enabling the use of computer software. The result of applying Taylor's expansion to function (2) is as expressed in equation (3) following:

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[2]L. Auer, "Comparative Analysis of Canadian and United States Productivity," A North American Common Market, Iowa State University Press, Ames, Iowa; U.S.A. 1969, p. 109.

$$\Delta Y = \sum_{i}^{n} \Delta X_i \left(\frac{\partial Y}{\partial X_i}\right)_t + \frac{1}{2!} \sum_{i}^{n} \sum_{j}^{n} \Delta X_i \, \Delta X_j \left(\frac{\partial^2 Y}{\partial X_i \partial X_j}\right)_t + \ldots\ldots + R \quad (3)$$

A rearrangement of terms in (3) yields (4):

$$\Delta Y = \Delta X_1 \left[\left(\frac{\partial Y}{\partial X_1}\right)_t + \frac{1}{2!} \sum_{j}^{n} \Delta X_j \left(\frac{\partial^2 Y}{\partial X_1 \partial X_j}\right)_t + \ldots\ldots\ldots\right]$$
$$\Delta X_2 \left[\left(\frac{\partial Y}{\partial X_2}\right)_t + \frac{1}{2!} \sum_{j}^{n} \Delta X_j \left(\frac{\partial^2 Y}{\partial X_2 \partial X_j}\right)_t + \ldots\ldots\ldots\right]$$
$$\vdots$$
$$\Delta X_n \left[\left(\frac{\partial Y}{\partial X_n}\right)_t + \frac{1}{2!} \sum \Delta X_j \left(\frac{\partial^2 Y}{\partial X_n \partial X_j}\right)_t + \ldots\ldots\right] + R \quad (4)$$

where

$\Delta Y = Y_{t+1} - Y_t$

$\Delta X_i = X_{i,t+1} - X_{i,t}$

$\Delta X_j = X_{jt,t+1} - X_{jt}$

R = remainder term

Function (4) indicates that a change in output, ΔY, is attributed to a change in each of the n-factor inputs ΔX_i, marginal productivities $\partial Y / \partial X_i$, interaction effects among resources, and a remainder term R.

The above approach is applicable to different types of production functions.[3] For the purposes of this study, however, a Cobb-Douglas type production function is chosen because it is simple to use and equally applicable to the type of empirical

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[3]See A. A. Walters, "Production and Cost Functions: An Econometric Survey," Econometrica, Vol. 31, No. 1-2, Jan.-April, 1963, pp. 1-66.

analysis applied here. The Cobb-Douglas production function can be expressed in its general form as follows:

$$Y_t = a(t) \prod_{t}^{n} X_i^{b_i(t)}$$

where

$$\prod_{i}^{n} X_i^{bi} = X_1^{b1} X_2^{b2} \ldots\ldots\ldots\ldots X_n^{b_n}$$

Y is the level of output

X_i is the level of the ith resource input

b_i is the ith production elasticity

a(t) measures factor productivity or technological change

In this study a neutral technological change is assumed, and therefore the Cobb-Douglas production function can be expressed as in (5) below:

$$Y = a(t) \prod_{i}^{n} X_i^{b_i} \qquad (5)$$

This means that resource inputs are allowed to vary, but production elasticities (b_i) are assumed to remain constant. This implies that technological change shifts marginal and average productivities equi-proportionately. Neutral technological change in this formulation can be represented by an exponential shift variable for the term a(t) in function (5) after Tinbergen's proposition[5], i.e., a(t) can be represented by $A_o e^{vt}$.

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[4]Factor productivity which measures improvements in the overall level of resource use due to technology is treated here in the same way as other variables.

[5]M. Brown, "On the Theory and Measurement of Technological Change," Cambridge University Press, 1966, p. 111.

Taylor's expansion can be applied to function (5) to express changes in output due to changes in resource inputs as in equation (6).

$$\Delta Y = \Delta a \frac{Y}{a}\left(1 + \frac{1}{2!}\sum_{i}^{n} b_i\left(\frac{\Delta X_i}{X_i}\right)_t + \ldots\ldots\ldots\ldots\right)$$

$$+ b_i \Delta X_1 \frac{Y}{X_1}\left(1 + \frac{1}{2!}\sum_{i}^{n} b_i\left(\frac{\Delta X_i}{X_i}\right)_t + \ldots\ldots\right)$$

$$\vdots$$

$$+ b_n \Delta X_n \frac{Y}{X_n}\left(1 + \frac{1}{2!}\sum_{i}^{n} b_i\left(\frac{\Delta X_i}{X_i}\right)_t + \ldots\ldots\right) + R \qquad (6)$$

A. Growth Rates in Output and Resource Inputs:

The changes in output and resource inputs can be converted to growth rates r_i . This is achieved by dividing expression (6) by Y to obtain (7).

$$r_y = r_a \left(1 + \frac{1}{2}\sum_{i}^{n} b_i r_i + \ldots\ldots\ldots\ldots\ldots\ldots\right)$$

$$+ b_1 r_1 \left(1 + \frac{1}{2}\sum_{i}^{n} b_i r_i + \ldots\ldots\ldots\ldots\ldots\right)$$

$$+ b_n r_n \left(1 + \frac{1}{2}\sum_{i}^{n} b_i r_i + \ldots\ldots\ldots\ldots\ldots\right) + R \qquad (7)$$

if $i = j$, $b_i = b_j - 1.0$

According to (7) growth in output r_y, is the sum of the growth rates in each resource input r_i, each weighted by its production elasticity, and the set of interaction terms of the different resource inputs.

B. Estimation Procedure for Production Elasticities:

The conventional method of estimating production elasticities is to use the ordinary least squares technique on function (5).

However, since the current study is interested in a disaggregate analysis the OLS procedure would result in problems of multicollinearity. Production elasticities (b_i), can be shown to be proportionate or equal to factor shares of individual resources under a set of assumptions. These assumptions are that, resources in agriculture are allocated with the objective of maximizing net revenue and that quality and costs of resources use are constrained by the state of technology, risk, uncertainty, market demand and other restrictions. When all these restraints are combined, overall restriction on capital use can be derived as in (8).

$$R = \left(a \prod_{i}^{n} X_i^{b_i}\right) P_y - \sum_{i}^{n} X_i P_i + \mu \left(C - \sum_{i}^{n} X_i P_i\right) \qquad (8)$$

where μ is a Lagrange multiplier;

R is net revenue or value of output Y at price P_y;

X_i are resource input at price P_i; and

C is capital resource constraining resource use.

The necessary[6] conditions for maximizing net revenue R, subject to capital constraint C is expressed in (9),

$$\frac{\partial R}{\partial X_i} = P_y \frac{\partial Y}{\partial X_i} - (1 + \mu)P_i = 0 \qquad (9)$$

$$\therefore P_y \frac{\partial Y}{\partial X_i} = (1 + \mu) P_i$$

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[6]See Clopper Almon, Jr., "Matrix Methods in Economics," Reading, Mass., Addison-Wesley Publishing Company, 1967. Chapter 5, for a description of "necessary" conditions of a constrained maximum.

which implies that all resources are allocated in proportion to their marginal productivities.

In terms of production elasticities, function (9) can be expressed as in (10),

$$\frac{\partial R}{\partial X_i} = P_y b_i \frac{Y}{X_i} - (1 + \mu)P_i = 0 \qquad (10)$$

$$\therefore b_i = (1 + \mu) \frac{P_i X_i}{P_y Y}$$

where

b_i is production elasticity, and

$\frac{P_i X_i}{P_y Y}$ measures factor share of individual resources.

From (10) it follows that if capital is restricted, all resources are paid in proportion $1 + u > 1$ of their marginal productivities. However, if capital is unrestricted, $u = 0$, and all resources are paid exactly their marginal value productivities. This is what is assumed here in this study; that is, capital is unrestricted in Canadian agriculture and therefore production elasticities of resource inputs can be approximated by their factor shares, or in this case, "expenditure shares".

The contribution of each factor input to growth in output can therefore be estimated as its growth rate (r_i) weighted by its factor share (b_i). When the sum of their contributions is subtracted from growth in output, the residual is a measure of gains in factor productivity. The growth in output to resource use and factor improvements over a number of years can then be estimated as an average of this annual contribution of each resource input.

C. Labor Productivity Function:

Labor productivity has earlier been defined as output per worker. In terms of function (5), a labor productivity function can be derived as in (11),

$$\frac{Y}{X_1} = a \frac{X_1^{b_1}}{X_1} \prod_{2}^{n} X_i^{b_i} \qquad (11)$$

where

X_1 is the labor input variable.

Labor productivity then is a function of factor productivity and other resource inputs. As in (7) above, growth in labor productivity can be imputed to changes in resource inputs and factor productivity as expressed in (12).

$$\begin{aligned} r_y^* = {} & r_a \left[1 + \frac{1}{2} \sum_{i}^{n} b_i r_i + \cdots\cdots\cdots\cdots \right] \\ & + b_1^* r_1 \left[1 + \frac{1}{2} \sum_{i}^{n} b_i r_i + \cdots\cdots\cdots\cdots \right] \\ & \vdots \\ & + b_n r_n \left[1 + \frac{1}{2} \sum_{i}^{n} b_i r_i + \cdots\cdots\cdots\cdots \right] + R \qquad (12) \end{aligned}$$

where

$$r^*_y = \frac{\Delta Y}{\Delta X_i} \div \frac{Y}{X_i}$$

$$b^*_i = b_i - 1.0$$

The production elasticity, b^*_i, of the labor input will be negative because the b_i exponent obtained earlier is less than 1.0. This negative value of b^*_i implies that a reduction in labor inputs would result in greater labor productivity. If increased capital inputs, and other productivity improvements combine with reductions in labor inputs to bring about greater labor productivity, then additional gains must be imputed to factor productivity and other factor inputs used in conjunction with labor. For example, if capital stocks in machinery and equipment, real estate, and livestock and poultry (breeding stock) have changed, additional contributions to labor productivity improvements are imputed to changes in depreciation and capital cost or interest charges.

The analysis will be carried out with capital and material inputs which are disaggregated as follows:

1) Labor Input..(X_1)

2) Capital and Material Inputs

a) Land and Buildings

Interest on real estate...............................(X_2)

Depreciation on buildings.............................(X_3)

Taxes on real estate..................................(X_4)

Building repairs......................................(X_5)

b) Machinery and Equipment

Interest on capital stock.............................(X_6)

Depreciation on machinery.............................(X_7)

Machinery operating expenses..........................(X_8)

c) Crop Yield Inputs

Fertilizer and lime...................................(X_9)

Other crop expenses (includes seed purchased).........(X_{10})

d) Livestock Yield Inputs

Interest on capital stock............................(X_{11})

Feed purchased.......................................(X_{12})

Other livestock expenses.............................(X_{13})

e) Miscellaneous operating expenses ....(X_{14})

D. The Data Used in the Study:

The procedures applied in this study for the analysis of growth in agricultural labor productivity require time series data on gross value of production, labor employed in agriculture and wages paid to farm labor, as well as data on the aggregated series of land and buildings, mechanization, crop yield inputs, livestock yield inputs, and other miscellaneous operating expenses. While some of these series were obtained from publications of Statistics Canada, other series had to be derived and adjusted by procedures to be explained shortly. The series are shown in Appendix Tables 4 and 7. The constant dollar values of the series found in Appendix Table 5 and 8, were measured in 1961 constant dollars by deflating each series by an appropriate price index using 1961 as the base year.

Gross Farm Production Series

Estimates of Gross Farm Income[7] include cash receipts from farm marketings of crop and livestock production, the value of farm products consumed by the farm household, the rental value of

[7]Dominion Bureau of Statistics Handbook of Agricultural Statistics Part II, Farm Income Catalogue No. 21-511, Ottawa, Queens Printer, 1967.

farm dwellings, as well as different types of government payments. Since 1940 farmers in Canada have received various supplementary and deficiency payments for abnormal losses or low returns in production of wheat, potatoes, sugar beets, wool and dairy products.[8] The gross farm income series were therefore adjusted for government payments and inventory changes to arrive at gross farm production.[9]

Weather variations in Canada have significant influence on agricultural production, particularly with respect to crop yields. For this reason, the annual estimates of gross farm production were adjusted in order to eliminate the effects of weather from output. For this adjustment, linear yield trends were fitted to yields per acre of selected principal crops for each region:

Alberta: wheat, oats, barley, rye, flaxseed.

Saskatchewan: wheat, oats for grain, barley, rye, flaxseed, rapeseed.

Manitoba: wheat, oats, barley, flaxseed, rapeseed.

Quebec: oats, fodder, corn, wheat, barley.

Ontario: wheat, oats for grain, barley, sorghum, corn for grain.

Prince Edward Island: oats for grain, potatoes, tame hay.

Nova Scotia: oats for grain, potatoes, tame hay.

New Brunswick: oats, potatoes, tame hay.

British Columbia: wheat, oats, barley.

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[8]Ibid.

[9]This series could not be adjusted for the rental value of farm dwellings because of lack of information about the series on dwellings. The adjustment procedure for British Columbia is shown in Appendix .

The estimated trend was then subtracted from the observed yield. The differences between the observed and the estimated yields of individual crops were then weighted by their respective acreages and average prices per unit. These trend values were summed across crops and the sum was added to (if negative) or subtracted from (if positive) the observed values of farm production. This had the effect of lowering or raising the value of farm production during crop yield years of above (positive value) or below (negative values) "normal" production as shown in Appendix 6 for the British Columbia region.

Farm Labor Input Series

The series data on agricultural labor employed was measured in terms of number of workers. This series, obtained directly from Statistics Canada data, is comprised of unpaid family labor, hired farm labor, and farm operators, of fourteen years of age and older. The series was not adjusted for age or sex composition because it is assumed that each worker is paid the estimated market wage for agricultural labor. In any case, the measure of labor productivity employed in this study is output per worker. It would have been necessary to adjust the series for age and sex composition and for length of year worked if productivity were measured in man-equivalents or man-hours.

Land and Buildings

The land and buildings category consists of data series on interest on real estate, depreciation on buildings, taxes on real estate, and building repairs. The series on depreciation on buildings, taxes, and building repairs were extracted directly from Statistics Canada publications. The capital cost on real estate was however estimated by an indirect method. Land, for example, has two market values. Firstly, the net rent paid per acre is the short term rate which should reflect current net productivity of land. Secondly, the mortgage rate charged by lending institutions reflects the amount that capital will earn over a longer period. Since no series on rental rates on land and buildings could be found for the period of the study, and since it was observed that mortgage rates during the period varied from one lending institution to another for agricultural production, it was finally decided to apply the average yield on Government of Canada bonds for ten years and over, to estimate interest charges on land and buildings. The series of average bond yields were applied to the capital stock on land and buildings series shown in Appendix 9. However, rental rates on real estate are likely to be more sensitive to change than average bond yields. Therefore, the estimate obtained for this series as explained here may be lower than actual interest charges on rural real estate during the period.

Machinery and Equipment

This consists of interest on investment in machinery and equipment, machinery depreciation, and machinery operating expenses. The series on machinery depreciation, and machinery operating expenses, were obtained from Statistics Canada data. Machinery operating expenses include expenditure on spare parts, gas, oil, and other lubricants. As in the case of land and buildings, government average annual bond yield rates were applied to capital stock on machinery and equipment series to measure the interest charges on these items. Government of Canada average bond yield rates for three to five years were used.

Crop Yield Inputs

The crop yield inputs include expenditures on fertilizer and limestone, purchased seed, as well as expenses on insecticides and pesticides. The series on fertilizer and lime, and other crop expenses were derived from Statistics Canada publications as shown in the relevant appendix.

Livestock Yield Inputs

This group of inputs consists of the series of data on interest on capital investment in livestock and poultry, expenses on purchased feed, and other livestock expenses. Expenditures on feed, and other livestock items, are as published by Statistics Canada. The series on other livestock expenses cover such items as drugs, veterinary expenses, and artificial insemination. Interest charges on livestock investments were estimated by applying average bond yield rates between one to three years, to the capital stock series on livestock and poultry (see Appendix Tables 9 (A-F)). These rates were chosen because they reflect approximately the returns to capital on short-term investments and because livestock production is a short-term venture.

Miscellaneous Operating Expenses Series

This series, which covers other expenditures not covered by the various categories discussed above, is taken directly from

Statistics Canada publications. The series covers such items as fencing, custom work, insurance, and other expenses on supplies and services not previously specified.

CHAPTER V

EMPIRICAL RESULTS

A. Estimates of Factor Shares:

In the last chapter it was indicated that if the production elasticities of all variables in function (5) were estimated simultaneously by application of the conventional technique of ordinary least squares, problems of multicollinearity would arise and result in unreliable parameter estimates. In a disaggregate analysis, such as the one attempted in this study, these multicollinearity problems could be quite serious. The short-cut method employed in the study assumes that employment of resources tends toward equilibrium levels where marginal costs are equal or proportionate to marginal returns. Marginal costs can be equated to marginal revenue in perfect equilibrium conditions and therefore production elasticities of individual resource inputs are equated to their factor shares as presented in the previous Chapter (IV).

As a working hypothesis, it is assumed that equilibrium factor shares remain unchanged over the period and therefore estimates for the elasticity parameters are obtained by averaging the annual values of the factor shares of individual resource inputs.[1]

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[1]This hypothesis was statistically tested and the findings are presented in the Appendix of the study.

The factor shares of labor and capital inputs are estimated as the ratio of input cost to output returns, and the results for Canada and the regions are presented in Table IV. The results are based on five year "range estimates", and can be interpreted as the contribution to growth of both changes in resource use and advances in technology.

TABLE IV

FACTOR SHARES (OR PRODUCTION ELASTICITIES) OF RESOURCE INPUTS IN AGRICULTURAL OUTPUT, ANNUAL AVERAGES, CANADA AND REGIONS, 1950 - 1974.

Resource Description:*	Canada	Atlantic	Quebec	Ontario	Prairie	B.C.
Land and buildings	.248	.192	.263	.257	.282	.279
Labor	.338	.496	.492	.299	.325	.275
Capital Inputs Related to:	.426	.476	.454	.497	.427	.408
Mechanization	.224	.180	.102	.178	.304	.145
Crop yield technology	.046	.093	.050	.064	.037	.045
Livestock yield technology	.124	.174	.257	.211	.061	.189
Miscellaneous operating expenses	.032	.029	.045	.044	.025	.029
Total	1.012	1.164	1.209	1.053	1.034	.962

Source: Based on data from Statistics Canada (See Appendix Tables 4 (A-F). and Appendix Tables 7 (A-H)).

* This table presents a summary of average annual factor shares. A detailed breakdown of resource inputs and their average annual production elasticities are presented in Appendix Tables 1 - A to F. Also, the composition and description of land and buildings, mechanization, crop yield technology, and livestock yield technology are given in the present chapter.

The factor shares estimates above closely resemble the earlier analysis of resource inputs per worker (see Table II). With the exception of the Atlantic region, no significant differences are observed in the share of land and buildings in agricultural output among regions. However, Table IV shows significant regional differences in the share of mechanization, livestock yield inputs, and to a lesser degree, labor inputs. The share of mechanization ranges from a high of 0.30 in the Prairie region, to a low of 0.10 in the Quebec region. The Quebec region, however, had the highest share in output in the area of livestock yield inputs, about 0.25, while the corresponding estimate for the Prairie region was only 0.06. The share of crop yield inputs was observed to be comparatively lower in all regions.

B. Estimated Production Functions and Labor Productivity Trends:

In the last chapter, a Cobb-Douglas-type production function describing output per worker in terms of resource inputs was formulated. In its general form, this function can be expressed using log to base ten as follows:

$$Y = X_1^{b1} X_2^{b2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots X_n^{bn} 10^{a\ +b_i t}$$

where,

Y is output per worker, $b_1 \ldots\ldots b_n$ are factor shares, $X_1 \ldots\ldots\ldots X_n$ are resource inputs, and an exponential time - trend variable inserted to capture "all other changes" leading to improvements in productivity. The time - trend variable is estimated as shown in the regression equation below:

$$\log_{10} (Y/ \prod_{i}^{n} X_i^{bi}) = a_o + b_i t + e$$

The estimated production functions for Canada and the regions are as presented in the following equations:[2]

Canada:

$$Y = X_1^{.338} X_2^{.138} \ldots\ldots\ldots\ldots X_{14}^{.032} 10^{-.110 + .012t}$$

Atlantic Region:

$$Y = X_1^{.496} X_2^{.092} \ldots\ldots\ldots\ldots X_{14}^{.029} 10^{.731 + .017t}$$

Quebec Region:

$$Y = X_1^{.492} X_2^{.030} \ldots\ldots\ldots\ldots X_{14}^{.045} 10^{1.645 + .025t}$$

Ontario Region:

$$Y = X_1^{.299} X_2^{.142} \ldots\ldots\ldots\ldots X_{14}^{.044} 10^{-.001 + .011t}$$

Prairie Region:

$$Y = X_1^{.325} X_2^{.164} \ldots\ldots\ldots\ldots X_{14}^{.025} 10^{.060 + .008t}$$

British Columbia Region:

$$Y = X_1^{.275} X_2^{.184} \ldots\ldots\ldots\ldots X_{14}^{.029} 10^{1.027 + .003t}$$

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[2]Resource inputs $X_1 \ldots\ldots X_{14}$ denote labor and capital inputs as specified in Appendix Tables 1 - A to F.

The estimated production functions above, describe agricultural production as proposed by Tinbergen, in which capital and labor inputs are disaggregated and the exponents of capital and labor inputs are estimated from factor shares.[3]

From these functions trends in agricultural labor productivity for Canada and the five regions are derived by dividing each function by the labor input variable X_1, as shown below:

Canada:

$$Y/X_1 = X_1^{.338-1.00} X_2^{.138} \ldots\ldots\ldots\ldots\ldots X_{14}^{.032} 10^{-.110 + .012t}$$

Atlantic Region:

$$Y/X_1 = X_1^{.496-1.00} X_2^{.092} \ldots\ldots\ldots\ldots\ldots X_{14}^{.029} 10^{.731 + .017t}$$

Quebec Region:

$$Y/X_1 = X_1^{.492-1.00} X_2^{.030} \ldots\ldots\ldots\ldots\ldots X_{14}^{.045} 10^{1.645 + .025t}$$

Ontario Region:

$$Y/X_1 = X_1^{.299-1.00} X_2^{.142} \ldots\ldots\ldots\ldots\ldots X_{14}^{.044} 10^{-.001 + .011t}$$

Prairie Region:

$$Y/X_1 = X_1^{.325-1.00} X_2^{.164} \ldots\ldots\ldots\ldots\ldots X_{14}^{.025} 10^{.060 + .008t}$$

British Columbia Region:

$$Y/X_1 = X_1^{.275-1.00} X_2^{.184} \ldots\ldots\ldots\ldots\ldots X_{14}^{.029} 10^{1.027 + .0035}$$

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[3]See M. Brown, op. cit. and also, Fred H. Tyner and Luther G. Tweeten, "A Methodology for Estimating Producting Function Parameters," Journal of Farm Economics, Vol. 47, No. 5, Dec. 1965, p. 1462.

These production function estimates of trends in labor productivity and the actual production per worker are as drawn in Figure 1 (a-f) and shown in Appendix Tables 5 (A-F), for Canada and the regions. Figures 1 (a-f) demonstrate that the specified Cobb-Douglas-type production function closely approximates the actual output per worker.

C. Estimates of Components of Growth in Labor Productivity:

Taylor's expansion is then applied to these labor productivity "trend functions" to obtain estimates of "components of growth" in labor productivity. The expansion technique is illustrated below using estimates for Canada as a whole.

$$r_y/x_1 = r_1(0.338 - 1.00)(1.0 + \tfrac{1}{2}(.338 - 2.00)r_1 + \tfrac{1}{2}(.030)r_2 + \ldots.)$$

$$+ r_2(.030)(1.0 + \tfrac{1}{2}(.338 - 1)r_1 + \tfrac{1}{2}(.030 - 1.00)r_2 + \ldots\ldots..)$$

$$\vdots$$

$$+ r_{14}(0.32)(1.0 + \tfrac{1}{2}(.338 - 1.00)r_1 + \tfrac{1}{2}(.030)r_2 + \ldots\ldots\ldots)$$

$$r_a(1.00)(1.0 + \tfrac{1}{2}(.338 - 1.00)r_1 + \tfrac{1}{2}(0.30)\ r_2 + \ldots\ldots\ldots)$$

where

r_y/x_1 is the annual growth rate of gross output per worker;

$r_1 \ldots\ldots.. r_{14}$ refer to annual growth rates of individual resource inputs, (see Appendix Table 2);

r_a describes productivity improvements due to "all other changes".

Each line in the expansion represents the annual average growth in labor productivity imputed to a particular resource.

Thus, the contribution of changes in resource use and technology to growth in labor productivity is measured in terms

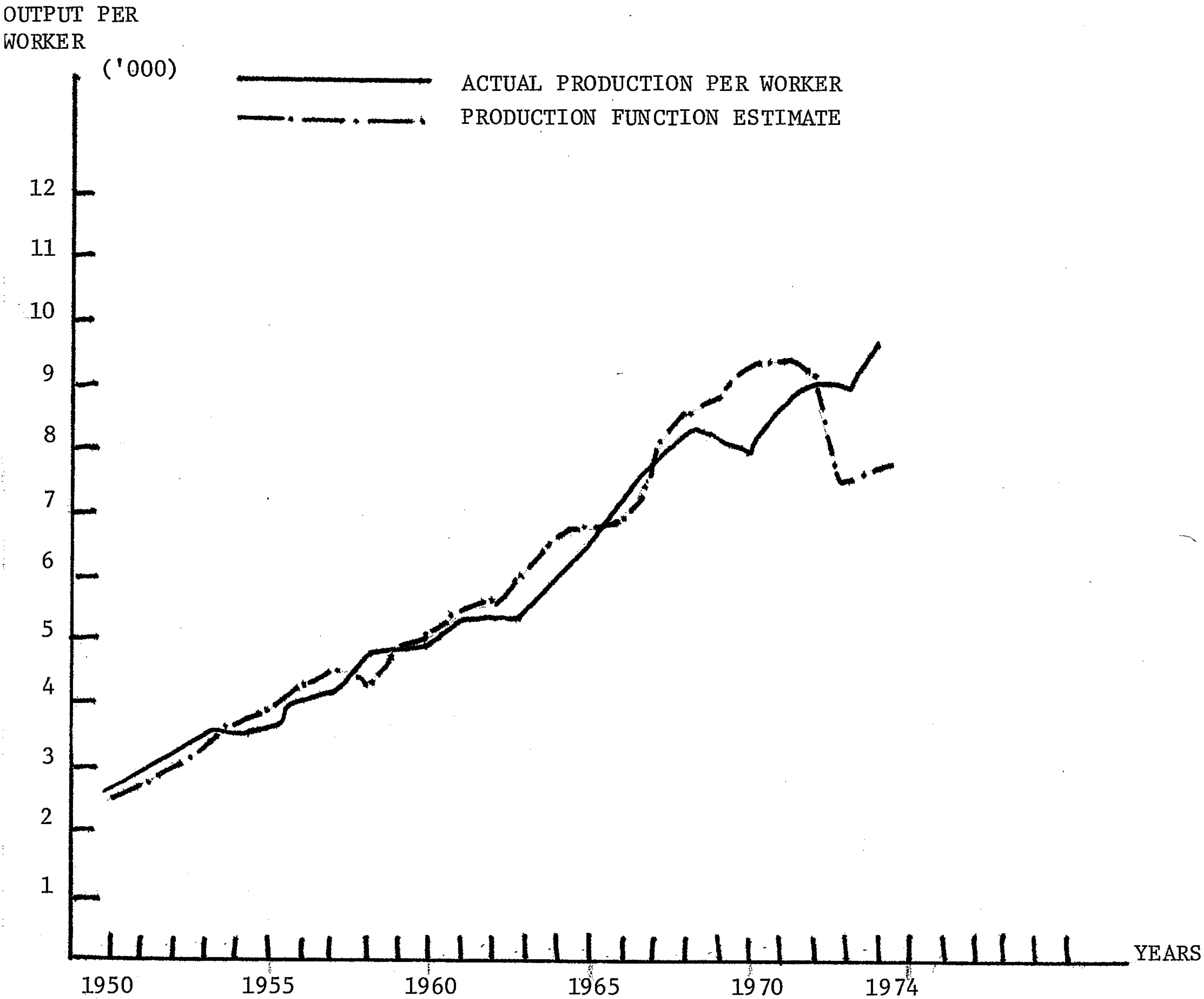

FIGURE 1 (a) - Gross value of production per worker in agriculture, Canada - constant dollars in thousands.
Source: See Appendix Table 5 - A.

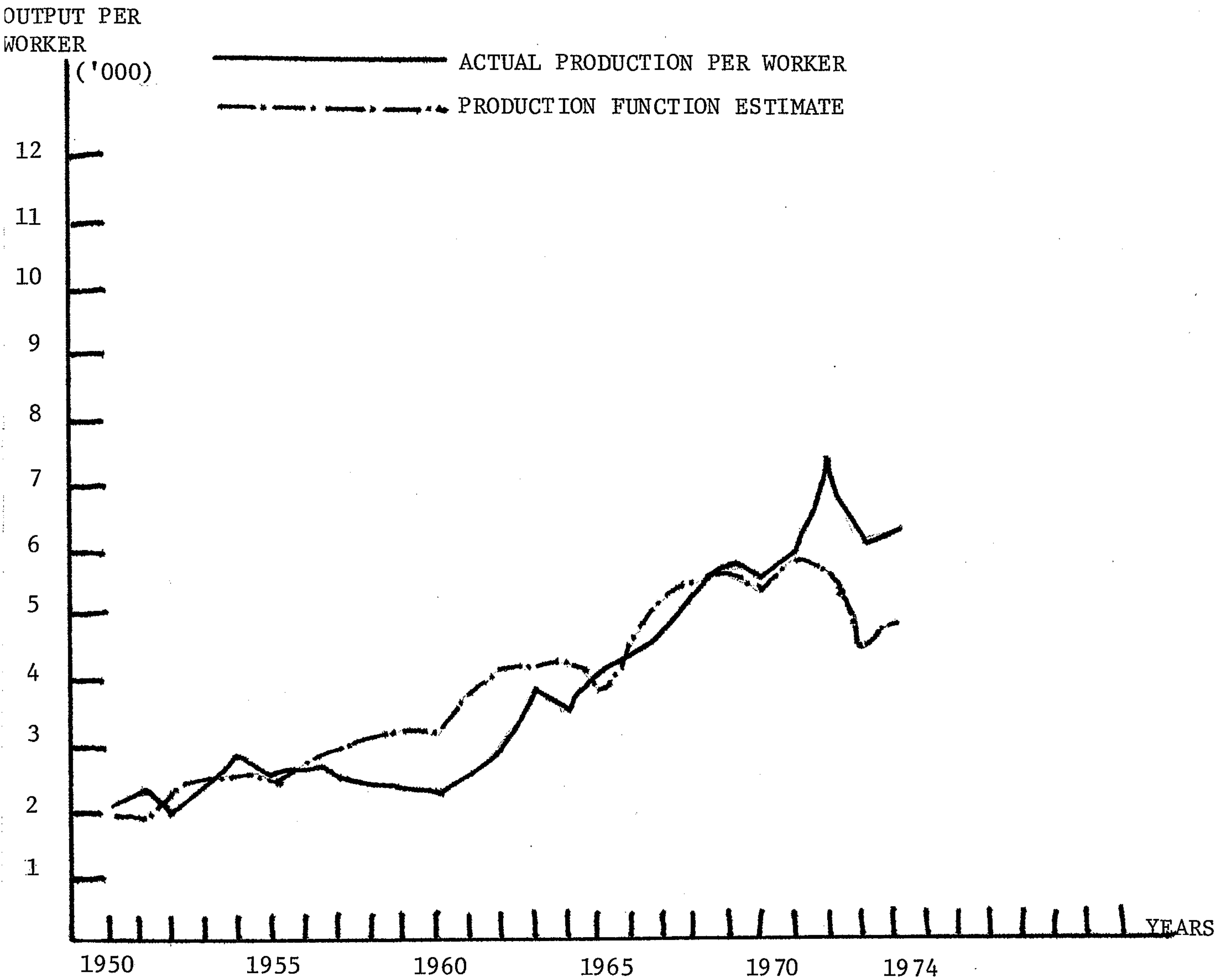

FIGURE 1 (b) - Gross value of production per worker in agriculture, Atlantic Region - constant dollars in thousands. Source: See Appendix Table 5 - B.

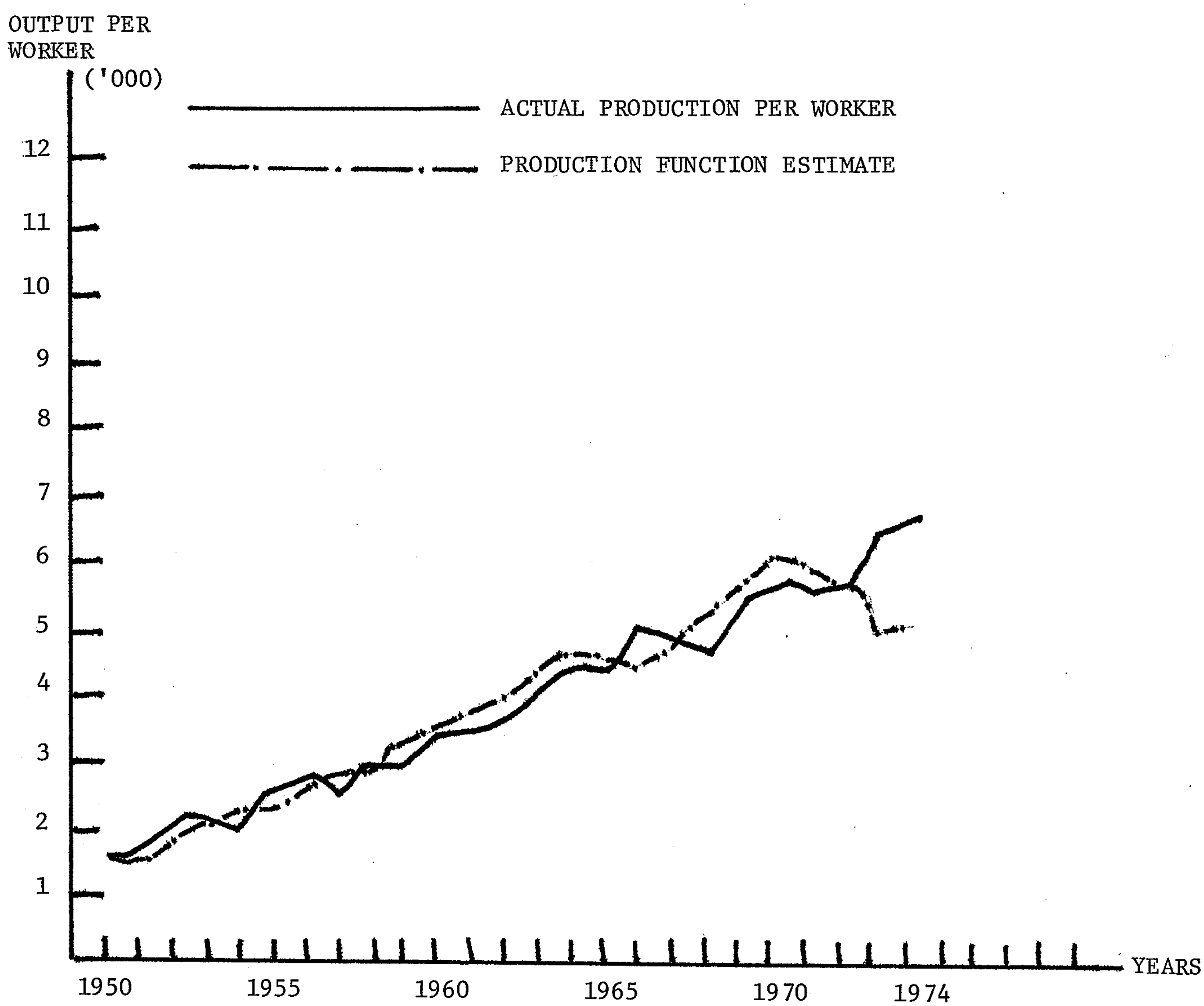

FIGURE 1 (c) - Gross value of production per worker in agriculture, Quebec Region - constant dollars in thousands.
Source: See Appendix Table 5 - C.

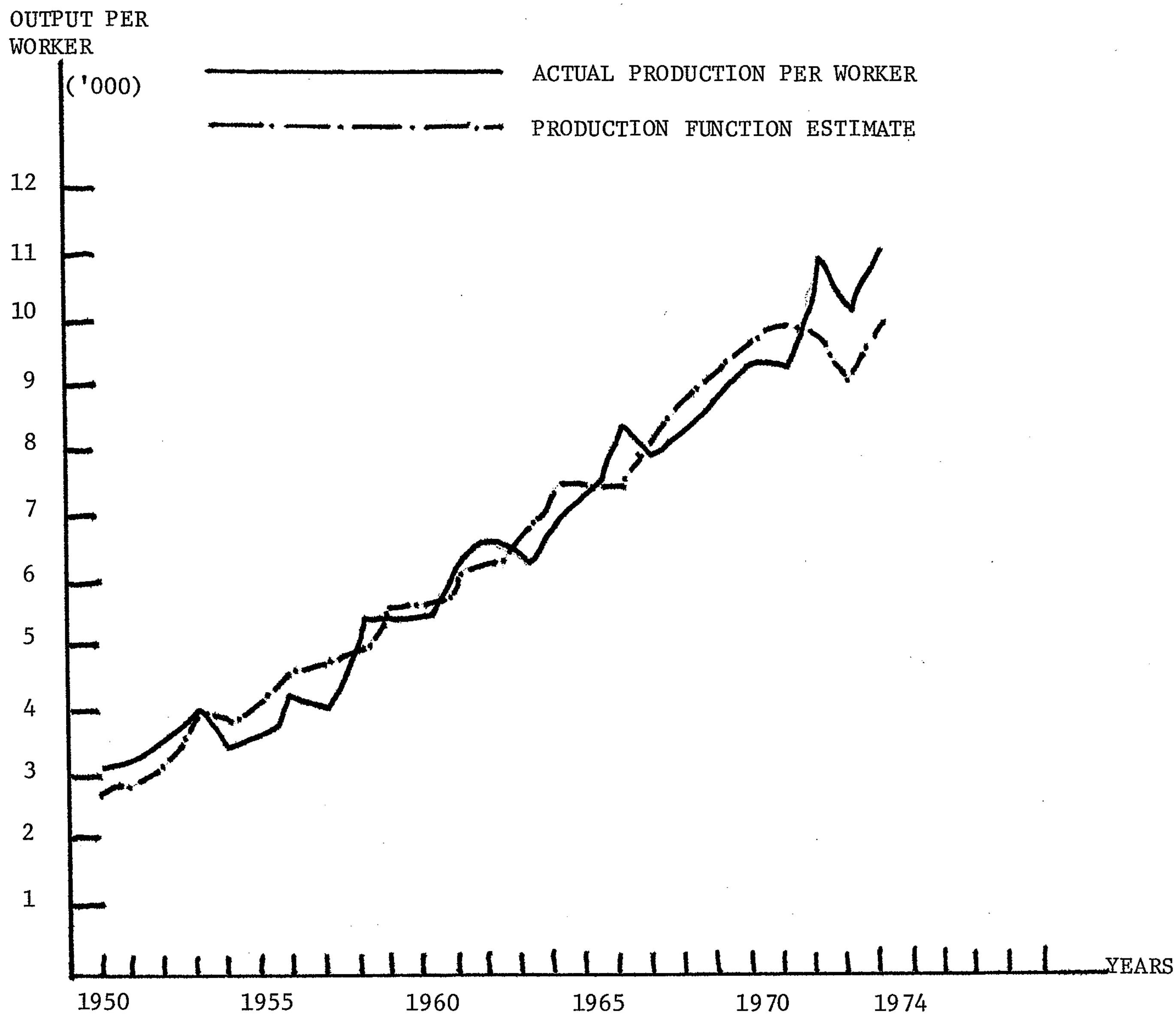

FIGURE 1 (d) - Gross value of production per worker in agriculture, Ontario Region - constant dollars in thousands.
Source: See Appendix Table 5 - D.

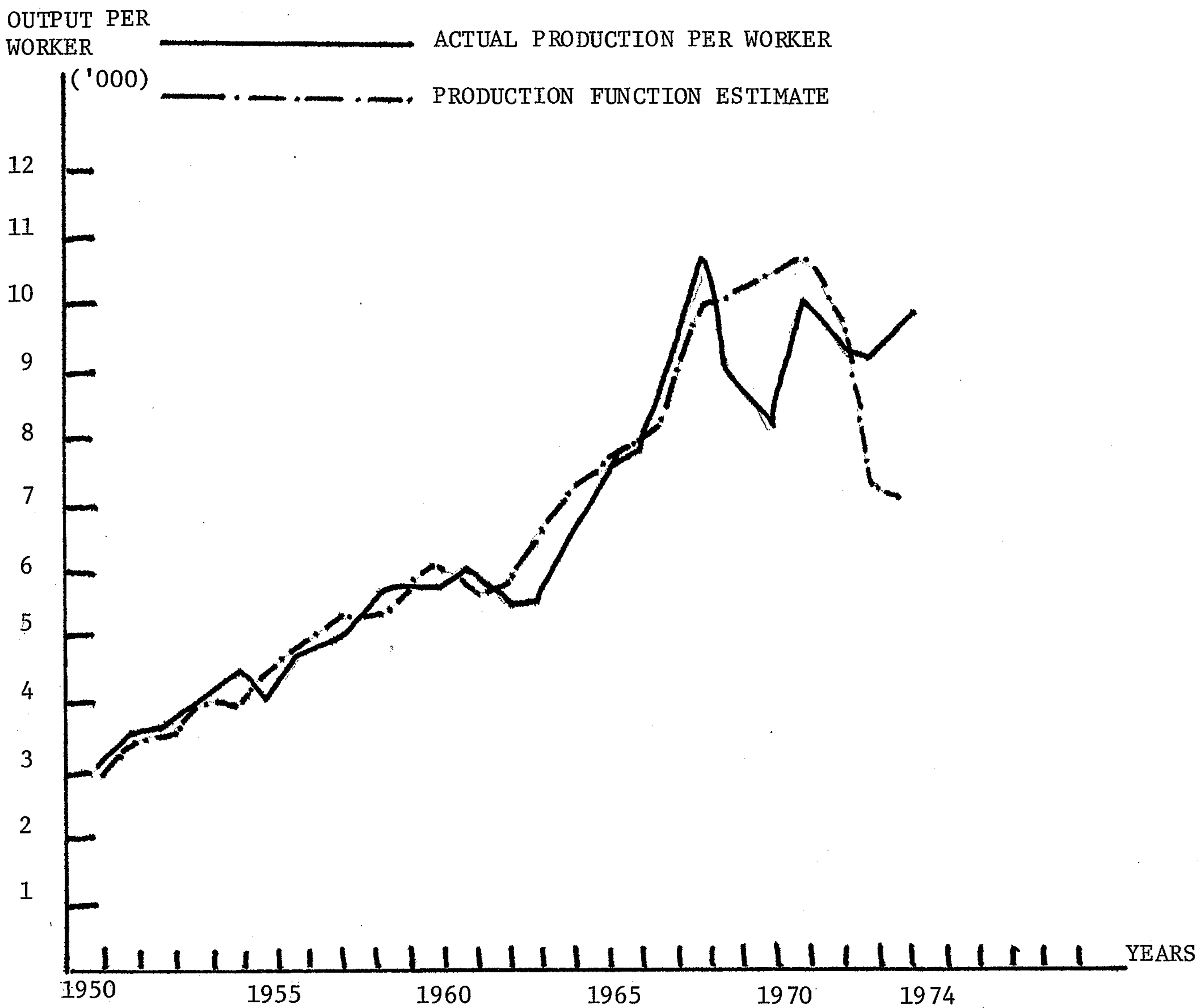

FIGURE 1 (e) - Gross value of production per worker in agriculture, Prairie Region - constant dollars in thousands. Source: See Appendix Table 5 - E.

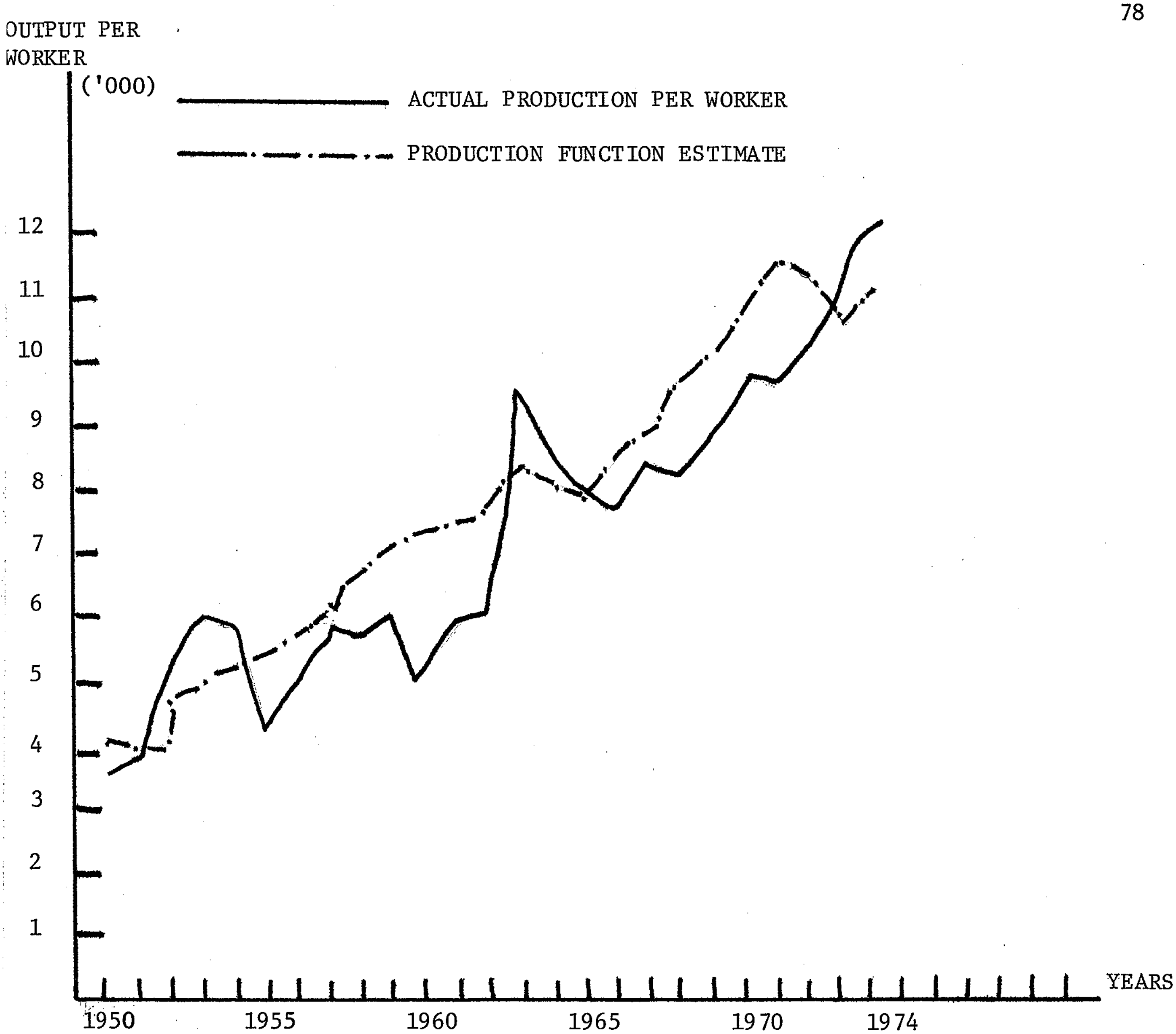

FIGURE 1 (f) - Gross value of production per worker in agriculture, British Columbia Region, constant dollars in thousands.
Source: See Appendix Table 5 - F.

of their average annual growth rates weighted by their elasticities. Overall growth rates in gross real output (r_y/x_1), per worker, weighted annual growth rates of individual resource inputs and technology ($r_i b_i$) are computed as described above, and summarized in Tables V to X for Canada and the regions.[5]

For Canada as a whole the overall growth rate in labor productivity is over 6 percent per annum. This result is slightly higher than that obtained by Auer in an earlier work.[6] The major contribution to overall growth in labor productivity came from capital and material inputs including land and buildings. Of the three principal capital input categories, namely mechanization, crop yield inputs, and livestock yield inputs, mechanization ranked highest in contributing to overall growth in labor productivity in Canadian agriculture, with crop yield technology making the smallest contribution to productivity growth.

The overall growth rate per annum of labor productivity in the Atlantic region during the period is more or less of the same magnitude as the national average of 6 percent. However, unlike Canada as a whole, the estimates for the Atlantic region show that other technological changes contributed the major proportion in overall growth -- roughly about 50 percent. The labor input was next with over 25 percent and the remaining contribution was made by the capital and material inputs category (see Table VI).

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[5]See Appendix Table 3 for detailed breakdown for Canada and the regions.

[6]Auer, op. cit.

TABLE V

COMPONENTS OF GROWTH IN AGRICULTURAL LABOR PRODUCTIVITY, CANADA, 1950-1974

	Average Annual Percentage Change	Percent
Growth in Labor Productivity	6.21	100
Components:		
Labor Input (effect of outmigration)	1.46	23
Capital and Material Inputs	2.71	44
Land & Buildings	1.07	
Mechanization	.64	
Crop Yield Technology	.40	
Livestock Yield Technology	.49	
Miscellaneous	.11	
All other changes*	2.04	33

Source: Based on Statistics Canada data (see Appendix Table 1-A and Appendix Table 2).

* These changes are specified and discussed later on in this section of the study.

TABLE VI

COMPONENTS OF GROWTH IN AGRICULTURAL PRODUCTIVITY, ATLANTIC REGION, 1950-1974

	Average Annual Percentage Change	Percent
Growth in Labor Productivity	6.01	100
Components:		
Labor Input (effect of outmigration)	1.74	29
Capital & Material Inputs	1.40	23
Land and Buildings	.40	
Mechanization	.38	
Crop Yield Technology	.19	
Livestock Yield Technology	.34	
Miscellaneous	.09	
All other changes	2.87	48

Source: Based on Statistics Canada (see Appendix Table 1-B, and Appendix Table 2).

Mechanization contributed 50 percent more to growth in productivity than crop yield inputs, and contributed about 5 percent more than livestock yield inputs.

Estimates of agricultural performance in the Quebec region are shown in Table VII. Agricultural labor productivity in the Quebec region grew at an annual rate of a little over 5.5 percent during the period under consideration. Nearly 40 percent of this growth in agricultural labor productivity came from "all other changes" or improvements in resource productivity. Capital and material inputs accounted for a third of the growth in overall labor productivity growth, with the labor input contributing the remaining 25 percent.

The estimates for the Ontario region bear a close resemblance to the national average growth rates. Table VIII shows that like Canada as a whole, the major contributor to the 6 percent per year rate of growth in agricultural labor productivity in the Ontario region is capital and material inputs. This resource input category accounted for more than 50 percent of the growth in agricultural labor productivity in that region. However, unlike the national estimates, the labor input contributed a little over 25 percent, with "all other changes" making up about 20 percent. Livestock yield inputs dominated mechanization, and crop yield inputs. Livestock yield technology contributed about 10 percent more than mechanization and about 25 percent more than crop yield technology in the Ontario region.

TABLE VII

COMPONENTS OF GROWTH IN AGRICULTURAL LABOR PRODUCTIVITY,
QUEBEC REGION, 1950-1974

	Average Annual Percentage Change	Percent
Growth in Labor Productivity	5.65	100
Components:		
Labor Input (effect of outmigration)	1.42	25
Capital and Material Inputs	1.92	34
Land & Buildings	.42	
Mechanization	.40	
Crop Yield Technology	.40	
Livestock Yield Technology	.56	
Miscellaneous	.14	
All other changes	2.21	39

Source: Based on data from Statistics Canada (See Appendix Table 1-C, and Appendix Table 2).

TABLE VIII

COMPONENTS OF GROWTH IN AGRICULTURAL LABOR PRODUCTIVITY, ONTARIO REGION, 1950-1974

	Average Annual Percentage Change	Percent
Growth in Labor Productivity	6.05	100
Components:		
Labor Input (effect of outmigration)	1.57	26
Capital and Material Inputs	3.21	53
Land & Buildings	1.46	
Mechanization	.54	
Crop Yield Technology	.40	
Livestock Yield Technology	.64	
Miscellaneous	.17	
All other changes	1.27	21

Source: Based on data from Statistics Canada (see Appendix Table 1-D, and Appendix Table 2).

The major role which capital and material inputs play in contributing to growth is again shown by the estimates for the Prairie, and the British Columbia regions. As in the Ontario region, capital and material inputs made the dominant contribution to growth in agricultural productivity. Prairie agricultural labor productivity increased at an annual rate of over 6.5 percent. This is made up of some 47 percent from capital and material inputs, 37 percent from "all other changes", and some 16 percent by adjustments in the farm labor force, as shown in Table IX. Here again, mechanization predominates over livestock yield, and crop yield technologies.

The pattern in the British Columbia region is similar to the Prairie region, except for the fact that adjustments in the farm labor force, and other technological changes contributed about equal proportions to the overall growth rate in labor productivity in British Columbia, a little over 9 percent per annum. Capital and material inputs contributed about half of this overall growth, with the other half shared more or less equally between the labor input adjustments and "all other changes". Table X shows these estimates.

The magnitude of the overall rate of growth in labor productivity ranged from a high of over 9 percent in the British Columbia region to a low of about 5.5 percent in the Quebec region. The earlier estimates of the absolute magnitude of labor productivity revealed that superior performance was achieved by the British Columbia, Ontario, and Prairie regions, compared with that achieved by Quebec and the Atlantic regions

TABLE IX

COMPONENTS OF GROWTH IN AGRICULTURAL LABOR PRODUCTIVITY, PRAIRIE REGION, 1950-1974

	Average Annual Percentage Growth	Percent
Growth in Labor Productivity	6.62	100
Components:		
Labor Inputs (effect of outmigration)	1.05	16
Capital and Material Inputs	3.13	47
Land & Buildings	1.32	
Mechanization	.75	
Crop Yield Technology	.49	
Livestock Yield Technology	.51	
Miscellaneous	.06	
All other changes	2.44	37

Source: Based on Statistics Canada (see Appendix Table 1-E and Appendix Table 2).

TABLE X

COMPONENTS OF GROWTH IN AGRICULTURAL PRODUCTIVITY,

BRITISH COLUMBIA REGION, 1950-1975

	Average Annual Percentage Change	Percent
Growth in Labor Productivity	9.17	100
Components:		
Labor Inputs (effect of outmigration)	2.45	27
Capital and Material Inputs	4.37	48
Land & Buildings	2.46	
Mechanization	.63	
Crop Yield Technology	.22	
Livestock Yield Technology	.93	
Miscellaneous	.13	
All other changes	2.35	25

Source: Based on data from Statistics Canada (see Appendix Table 1-F and Appendix Table 2).

(see Table 1). On the basis of the estimates presented in Tables V to X, a plausible explanation can now be attempted in terms of the specified 'components' of labor productivity as summarized in these tables, namely labor inputs, land and buildings, mechanization, crop yield inputs, livestock yield inputs, and "all other changes".

Labor Input: The labor input made a significant contribution to overall growth in labor productivity in all five regions studied. This has come through adjustments in the farm labor force. Canadian agriculture has experienced dramatic structural changes since World War II. Whereas farm employment has declined remarkably, farm output, on the other hand, has increased substantially. The non-agricultural sector in each region has played a useful role in providing employment for those of the farm labor force, especially the young, who preferred to leave the agricultural sector. The trend has been towards larger farm units, probably due to farm consolidation. The operation of these larger farm units has been made possible by increased mechanization without employing additional farm labor. Gains in agricultural labor productivity, therefore, have been achieved as a result of adjustments in the farm labor force, and partly from increased mechanization. Outmigration has been growing between the high annual rate of about 3 percent in British Columbia to a low of 1.5 percent in the Prairie region during the period 1950-1974. The effect of outmigration, contributed a high of about 2.5 percent per annum in the British Columbia region, to a low of about 1 percent in the Prairie region, with the other regions falling inbetween that range.

Capital and Material Inputs: The regions of British Columbia, Ontario, and the Prairies derived the most significant contribution to growth in labor productivity from total capital and material inputs. About half of the overall growth in labor productivity in these regions has come from capital and material inputs. Although labor productivity gains from capital inputs (in aggregate) are similar in British Columbia, Ontario, and the Prairies, significant differences exist in the contribution of individual capital input categories, namely capital inputs related to mechanization, crop yield inputs, and livestock yield inputs as discussed below.

Mechanization: Apart from land and buildings, capital inputs related to mechanization contributed more significantly to overall growth in labor productivity than crop yield inputs, and livestock yield inputs, in the Prairie and Atlantic regions, as well as for Canada as a whole. These machinery items represent greater use of tractors, combine harvesters, trucks, pick-up balers, electric motors, and other equipment on farms, together with machinery operating expenses, such as machinery repairs and maintenance, diesel fuel, gasoline and lubricants.

Crop Yield Inputs: These inputs made the smallest contribution to overall growth in agricultural labor productivity. The estimates showed this to be the case for Canada as a whole, as well as all five regions. They represent purchases of fertilizer, lime, seed, and other crop expenses such as insecticides, and herbicides.

Livestock Yield Inputs: Compared to mechanization, and crop yield inputs, this input category made the most significant contribution to the overall growth in productivity, in British Columbia, Ontario, and Quebec, although its contribution to productivity in the Prairie and Atlantic regions was not as high compared with other input categories. These input items represent interest on livestock purchases, purchased feed, and other livestock expenses such as sprays, drugs, artificial insemination, and veterinary expenses.

"All Other Changes": In addition to capital and material inputs, other changes which could not be quantified in this conceptual framework also made a significant contribution to gains in labor productivity. These changes represent gains in labor productivity which can be attributed to research by various agencies (both public and private), better farm organization and management, increasing farm size, regional specialization in farm products, scale of operation, increased knowledge, skills and education of farmers and farm operators, and numerous other factors.[7]

The summaries of the components of growth in agricultural labor productivity presented in Tables V to X reveal some interesting differences among the five regions. In the Atlantic region the effect of outmigration and other technological changes

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[7] "The Challenge and Growth of Change," Economic Council of Canada, Fifth Annual Review, September 1968, p. 86.

were dominant contributors to growth in labor productivity. Quebec owed the bulk of the growth in its productivity to growth in livestock yield inputs, and to a lesser extent to outmigration and crop yield inputs. Ontario, like Quebec, achieved superior performance in livestock yield inputs, as well as land and buildings, while at the same time doing fairly well in outmigration, and crop yield inputs. While outmigration was lowest in the Prairies, growth in labor productivity did not suffer because of the better performance achieved in land and buildings, mechanization, and crop yield inputs. In British Columbia, high growth rates in land and buildings, livestock yield inputs and movement of labor from farms contributed effectively to improvements in growth in labor productivity. An important observation is that while growth is concentrated around one or two input categories in the Atlantic and Quebec regions, it is more evenly distributed among the various input categories in Ontario, the Prairies and British Columbia.

D. Implications for Resource Allocation:

The remarkable achievements in the overall labor productivity growth rates in Canada and the regions during the period under consideration has been made possible by the rapid decline in farm employment coupled with increased expenditure on capital and material inputs, as well as other technological changes.

The magnitude of outmigration of farm labor has been significant in all regions. The earlier productivity analysis by Auer showed that the labor input was by far the most significant contributor to overall growth in labor productivity in

Canadian agriculture[8] during the period 1947-1965. This high component of growth can be partially explained by the availability of increased non-farm employment opportunities which Canada experienced as a result of industrial expansion immediately following the post-war years. A plausible explanation of the process by which agricultural labor makes its exit from agriculture and entry into the non-agricultural sector is given by Gruen.[9] The estimates of the present study showed that although outmigration has continued to contribute effectively to overall growth in labor productivity, there has been a relative reduction in its contribution to growth. The present results indicate a slowing-down in the increased exodus from farms which characterized the period 1947-1965. This is to be expected in view of the rising unemployment rates in the non-agricultural sector in recent years. Nevertheless, as indicated by Denison, it can be said that high productivity has continued to play an important role in the economic development of the various regions and Canada as a whole during the analyzed period.[10]

According to the estimates of the present study, by far the most significant contribution to overall growth in labor productivity for Canada as a whole has come from capital and

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[8]Auer, op. cit.

[9]Gruen, H. F., "Agriculture and Technical Change," Journal of Farm Economics, Vol. 43, 1964.

[10]Denison, E., "How to Raise High-Employment Growth Rates by One Percentage Point," American Economic Review, Vol. 55, 1965.

material inputs during the period 1950-1974. This observation is also true for British Columbia, Ontario and the Prairie regions. These three regions were the same regions which achieved higher absolute productivity values than the national average (see Table I). A closer examination of individual resource inputs in the aggregated capital and material inputs in these regions explains the major sources which contributed to growth. In order of magnitude these are land and buildings, livestock yield inputs, and mechanization in British Columbia; land and buildings, mechanization, and livestock yield inputs in the Prairie region; land and buildings, livestock inputs, and mechanization in Ontario. In all cases crop yield technology contributed the least towards overall growth in productivity.

Most probably a much more important part of the productivity differences among regions can be attributed to the level of expenditure per worker on mechanization. Expenditure on resource inputs per worker, indicate that agriculture in the Prairies, Ontario, and British Columbia is more highly mechanized than in Quebec, and the Maritimes. Machinery inputs per worker in the Prairie region are almost three times those in the Atlantic region, and about four times higher than in Quebec. This may be partially due to the effect of differences in size and type of farm products. Wheat (also other grain crops), which is a highly mechanized crop in Canadian agriculture, constitutes the major crop grown on the Prairies, while large scale grain cultivation does not form the bulk of agricultural activity in either

Quebec or the Atlantic region. Then again, farm sizes, especially in the Prairies, are much larger than in Quebec and the Maritimes. The results demonstrate the importance of "capital formation" as a necessary source of growth. The Quebec and the Atlantic regions clearly lagged behind the rest of Canada in expenditures per worker in capital inputs related to mechanization, and in farm real estate developments, and this may partially explain the low absolute productivity values achieved by these two regions during the period under consideration. In order to bring productivity in Quebec and the Atlantic regions up to the national average, it may be important to direct agricultural policy towards investment in capital inputs related to mechanization, while at the same time emphasizing increased developments in farm real estate and research.

Other interesting results were also obtained in livestock yield technology as well as crop yield technology. The estimates indicated that livestock yield inputs per worker were comparatively high in Ontario, British Columbia and Quebec. Expenditure per worker in livestock yield inputs in the Prairie region measured only about one quarter that in Ontario and British Columbia. Concerning crop yield inputs per worker, the estimates revealed that compared with expenditures per worker in land and buildings and mechanization, crop yield estimates were lower in all regions and showed no great differences among regions. The contribution to growth in labor productivity of this input category followed a similar pattern, although more significantly in the Prairie region. It appears therefore that further gains in Canadian agricultural labor productivity can be achieved if policy considerations are directed towards crop yield and livestock yield technology in all regions. More public funds will have to be devoted to research directed at further improvements in crop varieties. Research into livestock yield technology, especially in the Prairies and the Atlantic regions, may contribute to achieving further increases in agricultural productivity. Concerning the part technological change plays in contributing to growth in productivity, Robert Solow has observed that, "...capital formation is not the only source of growth in productivity. Investment is at best a necessary condition for growth, but not a sufficient condition. A sufficient condition for growth in productivity is intangible capital invested in research, education, public health, and other technological activities...".[11]

Griliches pointed out that public expenditure on research and extension affect the level of agricultural output "significantly", and that their social rate of return is quite high.[12] The results of the present study indicate that other technological progress (measured as a "residual" in this case), has made a significant contribution to growth in productivity in Canadian

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[11] Solow, R. M., "Technical Progress, Capital Formation, and Economic Growth," American Economic Review, Vol. 52, 1962.

[12] Griliches, Z., "Research Expenditures, Education, and the Aggregate Agricultural Production Function," American Economic Review, Vol. 54, 1964.

agriculture during the period 1950-1974. Technological progress has contributed about 2 percent per year to overall growth in labor productivity in Canadian agriculture since 1950, and accounts for roughly a third of the overall growth in productivity. Since technological progress permits the substitution of knowledge for resources, public expenditure on research and extension to meet specific regional needs would be a policy in the right direction to bring about further gains in productivity with only moderate increases in labor and capital inputs. For example, research could be carried out to design and implement crop-livestock combination programs in the Prairies, while at the same time developing improved and disease resistant crop varieties, better insecticides and pesticides, all of which make for high yields per acre. Animal research efforts may have to be accelerated and expanded to increase the yield per animal and to achieve further productivity gains in Canadian agriculture. The developing of processing industries in the Prairie region will offer non-farm jobs to farm labor and increase the rate of outmigration. Government re-training programs may be necessary to reduce the hardships of the adjustments of farm labor. One thing that is clear, however, is that great potential for achieving further gains in Canadian agricultural labor productivity exists in all regions, but even more so in the Prairie region. Cooperative efforts by governments, university and private organizations in the areas of market development and organization for farm products, as well as increased farm research efforts, will aid further gains in labor productivity and provide necessary conditions for improving farm incomes.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Regional productivity growth in Canadian agriculture made dramatic gains during the period 1950-1974. According to the estimates of the current study labor productivity in Canadian agriculture grew at an annual rate of about 6 percent at the national level, and ranged between 5.5 percent in Quebec to 9 percent in British Columbia. At the national level, and also in the regions of British Columbia, Ontario and the Prairies, increased capital and material inputs constituted nearly half the overall growth in productivity, while the other half was split between the effect of farm labor outmigration, and other productivity improvements. In the Atlantic and Quebec regions, however, other productivity improvements contributed more significantly than either the movement of farm workers out of agriculture, or capital and material inputs.

The superior productivity performance achieved in British Columbia, Ontario, and the Prairies is associated with the significant contributions made by land and buildings, as well as livestock technology in British Columbia and Ontario; land and buildings, and mechanization in the Prairie region. The contributions of farm real estate and mechanization were comparatively lower in Quebec and the Atlantic regions, although livestock contributed quite significantly in Quebec.

The analysis also indicated that at both the national and regional levels crop yield technology contributed the least to productivity growth when compared with mechanization, and to a lesser extent, livestock technology.

The analysis has isolated major potential sources for achieving increased gains in Canadian agricultural productivity, namely improvements in yield technology, mechanization, and further adjustments in the farm labor force. The extent to which productivity gains are increased would depend on farmers rate of adoption of technology and more importantly their perception of its impact on their income, other things being equal. For a proper perspective, therefore, gains in productivity must be related to the broader issues which affect farm incomes, such as market demand, agricultural exports, adoption of machinery technology, farm size adjustments, and movement of the farm labor force out of agriculture.

Given the inelastic demand conditions which exist in domestic markets for agricultural products, any appreciable expansion of Canadian domestic demand for agricultural products can be brought about mainly through population growth. In the absence of significant population growth, gains in productivity, resulting from improvements in yield technology which make food cheaper, are likely to be detrimental to farm incomes. In other words, under conditions of inelastic demand for agricultural products, reductions in food prices brought about by improvements in yield technology, would result in lower farm incomes, since such price reductions would lead to less than proportionate increases in domestic food consumption. However, improvements in yield technology need not depress farm incomes if the potential exists for the development and expansion of agricultural export markets.

The Report of the Federal Task Force raised a number of important issues which are pertinent to the findings of the present study.[1] The report predicted a favourable demand for Canadian beef on both domestic and international markets, given, of course, lower Canadian prices and high quality beef. Improvement in yield technology is one sure way of achieving lower prices ultimately.

A casual observation of some of the policies which have been in force during the period of the present study seem to indicate that milk (dairy) and grain (mainly wheat) production were favoured over beef production.[2] However, as shown in Table XI, the general trend has been toward a decreasing proportion of commercial grain farms, and a gradual but significant movement toward cattle, hog and sheep farms in all regions. With the exception of British Columbia, and the Prairies, the proportion of commercial dairy farms has been on the increase during the period. Thus, if in the interest of improved productivity of resources and higher farm income, it is deemed necessary to evolve a policy or set of policies to increase beef

[1]Report of the Federal Task Force, "Canadian Agriculture in the Seventies," Queens Printer, Ottawa, 1969, Chapter 6.

[2]Price supports for butter and skim milk and powder, direct subsidies for the whole milk used in manufacturing, trade embargoes on imports of butter and milk pwder all favoured milk production, while the Temporary Wheat Reserves Act, and CWB quota policy, income tax exemptions and provincial government land clearing programs, all relate to wheat production. See the Report of the Federal Task Force, Ibid., p. 166.

TABLE XI

PROPORTION OF COMMERCIAL FARMS CLASSIFIED BY TYPE OF FARM: CANADA AND REGIONS, 1951, 1961 and 1971

	DAIRY	CATTLE, HOGS, SHEEP	WHEAT	SMALL GRAINS	FRUITS AND VEGETABLES	MIXED COMBINATION
				1951		
Canada	17.4	26.7	-	29.2	2.4	17.9
Atlantic	24.2	23.6	-	-	1.8	30.9
Quebec	36.5	22.2	-	0.4	2.0	30.5
Ontario	26.3	40.7	-	4.5	4.6	15.4
Prairie	2.8	21.2	-	60.3	0.1	13.5
B.C.	31.5	14.4	-	2.9	22.5	8.3
				1961		
Canada	22.4	24.5	21.9	9.2	2.8	11.8
Atlantic	29.2	19.0	-	0.2	3.4	21.9
Quebec	63.5	11.2	-	0.3	2.7	13.7
Ontario	29.1	41.1	0.4	4.9	5.6	7.7
Prairie	3.5	21.4	44.1	15.8	0.1	12.9
B.C.	26.6	19.4	1.6	2.7	22.5	3.3
				1971		
Canada	21.4	34.7	13.0	14.0	3.0	6.5
Atlantic	31.3	32.5	-	0.3	4.6	3.0
Quebec	69.9	12.7	-	0.8	0.8	4.4
Ontario	26.9	42.8	0.5	7.9	5.9	3.3
Prairie	3.5	38.2	24.5	23.0	0.1	11.1
B.C.	18.6	29.1	2.3	4.6	23.3	2.3

Source: Census of Canada Cat. # 96-722, September 1972.

cattle (feeder cattle) production, and to reduce milk (dairy) and grain (wheat) production, then a review of existing policies relating to milk and grain production may be needed. Two sets of policies may be needed to reduce the relative attractiveness of producing milk and wheat and to encourage beef production. Firstly it may be necessary to review some or all policies which appear to favour milk production (e.g. price supports for butter and skim milk powder, etc.) or policies which favour wheat production (e.g. Canadian Wheat Board quota policy, etc.). Secondly, new policies designed to provide adjustment grants to farmers who enter beef production, especially in the initial years, would be needed to provide the necessary encouragement to boost beef production.[3] Improvements in crop yield technology especially in feed grains would lead to lower costs of beef production and make Canadian beef more competitive in world markets. A well organized and carefully executed export market development policy aimed at exploring all possible means of expanding agricultural exports would help to reap the full benefits of productivity gains due to yield technology improvements. If properly harnessed, improvements in yield technology would contribute effectively to productivity growth which is necessary to bridge the gap between the level of farm income and the income level of the non-farm sector. However, improvements in yield technology alone will not be sufficient for sustained gains in productivity.

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[3]Some provincial governments have instituted programs which provide credit incentives to farmers who switch from grain to grass and livestock and this may partially explain the general trend alluded to in Table XI.

Although significant gains in the adoption of machinery technology were achieved, especially in the Prairie region, the analysis showed that there is still room for improvements, and particularly so in the Quebec and Atlantic regions. The use of machinery and equipment with greater performance and capacity would help to bring further gains in productivity, assuming the operation of feasible and economic farm units. The continuing consolidation of smaller farm units, particularly in the Atlantic and Quebec regions, coupled with reductions in the agricultural labor force would make the use of larger and more powerful units of machinery and equipment economical. Such farm size adjustments are a necessary prerequisite for improving the performance of the agricultural sector, especially in the Atlantic and Quebec regions where farm size units are comparatively smaller. It must be observed, however, that the process of farm consolidation although beneficial also has social costs attached to it. Individual farmers who are displaced during the process have heavy and often painful burdens imposed on them. There is the need to re-deploy or re-place such displaced farmers or farm families in productive economic activities. This implies that government policies and programs must be designed and implemented to ease the burdens of adjustments and re-placements in highly productive jobs. Such government policies may include financial assistance to farmers for farm consolidation; retirement and labor mobility programs; investment in education and research in crops and livestock, market development and production.

Advances in yield technology must be matched by market demand if they are not to aggravate an already depressed farm income situation in Canadian agriculture. Cost economies resulting from mechanization are achievable given larger farmer units. This process requires heavy investments in land, machinery, equipment, and other farm inputs, and can be hampered by the relatively high prices farmers pay for inputs from the non-farm sector while they continue to receive low prices for farm products. Also, the movement of farm labor from farms can be further increased if some kind of re-training programs are instituted in the various regions for farmers who may prefer to cease farm production given alternative avenues where their experience and energies can be put to a much more efficient use with the minimum of hardship in the interim.

The study attempted to isolate sources of regional productivity in agriculture and to assess regional performance over the period. It demonstrated that different regions derived their growth from different sources, and that there is room for further improvements in all regions. While the study fairly well documented these changes, at the regional level, it was silent on the 'forces' behind these changes. These forces (economic, social and political) which were at best alluded to, fell outside the domain of the current study. The isolation and analysis of the forces behind these changes would require different data. Such an analysis would be an interesting future study.

LIMITATIONS OF THE STUDY

The majority of studies which attempt quantitative measurements of theoretical concepts often do run into conceptual and/or empirical problems. The present study is no exception, and its shortcomings are discussed in the light of the extensive literature which exists on production function analysis and its limitations.[1]

A. Conceptual or Specification Problems:

For the purposes of this study a Cobb-Douglas (C-D) type production function was chosen because it is simple to use and is applicable to the type of analysis envisaged in the study. In its general form, the C-D production function assuming a neutral technological change can be expressed as shown below:

$$Y_t = a(t) \prod_{i}^{n} X_i^{b_i}$$

where,

$$X_i^{b_i} = X_1^{b_1} X_2^{b_2} \ldots\ldots\ldots X_n^{b_n}$$

The following points are raised in relation to the above postulated production function:

(i) The primary shortcoming of the above formulation is that the traditional least-squares (OLS) method cannot be applied

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[1]A very thorough discussion of specification issues is presented by M. Nerlove, "Estimation and Identification of Cobb-Douglas Production Functions," Chicago, Rand McNally, 1965. Also a review and extensive bibliography has been done by A. A. Walters, "Production and Cost Functions: An Econometric Survey," Econometrics, Vol. 31, No. 1-2, Jan.-April, 1963, p. 1-66.

to the function to obtain reliable empirical production function estimates (or production elasticities). This is because of the problems of multicollinearity among the numerous independent variables, which results in biased parameter estimates if the OLS technique is used directly.[2] This problem is even more serious in a disaggregated analysis such as was attempted in this study.

(ii) For the purposes of the present study, an indirect approach was employed to circumvent the multicollinearity problem. This second approach is based solely on the hard assumptions that economic equilibrium is reached, if not in the short-run, at least in the long-run. This implies the existence of a static economic setting where observed factor shares are equal or proportionate to equilibrium factor shares. This assumption implies that the formulation used here ignores gradual changes and lags in resource allocations. Observed factor shares are thus equated to production elasticities. However, in a dynamic situation factor shares are likely to change significantly over time, and this is probably the case in agriculture.

(iii) Attempts to modify the postulated production function to make it more applicable to dynamic economic setting have problems and disadvantages. Although such a modification has the advantage of making provision for 'optimal' equilibrium

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[2]Fourteen independent variables were specified in the disaggregate conceptual framework employed in this study (see Appendix Table 1-A)

factor shares by allowing for gradual change and lags in resource allocation, "...problems of interdependence among statistical estimates of returns to scale, technological change, and capital restrictions..." are encountered.[3]

a) Returns to scale in a C-D type production function are measured by the sum of the production elasticities ($\sum_{1}^{n} b_i$). Decreasing returns to scale, constant returns to scale, and increasing returns to scale are depicted by a sum less than, equal to, or greater than one, respectively. The present study assumed perfect equilibrium conditions, and therefore equilibrium factor shares were substituted for production elasticities.[4] Greater individual factor shares have the following implications:

a) greater returns to scale,

b) greater contribution imputed to individual resource inputs, and

c) smaller "residual" or other technological change.

In this analysis, factor shares are freely determined as the ratio of input cost to output returns. This means that returns to scale were freely determined statistically as opposed to "a-priori" information, or constant returns to scale formulation.

B. Empirical or Data Problems:

Added to the problems of specification of a production function, such as those discussed above, are the problems related to empirical or data issues. In agriculture, data

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[3]Auer, op. cit.

[4]See Appendix Tables 1 - A to F.

problems arise mainly as a result of non-market transactions which are a characteristic feature of the industry. In the words of Auer,

> "farm real estate, machinery, equipment, crop and livestock inventories are transferred from one generation to the next without a formal agreement or sale or other form of market transaction...A large part of the resource inputs used...is not bought in the market place, and some of the "by-products", are not sold in the market place".[5]

The existence of these non-market transactions, particularly in agriculture, poses data problems when it comes to deriving the factor income shares of farm labor and capital inputs directly from labor earnings and capital expenditures. This means that some indirect method must be employed to obtain necessary data for empirical analysis. Market prices are generally used to impute income derived from labor and capital stock, and this is the approach adopted in the present study. In this study, for example, labor's income is measured in terms of total labor employed in agriculture paid at hired labor market wage rates, even though the bulk of farm labor is family labor and is not paid at this imputed wage rate. The cost of capital, measured by interest payments on capital stock, is estimated on investment in capital stock related to machinery and equipment, land and buildings, and livestock and poultry. Average yields on Government of Canada bonds were used to measure interest payments (cost of capital) on all farm capital stock. However, it is possible that only part of the mortgage may attract

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[5]Auer, op. cit., p. 85.

interest payments. This method of using market prices to impute income to labor and capital inputs may result in problems of over-estimation or under-estimation. This implies that greater or smaller proportion of the overall growth in labor productivity may have been imputed to capital inputs, and adjustments to the labor force, and therefore a smaller or greater proportion to "other technological changes".

It must be borne in mind that all estimates of labor productivity were computed in terms of gross real output per worker. Estimates based on net real output per worker would have provided results different from those obtained in the current study.

APPENDIX A

AN ANALYSIS OF CHANGES IN SELECTED STATISTICS, CANADA & REGIONS, 1950-1974

As a prelude to the analytical review presented in the introductory chapter of this study, changes in a number of selected statistics were computed and examined. The object of this exercise was to examine the direction and magnitude of changes in output per worker and certain key input categories with a view to determining whether or not any direct trend relationship exists between labor productivity (i.e. output per worker) and any of the selected input categories. The selected input categories were, farm real estate expenditures per worker, mechanization expenses per worker, crop input expenses per worker, and livestock input expenses per worker.

The changes which are measured using 1950 as base year, are presented in the tables that follow.

(a) Farm real estate expenses per worker

	Canada	Atlantic	Quebec	Ontario	Prairie	B.C.
			(Thousands of constant dollars)			
1974 level (L_2)	3132	1625	2301	3205	3072	5571
1950 level (L_1)	524	344	301	518	697	685
$\frac{L_2 - L_1}{L_1}$	4.98	3.72	6.64	5.19	3.41	7.13

(b) Mechanization expenses per worker

	Canada	Atlantic	Quebec	Ontario	Prairie	B.C.
	(Thousands of constant dollars)					
1974 level (L_2)	2933	1707	829	2549	3604	2712
1950 level (L_1)	738	341	221	621	1200	611
$\frac{L_2 - L_1}{L_1}$	2.97	4.01	2.75	3.10	2.00	3.44

(c) Crop input expenses per worker

	Canada	Atlantic	Quebec	Ontario	Prairie	B.C.
	(Thousands of constant dollars)					
1974 level (L_2)	818	771	679	1086	742	712
1950 level (L_1)	108	231	73	172	66	194
$\frac{L_2 - L_1}{L_1}$	6.57	2.34	8.30	5.31	10.24	2.67

(d) Livestock input expenses per worker

	Canada	Atlantic	Quebec	Ontario	Prairie	B.C.
	(Thousands of constant dollars)					
1974 level (L_2)	1830	1657	2195	2689	1116	3199
1950 level (L_1)	424	436	438	764	179	799
$\frac{L_2 - L_1}{L_1}$	3.32	2.80	3.79	2.52	5.23	3.00

(e) Capital per worker*

	Canada	Atlantic	Quebec	Ontario	Prairie	B.C.
	(Thousands of constant dollars)					
1974 level (L_2)	5912	4317	4066	6797	5702	7090
1950 level (L_1)	1332	1047	790	1646	1506	1704
$\frac{L_2 - L_1}{L_1}$	3.44	3.12	4.15	3.13	2.97	3.16

* Capital is made up of expenditures on mechanization, crop expenses and livestock expenses.

(f) Output per worker (labor productivity)

	Canada	Atlantic	Quebec	Ontario	Prairie	B.C.
	(Thousands of constant dollars)					
1974 level (L_2)	9505	6083	6580	11327	9855	11982
1950 level (L_1)	2600	1950	1583	3087	2954	3625
$\frac{L_2 - L_1}{L_1}$	2.65	2.12	3.46	2.67	2.34	2.30

The results indicated significant regional changes and differences in the levels of resource inputs per worker. By far the most dramatic changes and regional differentials occurred in the input categories of farm real estate and crop input expenses. Changes in farm real estate ranged from a high of 7.13 times its 1950 level in British Columbia to a low of 3.41 in the Prairie region. Although the region of Quebec had the lowest level of farm real estate per worker in 1950, the region achieved the second highest change in this input category during the period being considered.

The Prairie region although having the highest level of mechanization expenses per worker in both 1950 and 1974, experienced the lowest change in this input category, while the Atlantic region recorded the highest change in mechanization expenses per worker employed in agriculture. Quebec with the lowest level in this input category in 1950 also achieved the lowest change for the period.

Changes in crop input expenses per worker were more dramatic, especially in the Prairie and the Quebec regions, and showed significant regional differences. Incidentally the two regions, Quebec and Prairie, which experienced the highest change in this input group, also had the smallest base year values. The Ontario region ranked third in significance of the changes in the crop input expenses per worker category. Changes in livestock expenses per worker during the period, followed a similar pattern as crop expenses, with the highest changes occurring in the Prairie and Quebec regions.

An observation of capital expenses per worker showed the highest change during the period was in the Quebec region with the rest of Canada being more or less at par. Quebec, however, had the lowest base year value in capital expenses per worker.

In 1950, output per worker was lowest in Quebec, while British Columbia had the highest base year value of output per worker. However the changes in output per worker showed that Quebec ranked number one whilst showing no significant differences among the rest of the regions. However it must be stated that in computing the above statistics only extreme values are used, and these values may favour some regions. Using selected periods to compute output per worker levels also showed significant differences in absolute levels among regions (see Table I of this study). The most important observation to be made from the various statistics computed above is that different input categories changed at different amounts in the different regions. No specific pattern of relationship appears to exist between output per worker changes and increases in a particular input category. Different regions owe growth in output to growth in different input categories. Thus a measure of overall growth in output per worker should include not only the changes in resource inputs per worker, but also the relative importance of each resource input in total output. While the use of 'range estimates' may provide reasonable estimates for a cursory review, more accurate and realistic estimates may be obtained by narrowing down the range as much as possible as was done in this study.

APPENDIX B

STATISTICAL ANALYSIS OF FACTOR SHARES, CANADA AND REGIONS, 1950-1974

The approach employed in the current study for the empirical estimates of labor productivity trends and components of growth assumed that production elasticities remain unchanged over the period considered. Production elasticities are therefore represented by constant, average-annual factor shares. Thus, for example, the factor share of labor for Canada is estimated to be a constant, average-annual value of .338 for the period 1950-1974. The study also assumed optimal resource use under perfect equilibrium conditions where all resources are paid the equivalent of their marginal productivities. In the real world, however, there are usually adjustment lags between observed and optimal resource use. Therefore an approach which allows for changes in production elasticities over time as well as adjustment lags in resource use may be more realistic. If distributed-lag analysis is used it may be postulated that resource use in agriculture adjusts towards, but does not reach, equilibrium. According to Tyner and Tweeten it may be assumed,

> that the employment of a factor (expenditure on factor) tends towards an equilibrium as indicated by the adjustment equation.
>
> $$b_t - b_{t-1} = g(b^o - b_{t-1})$$

where,

b_t is current factor share,

b_{t-1} is lagged factor share, and

b^o "...is the current equilibrium factor share, and g is the proportion of adjustment to equilibrium made in one period." [1]

The assumption made in the present study seems to imply an instantaneous adjustment process. However,

> "...the process of adjustment is not instantaneous because of risk, uncertainty, technical restraints, institutional rigidities, and psychological resistance to change..."[2]

In an industry such as agriculture, factor shares are more likely to change over time and resource use is likely to move continuously towards equilibrium. If factor shares change significantly over the period of the study, then the model used may be unrealistic. For these reasons it was decided to test statistically the following hypotheses:

(i) that "optimal equilibrium factor shares change significantly over time, and

(ii) that significant adjustment lags exist between actual and optimal expenditures on resource time.

In short, the observed factor shares are tested statistically for trends and adjustment lags. For this analysis the distributed-lag model postulated by Tyner and Tweeten above is modified following Auer's example as shown below.[3]

If optimal factor shares (b_i^o) of individual resource inputs changed gradually over time, such a change can be represented as follows:

$$b_i^o = b_i + a_i t$$

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[1]Tyner and Tweeten, op. cit. p. 1462.

[2]Ibid.

[3]See Auer, op. cit., p. 50.

and in conjunction with the adjustment equation

$$b_{it} - b_{it-1} = g_i(b_i^o - b_{it} - 1) + e$$

the actual factor share may be expressed as a function of optimal factor shares (b_i^o) which, in relation to a certain base year value (b_i), change gradually at a rate of a_i and adjust annually to the difference between actual and optimal expenditure on resource use at the rate g_i as expressed in the regression equation below:

$$b_{it} = gb_{it-1} + g_i a_i t + (1-g)b_{it-1} + e$$

where e is an error term.

The significant coefficients obtained from the above regression equation are then used to test the hypotheses. If the coefficient a_i of the time-trend variable turns out to be statistically significant, it implies that factor shares changed significantly over the period and the first hypothesis is accepted, otherwise it is rejected, in which case the model used in this study is a fair approximation of reality. The second hypothesis is acceptable if the coefficient of the lagged factor shares turns out to be statistically significant.

The regression coefficients for the individual resource inputs for Canada and the various regions are presented in this Appendix.

Almost invariably for all regions, in the majority of cases adjustment lags turned out to be statistically significant, while trends were either not significant or at best less significant than adjustment lags. Thus although the tests indicated significant lag between actual and optimal expenditures on resource use, they, however, demonstrated that in most cases factor shares did not change significantly over the period considered.

REGRESSION COEFFICIENTS

OF DISTRIBUTED-LAG FUNCTIONS OF FACTOR SHARES

CANADA, 1950-1974

	Regression Coefficients (1)			
	R^2	DW	Trend (2)	Lag
Labor	.80	1.33	-.36*	.53**
Capital and Material Inputs				
Land and Buildings				
Interest on real estate	.92	1.61	.31*	.63**
Depreciation on buildings	.84	1.34	-.02	1.09**
Taxes on real estate	.42	1.90	-.03	.66**
Building repairs	.45	1.71	.01*	.31
Machinery				
Interest on capital stock	.78	1.83	.03	.63**
Depreciation	.56	1.83	-.03	.85**
Machinery operating expenses	.38	1.68	-.00	.60**
Crop Yield Inputs				
Fertilizer and lime	.87	1.62	.02	.78**
Other Crop Expenses	.77	1.73	.02	.79**
Livestock Yield Inputs				
Interest on capital stock	.80	1.63	.08**	.32*
Feed, purchased	.60	1.79	.11**	.00
Other livestock expenses	.82	1.72	-.01	1.08**
Miscellaneous operating expenses	.48	1.63	.03	.58**

The following footnotes apply to all the tables in Appendix B:

**, *, represent 1% and 5% level of significance respectively.

(1) R^2 and DW are multiple correlation and Durbin-Watson statistics. The DW statistics are likely to be biased. See Zvi Griliches, "Distributed Lags: A Survey," Econometrica, Vol. 35, No. 1, (January 1967), p. 46.

(2) Trend coefficients are adjusted by a factor of 100.0.

REGRESSION COEFFICIENTS
OF DISTRIBUTED-LAG FUNCTIONS OF FACTOR SHARES
ATLANTIC REGION, 1950-1974

			Regression Coefficients[1]	
	R^2	DW	Trend[2]	Lag
Labor	.49	1.96	-.33	.62**
Capital and Material Inputs				
Land and Buildings				
Interest on real estate	.89	1.86	.22**	.49**
Depreciation on buildings	.20	1.80	.02	.27
Taxes on real estate	.53	2.24	-.18	.77**
Building repairs	.56	2.24	-.00	.75**
Machinery				
Interest on capital stock	.83	1.89	.03	.70**
Depreciation	.55	2.01	.01	.67**
Machinery operating expenses	.53	1.82	.11*	.36
Crop Yield Inputs				
Fertilizer and lime	.36	1.88	.00	.60**
Other crop expenses	.53	1.80	.05*	.40*
Livestock Yield Inputs				
Interest on capital stock	.74	1.63	.05**	.37*
Feed, purchased	.73	1.99	.33**	.21
Other livestock expenses	.82	1.84	.00	.83**
Miscellaneous operating expenses	.15	1.89	.00	.34*

**, *, represent 1% and 5% level of significance respectively.

REGRESSION COEFFICIENTS

OF DISTRIBUTED-LAG FUNCTIONS OF FACTOR SHARES

QUEBEC REGION, 1950-1974

	Regression Coefficients(1)			
	R^2	DW	Trend(2)	Lag
Labor	.82	1.79	-.94**	.28
Capital and Material Inputs				
Land and Buildings				
Interest on real estate	.85	1.86	.03	.61**
Depreciation on buildings	.76	2.01	-.01	.88**
Taxes on real estate	.84	2.03	.06*	.60**
Building Repairs	.83	1.80	.17*	.43*
Machinery				
Interest on capital stock	.68	1.61	-.01	.84**
Depreciation	.68	1.49	-.01	.96**
Machinery operating expenses	.33	1.89	.01	.47*
Crop Yield Inputs				
Fertilizer and lime	.78	1.80	.04*	.57**
Other crop expenses	.61	1.93	.03	.92**
Livestock Yield Inputs				
Interest on capital stock	.75	1.21	.06*	.45*
Feed, purchased	.50	1.90	.05	.63**
Other livestock expenses	.92	1.90	.00	.89**
Miscellaneous operating expenses	.94	2.02	-.01	.91**

**, *, represent 1% and 5% level of significance respectively.

REGRESSION COEFFICIENTS

OF DISTRIBUTED-LAG FUNCTIONS OF FACTOR SHARES

ONTARIO REGION, 1950-1974

	Regression Coefficients (1)			
	R^2	DW	Trend (2)	Lag
Labor	.81	1.64	-.45**	.43*
Capital and Material Inputs				
Land and Buildings				
Interest on real estate	.94	1.33	.37*	.60**
Depreciation on buildings	.90	1.39	.00	.86**
Taxes on real estate	.28	2.24	-.03	.57**
Building repairs	.30	1.98	.01	.28
Machinery				
Interest on capital stock	.07	0.77	-.07	-.21
Depreciation	.78	1.92	-.02	.89**
Machinery operating expenses	.29	1.84	.01	.50**
Crop Yield Inputs				
Fertilizer and lime	.67	1.98	.01	.72**
Other crop expenses	.70	1.95	.04*	.78**
Livestock Yield Inputs				
Interest on capital stock	.71	1.38	.05*	.40*
Feed, purchased	.07	1.87	.03	.15
Other livestock expenses	.65	1.75	.02	.59*
Miscellaneous operating expenses	.89	1.81	-.02	.88*

**, *, represent 1% and 5% level of significance respectively.

REGRESSION COEFFICIENTS

OF DISTRIBUTED-LAG FUNCTIONS OF FACTOR SHARES

PRAIRIE REGION, 1950-1974

	Regression Coefficients (1)			
	R^2	DW	Trend (2)	Lag
Labor	.51	1.57	-.27*	.49*
Capital and Material Inputs				
Land and Buildings				
Interest on real estate	.84	1.79	.34	.63**
Depreciation on buildings	.71	1.97	-.01	.95**
Taxes on real estate	.29	1.77	-.12**	-.02
Building repairs	.78	1.74	.03**	.29
Machinery				
Interest on capital stock	.64	1.86	.06	.55**
Depreciation	.37	1.85	-.04	.70**
Machinery operating expenses	.21	1.79	-.04	.47*
Crop Yield Inputs				
Fertilizer and lime	.90	1.38	.04	.75**
Other crop expenses	.76	1.71	.04**	.36
Livestock Yield Inputs				
Interest on capital stock	.77	1.81	.11**	.28
Feed, purchased	.90	2.22	.09**	.26
Other livestock expenses	.81	1.45	.01	.68*
Miscellaneous operating expenses	.35	1.82	.02	.12

**, *, represent 1% and 5% level of significance respectively.

REGRESSION COEFFICIENTS

OF DISTRIBUTED-LAG FUNCTIONS OF FACTOR SHARES

BRITISH COLUMBIA REGION, 1950-1974

	Regression Coefficients (1)			
	R^2	DW	Trend (2)	Lag
Labor	.20	1.71	-.11	.39*
Capital and Material Inputs				
Land and Buildings				
Interest on real estate	.92	1.54	.48*	.69**
Depreciation on buildings	.85	1.41	.04	.57**
Taxes on real estate	.46	1.02	.00	.71**
Building repairs	.59	1.38	.02*	.77**
Machinery				
Interest on Capital Stock	.87	1.70	.04	.59**
Depreciation	.74	1.82	-.01	.96**
Machinery operating expenses	.77	1.78	.06*	.63**
Crop Yield Inputs				
Fertilizer and lime	.19	2.12	-.00	.42*
Other crop expenses	.38	1.49	.01	.74**
Livestock Yield Inputs				
Interest on Capital stock	.49	1.85	.09**	.08
Feed, purchased	.12	1.96	.15	.16
Other livestock expenses	.03	1.99	.09	-.05
Miscellaneous operating expenses	.12	2.05	.01	.31

**, * represent 1% and 5% level of significance respectively.

APPENDIX TABLE 1-A

PRODUCTION ELASTICITIES:

(CURRENT FACTOR SHARES ESTIMATES)

ANNUAL AVERAGES, 1950-1974, CANADA

Resource Description:	X_i	
LABOR INPUT	X_1	.338
CAPITAL INPUTS:		.426
Land and Buildings		.248
Interest on real estate	X_2	.138
Depreciation on buildings	X_3	.032
Taxes on real estate	X_4	.058
Building repairs	X_5	.020
Mechanization		.224
Interest on capital stock	X_6	.037
Depreciation on machinery	X_7	.077
Machinery operating expenses	X_8	.110
Crop Yield Inputs		.046
Fertilizer and lime	X_9	.025
Other crop expenses	X_{10}	.021
Livestock Yield Inputs		.124
Interest on capital stock	X_{11}	.024
Feed, purchased	X_{12}	.100
Other livestock expenses	X_{13}	.015
Miscellaneous operating expenses	X_{14}	.032

Source: Based on data from Statistics Canada, (See Appendix Table 4A, and Appendix Table 7A).

APPENDIX TABLE 1-B

PRODUCTION ELASTICITIES:

(CURRENT FACTOR SHARES ESTIMATES)

ANNUAL AVERAGES, 1950-1974, ATLANTIC REGION

Resource Description:	X_i	
LABOR INPUT	X_1	.496
CAPITAL INPUTS		.476
Land and Buildings		.192
Interest on real estate	X_2	.092
Depreciation on buildings	X_3	.036
Taxes on real estate	X_4	.030
Building repairs	X_5	.034
Mechanization		.180
Interest on capital stock	X_6	.033
Depreciation on machinery	X_7	.052
Machinery operating expenses	X_8	.095
Crop Yield Inputs		.093
Fertilizer and lime	X_9	.59
Other crop expenses	X_{10}	.034
Livestock Yield Inputs		.174
Interest on capital stock	X_{11}	.021
Feed, purchased	X_{12}	.146
Other livestock expenses	X_{13}	.007
Miscellaneous operating expenses	X_{14}	.029

Source: Based on data from Statistics Canada, (See Appendix Table 4-B, and Appendix Table 7-B).

APPENDIX TABLE 1-C

PRODUCTION ELASTICITIES:

(CURRENT FACTOR SHARES ESTIMATES)

ANNUAL AVERAGES, 1950-1974, QUEBEC REGION

Resource Description:	X_i	
LABOR INPUT	X_1	.492
CAPITAL INPUTS		.454
Land and Buildings		.263
Interest on real estate	X_2	.030
Depreciation on buildings	X_3	.051
Taxes on real estate	X_4	.082
Building repairs	X_5	.100
Mechanization		.102
Interest on capital stock	X_6	.036
Machinery depreciation	X_7	.031
Machinery operating expenses	X_8	.035
Crop Yield Inputs		.050
Fertilizer and lime	X_9	.028
Other crop expenses	X_{10}	.022
Livestock Yield Inputs		.257
Interest on capital stock	X_{11}	.028
Feed, purchased	X_{12}	.220
Other livestock expenses	X_{13}	.009
Miscellaneous operating expenses	X_{14}	.045

Source: Based on data from Statistics Canada, (See Appendix Table 4-C, and Appendix Table 7-C).

APPENDIX TABLE 1-D

PRODUCTION ELASTICITIES:

(CURRENT FACTOR SHARES ESTIMATES)

ANNUAL AVERAGES, 1950-1974, ONTARIO REGION

Resource Description:	X_i	
LABOR INPUT	X_1	.299
CAPITAL INPUTS		.497
Land and Buildings		.257
Interest on real estate	X_2	.142
Depreciation on buildings	X_3	.041
Taxes on real estate	X_4	.048
Building repairs	X_5	.026
Mechanization		.178
Interest on capital stock	X_6	.035
Machinery depreciation	X_7	.056
Machinery operating expenses	X_8	.087
Crop Yield Inputs		.064
Fertilizer and lime	X_9	.037
Other crop expenses	X_{10}	.027
Livestock Yield Inputs		.211
Interest on capital stock	X_{11}	.025
Feed, purchased	X_{12}	.151
Other livestock expenses	X_{13}	.035
Miscellaneous operating expenses	X_{14}	.044

Source: Based on data from Statistics Canada, (See Appendix Table 4-D and Appendix Table 7-D).

APPENDIX TABLE 1-E

PRODUCTION ELASTICITIES:

(CURRENT FACTOR SHARES ESTIMATES)

ANNUAL AVERAGES, 1950-1974, PRAIRIE REGION

Resource Description	X_i	
LABOR INPUT	X_1	.325
CAPITAL INPUTS		.427
Land and Buildings		.282
Interest on real estate	X_2	.164
Depreciation on buildings	X_3	.025
Taxes on real estate	X_4	.079
Building repairs	X_5	.014
Mechanization		.304
Interest on capital stock	X_6	.049
Machinery depreciation	X_7	.108
Machinery operating expenses	X_8	.147
Crop Yield Inputs		.037
Fertilizer and lime	X_9	.017
Other crop expenses	X_{10}	.020
Livestock Yield Inputs		.061
Interest on capital stock	X_{11}	.027
Feed, purchased	X_{12}	.028
Other livestock expenses	X_{13}	.006
Miscellaneous operating expenses	X_{14}	.025

Source: Based on data from Statistics Canada, (See Appendix Table 4-E and Appendix Table 7-E).

APPENDIX TABLE 1-F

PRODUCTION ELASTICITIES:

(CURRENT FACTOR SHARES ESTIMATES)

ANNUAL AVERAGES, 1950-1974, BRITISH COLUMBIA REGION

Resource Description:	X_i	
LABOR INPUT	X_1	.275
CAPITAL INPUTS		.408
Land and Buildings		.279
Interest on real estate	X_2	.184
Depreciation on buildings	X_3	.043
Taxes on real estate	X_4	.038
Building repairs	X_5	.014
Mechanization		.145
Interest on capital stock	X_6	.028
Machinery Depreciation	X_7	.045
Machinery operating expenses	X_8	.072
Crop Yield Inputs		.045
Fertilizer and lime	X_9	.021
Other crop expenses	X_{10}	.024
Livestock Yield Inputs		.189
Interest on capital stock	X_{11}	.021
Feed, purchased	X_{12}	.155
Other livestock expenses	X_{13}	.013
Miscellaneous operating expenses	X_{14}	.029

Source: Based on data from Statistics Canada, (See Appendix Table 4-F and Appendix Table 7-F).

APPENDIX TABLE 2

AVERAGE ANNUAL GROWTH RATES OF RESOURCE INPUTS,

CANADA AND REGIONS, 1950-1974

Resource Input:*	Annual percentage change					
X_i	Canada	Atlantic	Quebec	Ontario	Prairie	British Columbia
X_1	-2.20	-3.46	-2.79	-2.24	-1.55	-3.38
X_2	8.56	4.96	5.04	7.96	7.97	11.99
X_3	2.10	-0.79	0.64	3.55	1.22	3.12
X_4	-5.18	-1.80	-0.09	-0.19	-1.18	1.14
X_5	3.56	0.60	2.49	2.75	5.18	4.83
X_6	6.61	5.79	5.37	6.41	6.67	7.33
X_7	1.72	1.25	2.00	2.63	1.54	2.44
X_8	2.47	1.24	4.29	1.95	1.67	4.50
X_9	6.22	0.28	2.71	4.65	19.28	4.07
X_{10}	8.22	5.00	14.77	8.39	8.21	5.43
X_{11}	9.49	5.33	8.45	8.17	12.88	11.02
X_{12}	2.05	1.42	1.25	1.67	4.87	4.04
X_{13}	3.12	2.40	4.21	5.29	3.93	5.08
X_{14}	3.53	2.94	3.22	3.83	2.34	4.67

Source: Based on data from Statistics Canada, (See Appendix Tables 5 (A-f), and Appendix Tables 7 (A-F)).

* Resource inputs X_1.......X_{14} are as specified in Appendix Tables 1 - A to F.

APPENDIX TABLE 3

DISAGGREGATE COMPONENTS OF GROWTH IN AGRICULTURAL LABOR PRODUCTIVITY, 1950-1974, CANADA AND REGIONS

Resource Input:*	Average annual percentage change					
X_i	Canada	Atlantic	Quebec	Ontario	Prairie	British Columbia
X_1	1.46	1.74	1.42	1.57	1.05	2.45
X_2	1.18	0.46	0.15	1.25	1.31	2.21
X_3	0.07	-0.03	0.03	0.15	0.03	0.13
X_4	-0.25	-0.05	-0.01	-0.01	-0.09	0.04
X_5	0.07	0.02	0.25	0.07	0.07	0.07
X_6	0.24	0.19	0.19	0.22	0.33	0.20
X_7	0.13	0.07	0.06	0.15	0.17	0.11
X_8	0.17	0.12	0.15	0.17	0.25	0.32
X_9	0.16	0.02	0.08	0.17	0.33	0.09
X_{10}	0.17	0.17	0.32	0.23	0.16	0.13
X_{11}	0.23	0.11	0.24	0.20	0.35	0.23
X_{12}	0.21	0.21	0.28	0.25	0.14	0.63
X_{13}	0.05	0.02	0.04	0.19	0.02	0.07
X_{14}	0.11	0.09	0.14	0.17	0.06	0.13

Source: Computed from Appendix Tables 1 (A-F) and Appendix Table 2, using Taylor's expansion.

* Resource inputs $X_1 \ldots\ldots X_{14}$ are as specified previously.

APPENDIX TABLE 4-A

RESOURCE INPUTS IN AGRICULTURE
CANADA, 1950-1974
(in thousands of current dollars)

YEAR	LAND AND BUILDINGS				MACHINERY			CROP INPUTS		LIVESTOCK INPUTS			
	1 Interest	2 Bldg. Deprec.	3 Taxes	4 Bldg. Repairs	5 Interest	6 Deprec.	7 Operating Expenses	8 Fert. and Lime	9 Other Expenses	10 Interest	11 Feed Purchased	12 Other Expenses	13 Misc. Optg. Expenses
1950	139,629	62,594	166,690	44,206	43,540	157,183	267,060	40,264	40,264	31,553	267,195	18,733	46,353
1951	178,606	65,617	184,922	53,165	65,298	181,132	285,987	45,400	46,519	55,379	274,180	24,759	69,836
1952	203,498	68,138	200,714	50,235	75,180	197,175	306,721	49,179	50,331	51,935	273,896	21,906	74,523
1953	236,729	75,489	179,152	59,310	80,823	217,888	320,121	56,141	46,566	46,384	240,288	27,206	76,108
1954	198,476	76,548	154,070	56,205	74,811	230,504	314,011	54,135	45,912	40,729	260,379	30,163	78,160
1955	204,892	82,431	177,780	55,268	74,218	226,243	329,065	51,373	51,578	41,103	264,789	32,957	83,573
1956	246,010	87,563	186,432	60,384	85,100	225,748	351,194	52,847	59,532	43,820	304,763	37,893	90,548
1957	290,169	90,927	173,726	54,977	96,753	238,041	364,202	54,776	62,999	49,609	278,267	35,566	91,852
1958	306,816	98,707	182,620	60,834	97,159	247,085	370,297	59,558	63,061	69,209	320,197	38,814	102,458
1959	388,188	104,517	190,804	67,609	120,965	255,818	388,615	66,723	70,479	80,019	335,510	47,097	108,955
1960	419,577	103,213	213,727	68,032	132,614	265,059	398,743	69,942	74,179	82,632	329,996	42,073	114,727
1961	434,472	113,326	204,041	68,006	126,224	266,820	392,345	80,298	79,454	81,600	334,890	52,405	118,715
1962	458,573	117,215	232,893	73,395	132,545	276,706	402,758	86,988	78,467	95,501	378,111	49,717	122,632
1963	490,638	123,372	258,337	77,413	141,870	293,281	423,463	101,572	86,736	89,673	410,148	51,951	130,299
1964	552,994	134,201	248,932	79,183	154,189	316,771	443,749	122,700	93,303	95,533	434,042	62,087	141,346
1965	615,652	148,204	270,991	85,072	166,099	345,212	464,514	138,685	87,673	96,631	463,334	67,863	155,138
1966	748,225	164,097	304,664	100,861	203,349	378,162	495,560	165,999	98,673	127,183	514,611	88,914	165,064
1967	880,793	181,758	285,733	103,485	221,158	420,450	516,020	192,528	107,265	133,192	567,483	109,290	174,805
1968	1,135,507	199,471	305,738	102,122	265,268	458,541	535,704	215,957	110,183	158,596	530,471	106,806	179,709
1969	1,260,278	208,453	314,879	99,951	304,604	483,284	558,884	160,643	106,747	221,390	547,275	97,062	178,198
1970	1,324,004	208,693	295,778	92,875	297,362	506,910	573,187	146,062	108,065	209,101	589,604	95,189	188,999
1971	1,173,692	211,917	292,117	121,211	240,151	441,732	674,679	162,859	165,490	151,326	557,670	99,902	212,148
1972	1,257,058	219,999	293,424	154,011	274,900	463,098	735,974	175,216	179,874	189,275	596,405	119,072	229,704
1973	1,534,024	258,178	356,976	182,626	311,337	499,952	850,303	221,113	241,948	318,700	925,613	139,230	254,780
1974	2,309,772	294,432	346,790	218,371	424,829	592,184	1,116,917	338,958	416,651	427,025	1,133,607	129,174	305,807

Sources: Columns (1), (5) and (10) are estimated from information in Appendix Table 9-A*. Remaining columns from Statistics Canada, Handbook of Agricultural Statistics, Part II-Farm Income, 1926-1965, Cat. # 21-511. Statistics Canada, Quarterly Bulletin of Agricultural Statistics, April-June, 1966-1975.

* Corresponding columns in Appendix Tables 4 - (B-F) are estimated from corresponding tables in Appendix Tables 9 (B-F). Sources in the remaining columns of Appendix Tables 4 (B-F), are as shown for Appendix Table 4-A above.

APPENDIX TABLE 4-B

RESOURCE INPUTS IN AGRICULTURE
ATLANTIC REGION, 1950-1974
(in thousands of current dollars)

YEAR	LAND AND BUILDINGS				MACHINERY			CROP INPUTS		LIVESTOCK INPUTS			
	1 Interest	2 Bldg. Deprec.	3 Taxes	4 Bldg. Repairs	5 Interest	6 Deprec.	7 Operating Expenses	8 Fert. and Lime	9 Other Expenses	10 Interest	11 Feed Purchased	12 Other Expenses	13 Misc. Optg. Expenses
1950	6,477	4,756	3,631	3,762	1,610	4,349	8,722	8,692	3,214	1,536	15,266	477	2,023
1951	7,809	4,824	3,738	4,829	2,315	4,792	9,209	7,332	3,835	2,434	16,846	495	3,882
1952	8,697	4,854	3,821	3,944	2,676	4,313	10,513	8,298	4,149	2,393	17,419	507	4,012
1953	9,034	4,847	3,943	4,067	2,905	5,961	11,036	8,613	3,869	2,132	14,597	590	3,957
1954	7,669	4,882	4,026	4,084	2,704	6,371	11,235	7,504	3,712	1,827	15,907	632	3,856
1955	7,453	4,935	4,113	3,803	2,694	6,333	11,954	7,973	4,272	1,837	15,731	656	3,859
1956	8,549	4,991	4,260	4,377	3,189	6,568	12,655	7,868	4,607	1,900	16,905	686	3,993
1957	9,902	5,050	4,347	3,870	3,677	7,064	12,776	7,736	4,771	1,920	14,121	736	3,879
1958	9,707	5,093	4,565	3,905	3,629	7,258	12,845	8,061	4,773	2,402	16,054	755	4,574
1959	11,611	5,064	4,677	4,638	4,442	7,406	13,167	7,940	5,319	2,818	17,036	897	4,703
1960	11,941	5,055	4,682	5,828	4,718	7,438	13,636	8,344	5,015	2,937	16,970	980	4,657
1961	11,710	5,008	4,968	5,092	4,368	7,293	13,891	9,286	4,419	2,755	17,650	1,088	3,915
1962	11,635	5,031	5,194	5,334	4,631	7,660	13,410	8,873	4,489	3,093	20,857	1,096	3,902
1963	11,559	5,057	4,374	5,799	4,891	7,855	13,049	9,073	5,037	2,812	23,002	1,237	3,998
1964	12,247	5,209	5,565	6,483	4,192	8,108	13,910	8,965	5,233	2,834	23,595	1,207	4,252
1965	12,981	5,361	5,530	7,477	5,148	8,512	14,677	10,753	4,602	3,034	27,876	1,464	4,532
1966	15,202	5,813	5,894	7,415	6,127	9,087	15,749	13,256	5,385	3,786	28,713	1,750	4,898
1967	16,810	6,190	4,527	6,449	6,614	9,758	16,326	11,306	6,000	3,857	29,859	1,793	5,060
1968	20,670	6,723	4,501	6,614	7,944	10,556	17,193	11,612	5,908	4,647	29,649	1,690	5,005
1969	24,843	7,218	4,511	6,877	9,173	11,126	17,568	12,306	5,850	5,922	30,523	1,744	5,742
1970	27,219	7,611	4,574	5,824	9,008	11,475	19,154	11,822	5,894	5,437	31,932	1,687	5,924
1971	23,661	7,351	4,854	4,310	7,303	10,996	23,031	8,883	7,191	3,896	31,698	1,826	5,460
1972	26,393	7,863	4,744	6,009	8,454	11,538	24,657	8,276	8,414	4,455	32,750	1,997	5,786
1973	31,897	9,083	4,211	6,956	9,380	12,325	27,954	10,827	11,780	7,068	47,842	2,251	6,659
1974	47,829	10,654	5,034	9,531	12,573	14,412	32,742	15,784	18,016	10,405	59,782	2,420	7,972

Sources: See Appendix Table 4-A.

APPENDIX TABLE 4-C

RESOURCE INPUTS IN AGRICULTURE
QUEBEC, 1950-1974
(in thousands of current dollars)

YEAR	LAND AND BUILDINGS				MACHINERY			CROP INPUTS		LIVESTOCK INPUTS			
	1 Interest	2 Bldg. Deprec.	3 Taxes	4 Bldg. Repairs	5 Interest	6 Deprec.	7 Operating Expenses	8 Fert. and Lime	9 Other Expenses	10 Interest	11 Feed Purchased	12 Other Expenses	13 Misc. Optg. Expenses
1950	20,927	13,034	11,335	10,094	4,911	13,272	19,852	7,668	5,952	5,795	78,360	1,602	7,143
1951	27,442	13,900	12,083	13,550	7,163	14,836	21,987	8,290	7,453	9,355	84,886	1,858	10,468
1952	30,906	14,498	12,260	12,570	8,275	16,510	24,427	7,986	8,909	9,533	87,861	2,008	11,795
1953	32,641	14,994	12,530	14,310	8,781	18,252	26,344	8,683	8,284	8,481	75,446	2,206	12,496
1954	28,765	15,895	12,776	14,962	7,991	19,201	27,224	8,412	7,538	7,383	85,566	2,351	14,298
1955	28,168	16,405	13,069	15,548	8,041	19,382	29,728	8,390	8,054	7,040	87,495	2,594	15,722
1956	33,417	17,317	13,716	15,825	9,566	20,338	33,284	8,713	7,800	7,920	99,301	2,624	17,330
1957	38,816	17,754	14,121	14,548	11,102	22,146	36,582	9,470	8,366	8,411	89,162	2,738	17,561
1958	39,132	18,574	14,822	16,382	11,443	23,871	37,339	10,037	8,528	11,300	107,581	2,821	20,532
1959	48,151	18,976	15,397	17,905	14,464	25,346	39,712	10,528	9,354	12,854	111,707	3,296	22,147
1960	50,697	19,392	16,083	17,119	15,777	26,319	40,680	12,722	9,727	13,670	110,348	3,456	23,121
1961	51,241	19,794	16,672	18,117	14,822	26,285	43,027	15,738	10,081	12,705	101,565	3,995	25,353
1962	51,321	19,659	17,511	19,019	16,076	28,069	43,257	15,999	9,676	15,237	115,011	4,364	26,434
1963	52,701	20,062	19,425	19,363	17,633	29,976	45,626	15,334	10,693	14,180	127,716	5,234	27,769
1964	55,778	20,600	19,927	17,282	19,148	31,492	48,544	16,278	11,293	14,221	135,330	5,242	28,913
1965	57,520	21,537	20,740	19,134	18,421	32,483	50,347	18,622	10,874	14,560	145,252	6,466	30,568
1966	65,948	22,610	21,360	27,210	21,429	33,747	54,493	23,590	11,972	19,017	163,233	7,974	34,325
1967	70,591	23,370	21,745	27,030	23,059	37,113	59,977	24,745	12,176	20,628	177,761	8,891	35,637
1968	85,479	25,080	22,286	25,785	27,744	41,033	59,888	25,093	12,634	25,179	166,562	10,193	37,517
1969	100,253	26,409	23,025	26,030	32,378	44,563	66,983	26,804	10,407	32,634	167,417	8,879	37,549
1970	109,826	27,923	24,120	23,343	32,406	48,919	69,540	26,473	10,192	30,070	180,665	8,580	41,241
1971	91,732	27,388	25,694	25,471	26,294	41,748	77,836	25,026	27,613	20,635	144,680	9,044	42,183
1972	104,358	29,908	25,782	32,934	30,667	44,835	86,164	26,932	29,424	25,404	155,966	10,092	43,765
1973	123,961	33,976	27,041	40,015	35,086	48,904	96,537	29,176	40,365	42,428	246,270	11,480	49,588
1974	168,407	39,276	29,172	43,683	47,259	57,351	126,550	45,426	69,518	63,463	295,031	13,032	61,424

Sources: See Appendix Table 4-A.

APPENDIX TABLE 4-D

RESOURCE INPUTS IN AGRICULTURE
ONTARIO REGION, 1950-1974
(in thousands of current dollars)

YEAR	LAND AND BUILDINGS				MACHINERY			CROP INPUTS		LIVESTOCK INPUTS			
	1 Interest	2 Bldg. Deprec.	3 Taxes	4 Bldg. Repairs	5 Interest	6 Deprec.	7 Operating Expenses	8 Fert. and Lime	9 Other Expenses	10 Interest	11 Feed Purchased	12 Other Expenses	13 Misc. Optg. Expenses
1950	33,198	19,407	32,827	15,797	10,084	27,255	59,550	16,509	15,725	10,429	119,324	13,352	16,615
1951	45,987	20,816	36,030	21,492	14,605	31,170	64,309	19,364	17,975	18,829	124,274	18,698	25,187
1952	52,569	21,827	37,611	18,735	17,603	35,595	67,247	21,934	18,962	16,273	126,353	15,312	26,870
1953	60,174	24,242	39.019	21,385	18,601	39,692	69,448	25,430	16,190	14,604	112,836	19,722	28,015
1954	53,519	25,662	40,701	21,109	16,903	42,207	71,490	27,365	16,149	13,005	116,444	22,135	29,360
1955	56,263	28,257	41,926	22,013	16,932	42,955	74,564	26,725	18,515	12,906	117,508	24,038	31,186
1956	67,967	30,134	43,323	23,368	19,791	44,839	77,637	27,541	21,533	13,246	140,607	28,587	34,826
1957	82,746	32,079	45,082	21,642	22,698	48,728	81,132	27,437	21,950	15,262	131,178	25,487	36,060
1958	88,994	35,548	47,923	23,572	22,872	51,822	82,532	30,136	20,446	21,423	143,818	28,097	39,392
1959	118,369	39,258	49,941	25,717	28,437	54,517	85,606	34,117	22,210	24,276	152,469	34,604	42,285
1960	120,839	38,898	52,556	25,670	30,725	56,575	87,868	32,670	23,925	25,437	148,729	28,885	45,179
1961	129,901	42,230	56,288	25,576	28,501	56,298	88,432	35,951	24,889	24,343	151,441	36,619	48,289
1962	137,038	43,831	59,456	26,731	29,851	59,381	87,165	39,568	24,862	29,336	155,029	33,758	48,668
1963	139,287	44,639	62,319	30,220	31,777	62,962	90,262	47,112	28,505	26,335	174,451	33,279	52,665
1964	154,035	48,116	65,469	31,044	34,321	67,420	95,817	54,679	31,342	27,759	181,913	42,613	55,674
1965	162,863	51,319	68,651	33,450	36,160	72,816	104,539	60,209	29,035	27,883	192,535	44,456	60,664
1966	196,370	56,658	73,871	39,248	43,456	79,026	112,344	61,092	32,715	36,496	211,650	61,006	65,142
1967	230,540	65,084	79,931	41,228	47,377	87,807	118,735	68,865	37,177	38,684	228,359	79,080	68,605
1968	295,269	74,963	82,211	39,177	57,071	95,912	122,907	78,905	37,572	47,448	208,184	70,895	69,958
1969	376,586	87,140	88,830	39,931	66,374	102,079	126,833	62,122	34,902	64,057	219,218	68,403	76,538
1970	395,904	89,803	80,505	38,847	66,536	109,496	133,424	65,930	35,594	57,082	235,000	65,186	80,682
1971	359,729	87,825	73,337	45,041	54,737	100,524	167,918	61,245	69,573	39,268	240,510	67,002	83,167
1972	391,251	91,690	73,883	55,265	63,404	107,170	176,511	60,878	77,676	48,718	252,535	83,539	86,770
1973	496,658	111,311	69,309	61,510	72,494	116,929	201,226	71,248	100,834	80,982	395,470	96,296	97,494
1974	760,097	125,336	75,386	76,889	98,302	138,348	249,771	108,779	150,982	104,287	455,581	82,760	113,109

Sources: See Appendix Table 4-A.

APPENDIX TABLE 4-E

RESOURCE INPUTS IN AGRICULTURE
PRAIRIES, 1950-1974
(in thousands of current dollars)

YEAR	LAND AND BUILDINGS 1 Interest	2 Bldg. Deprec.	3 Taxes	4 Bldg. Repairs	MACHINERY 5 Interest	6 Deprec.	7 Operating Expenses	CROP INPUTS 8 Fert. and Lime	9 Other Expenses	LIVESTOCK INPUTS 10 Interest	11 Feed Purchased	12 Other Expenses	13 Misc. Optg. Expenses
1950	71,899	22,070	114,857	12,782	25,546	108,498	172,410	6,550	13,250	12,660	37,827	3,041	18,336
1951	88,356	22,578	128,867	12,518	38,784	126,223	183,651	8,351	14,590	22,768	30,775	3,352	27,040
1952	101,184	23,421	142,764	13,697	44,370	135,283	196,880	8,458	15,502	21,889	25,487	3,688	28,488
1953	123,042	27,387	119,400	17,927	48,138	149,032	205,731	10,561	15,530	19,404	21,079	4,199	28,134
1954	97,906	25,792	92,231	14,363	45,014	157,491	196,299	8,174	15,704	16,915	24,326	4,483	27,130
1955	101,879	28,074	114,301	12,321	44,290	152,185	204,300	5,775	17,669	17,710	26,040	5,047	29,220
1956	122,894	30,114	120,490	14,948	49,842	148,308	218,541	6,296	22,383	19,258	27,115	5,341	30,402
1957	142,081	30,493	106,108	13,187	56,121	153,899	223,999	7,523	24,597	22,188	25,838	5,913	30,488
1958	150,528	33,453	110,034	15,045	56,016	157,574	227,632	8,375	26,006	31,458	32,689	6,397	33,686
1959	186,695	34,508	115,031	17,075	69,619	161,675	239,617	11,066	30,013	36,865	31,915	7,429	35,195
1960	210,953	37,857	134,083	17,259	76,953	167,486	245,715	12,862	32,475	37,291	30,929	7,778	37,586
1961	216,720	39,283	119,848	18,215	74,278	169,539	232,188	16,507	36,463	38,474	35,873	9,470	36,758
1962	232,824	41,483	144,363	22,929	77,506	173,797	244,622	19,316	36,091	43,481	53,960	9,166	40,168
1963	261,065	46,270	164,783	24,590	82,856	184,425	259,911	27,109	40,032	42,496	50,476	10,687	43,252
1964	303,501	52,598	150,866	28,545	90,606	201,203	271,323	40,025	43,519	46,518	55,003	11,426	49,721
1965	350,582	61,302	167,919	30,861	100,656	221,934	279,936	46,497	42,365	46,922	58,276	13,520	56,946
1966	429,292	68,662	193,339	33,737	125,257	245,976	299,515	65,139	48,179	62,358	66,701	15,845	58,180
1967	514,657	77,255	167,672	37,311	136,454	265,829	305,000	85,015	50,264	64,170	82,771	16,964	62,715
1968	635,922	82,435	174,804	39,183	163,106	282,073	321,273	97,329	54,387	74,199	77,994	15,432	66,368
1969	677,054	76,679	181,639	40,250	185,402	285,622	327,348	57,466	56,437	109,100	81,041	16,258	64,912
1970	697,562	74,177	167,786	38,708	177,903	284,166	344,623	40,901	53,843	107,450	83,727	17,667	69,664
1971	608,816	72,274	175,967	42,460	141,782	273,938	378,047	61,178	53,627	80,729	89,145	20,046	59,910
1972	637,065	72,639	176,270	51,854	161,024	284,441	418,108	72,977	56,227	102,362	100,574	21,142	82,705
1973	762,240	82,975	240,995	62,696	181,528	305,699	487,765	103,564	77,739	174,033	138,800	26,604	91,465
1974	1,136,869	95,874	230,874	82,408	249,556	367,359	611,325	158,151	161,791	228,685	224,203	27,957	103,450

Sources: See Appendix Table 4-A.

APPENDIX TABLE 4-F

RESOURCE INPUTS IN AGRICULTURE
BRITISH COLUMBIA, 1950-1974
(in thousands of current dollars)

YEAR	LAND AND BUILDINGS				MACHINERY			CROP INPUTS		LIVESTOCK INPUTS			
	1	2	3	4	5	6	7	8	9	10	11	12	13
	Interest	Bldg. Deprec.	Taxes	Bldg. Repairs	Interest	Deprec.	Operating Expenses	Fert. and Lime	Other Expenses	Interest	Feed Purchased	Other Expenses	Misc. Optg. Expenses
1950	7,129	3,327	4,040	1,771	1,389	3,755	6,526	1,845	2,477	1,133	16,418	291	2,236
1951	9,009	3,499	4,204	1,476	1,986	4,114	6,831	2,063	2,666	1,993	17,399	354	3,129
1952	10,176	3,538	4,258	1,289	2,255	4,484	7,654	2,503	2,763	1,839	16,776	391	3,358
1953	11,837	4,019	4,260	1,658	2,398	4,951	7,562	2,854	2,693	1,763	16,330	489	3,526
1954	10,617	4,317	4,336	1,687	2,200	5,234	7,763	2,680	2,799	1,598	18,136	562	3,516
1955	11,130	4,760	4,371	1,683	2,261	5,388	8,519	2,510	3,068	1,609	18,015	622	3,586
1956	13,185	4,007	4,643	1,866	2,713	5,695	9,077	2,429	3,209	1,696	20,835	655	3,997
1957	16,624	5,551	5,068	1,730	3,156	6,204	9,713	2,610	3,315	1,830	17,968	692	3,864
1958	17,454	6,039	5,276	1,930	3,198	6,560	9,949	2,949	3,308	2,627	20,055	744	4,274
1959	23,362	6,711	5,758	2,274	4,004	6,874	10,513	3,072	3,583	3,206	22,383	871	4,625
1960	25,145	7,011	6,123	2,156	4,430	7,241	10,844	3,344	3,911	3,297	23,020	974	4,784
1961	24,898	7,011	6,215	2,169	4,255	7,405	11,149	3,210	4,223	3,323	27,208	1,160	5,331
1962	25,754	7,211	6,369	2,503	4,481	7,799	10,886	4,016	4,233	3,994	30,950	1,205	5,022
1963	26,025	7,344	6,436	1,673	4,714	8,063	11,650	4,121	4,340	3,850	31,047	1,324	5,086
1964	27,431	7,678	7,105	2,075	5,013	8,548	12,360	4,322	4,412	4,103	33,593	1,345	5,524
1965	31,805	8,680	7,771	1,953	5,715	9,467	13,598	4,566	3,919	4,231	33,633	1,639	5,848
1966	41,416	10,350	8,436	2,615	7,079	10,326	14,937	5,279	4,711	5,526	36,496	1,957	6,195
1967	48,196	10,853	8,711	2,849	7,653	11,300	15,421	5,344	5,408	5,856	40,232	2,116	7,273
1968	65,490	12,252	9,702	2,577	9,403	12,044	17,149	5,253	5,885	7,125	36,800	1,946	6,871
1969	81,542	12,865	10,800	1,907	11,277	12,914	19,593	5,477	5,456	9,677	41,731	1,928	5,707
1970	93,493	13,424	11,225	1,170	11,509	13,930	21,306	4,766	5,811	9,063	45,000	1,900	7,145
1971	89,752	17,079	12,265	3,929	10,035	14,526	27,847	6,527	7,486	6,798	51,637	2,164	10,358
1972	97,991	17,899	12,725	8,605	11,451	15,114	32,524	6,063	8,133	8,335	54,580	2,302	10,678
1973	119,268	20,833	14,420	11,479	12,850	16,095	36,786	6,298	10,691	14,170	77,231	2,599	13,885
1974	196,571	23,292	15,100	13,207	17,139	18,725	45,928	9,819	17,354	20,184	99,010	2,836	17,813

Sources: See Appendix Table 4-A.

APPENDIX TABLE 5-A

RESOURCE INPUTS PER WORKER IN AGRICULTURE
CANADA, 1970-1974
(In thousands of constant 1961 dollars)

YEAR		LAND AND BUILDINGS				MACHINERY			CROP INPUTS		LIVESTOCK INPUTS			
	1 No. of Workers	2 Interest	3 Bldg. Deprec.	4 Taxes	5 Bldg. Repairs	6 Interest	7 Deprec.	8 Operating Expenses	9 Fert. and Lime	10 Other Expenses	11 Interest	12 Feed, Purchased	13 Other Expenses	14 Misc. Optg. Expenses
1950	1002	177	79	212	56	69	248	421	54	54	42	357	25	62
1951	939	208	76	216	62	97	269	425	59	61	72	358	32	91
1952	869	250	84	247	62	115	302	471	66	67	69	366	29	99
1953	858	291	93	220	73	125	336	494	77	64	64	329	37	104
1954	878	239	92	185	68	112	346	471	73	62	55	353	40	106
1955	819	263	106	228	71	119	362	527	74	75	59	383	48	121
1956	777	324	115	246	80	136	362	563	77	87	64	447	56	133
1957	748	389	122	233	74	151	371	567	81	93	73	410	52	135
1958	718	431	138	256	85	149	379	568	90	95	105	484	59	154
1959	700	552	149	271	96	181	383	582	100	105	120	502	70	163
1960	683	608	150	310	99	199	398	599	104	111	123	493	63	171
1961	681	638	166	300	100	185	392	576	118	117	120	492	77	174
1962	660	622	159	316	100	198	413	602	125	113	138	545	72	177
1963	649	660	166	347	104	211	437	631	145	124	128	585	74	186
1964	630	741	180	334	106	231	474	664	179	136	140	634	91	206
1965	594	813	196	358	112	260	540	727	208	132	145	696	102	233
1966	544	990	217	403	133	336	626	820	257	153	197	797	138	256
1967	559	1167	241	379	137	345	655	804	283	158	196	836	161	257
1968	546	1481	260	399	133	409	706	826	317	162	233	778	157	264
1969	535	1556	257	389	123	467	742	858	232	155	321	792	141	258
1970	511	1719	271	384	121	466	795	896	218	161	312	879	142	282
1971	510	1456	263	362	150	366	672	1027	235	239	218	805	144	306
1972	481	1484	260	346	182	431	726	1154	254	261	275	865	173	333
1973	467	1722	290	401	205	484	777	1322	284	311	409	1189	179	327
1974	473	2286	291	343	216	584	814	1535	367	451	462	1228	140	331

Source: Estimated from Appendix Table 4-A, using the information from Column 4 of Appendix Table 7-A, and appropriate deflators from Statistics Canada sources. Estimated in Appendix Tables 5 (B-F), are similarly obtained from corresponding tables in Appendix Tables 4 (B-F) and Appendix Tables 7 (A-F).

APPENDIX TABLE 5-B

RESOURCE INPUTS PER WORKER IN AGRICULTURE
ATLANTIC REGION, 1950-1974
(In thousands of constant 1961 dollars)

YEAR		LAND AND BUILDINGS				MACHINERY			CROP INPUTS		LIVESTOCK INPUTS			
	1 No. of Workers	2 Interest	3 Bldg. Deprec.	4 Taxes	5 Bldg. Repairs	6 Interest	7 Deprec.	8 Operating Expenses	9 Fert. and Lime	10 Other Expenses	11 Interest	12 Feed Purchased	13 Other Expenses	14 Misc. Optg. Expenses
1950	69	120	88	67	69	37	101	203	169	62	30	297	9	39
1951	58	150	92	72	79	57	117	225	154	81	51	355	10	82
1952	55	170	95	75	77	66	131	260	175	87	50	367	11	84
1953	56	172	92	75	77	70	144	267	182	82	45	308	12	83
1954	50	163	104	86	87	73	172	304	180	89	44	382	15	93
1955	49	160	106	88	82	74	173	327	193	103	44	380	16	93
1956	49	178	104	89	91	82	169	326	183	107	44	392	16	93
1957	53	185	95	81	73	81	156	282	160	99	40	293	15	80
1958	55	175	92	82	71	73	145	256	160	95	48	319	15	91
1959	56	205	89	82	82	83	138	245	149	100	53	319	17	88
1960	55	216	92	88	105	88	138	253	155	93	55	315	18	86
1961	55	213	91	90	92	79	133	253	169	80	50	321	20	71
1962	44	256	111	114	117	104	172	301	195	99	68	458	24	86
1963	34	317	139	147	159	141	226	375	252	140	78	640	34	111
1964	38	286	122	130	151	130	203	348	220	128	72	580	30	105
1965	34	324	134	133	186	141	233	402	287	123	81	744	39	121
1966	32	376	144	146	184	171	254	440	354	144	101	768	47	131
1967	29	438	161	118	168	204	301	504	321	170	110	848	51	144
1968	26	576	187	125	184	257	341	556	359	183	144	917	52	155
1969	26	638	185	116	177	287	349	551	369	176	178	916	52	172
1970	26	704	197	118	151	274	349	583	346	173	159	935	49	173
1971	23	658	204	135	120	242	364	763	284	230	125	1,015	58	175
1972	19	824	246	148	188	341	465	994	307	312	165	1,216	74	215
1973	20	880	250	144	192	334	439	995	318	346	208	1,406	66	196
1974	22	1064	237	112	212	359	412	936	360	411	237	1,365	55	182

Source: See Appendix Table 5-A.

APPENDIX TABLE 5-C

RESOURCE INPUTS PER WORKER IN AGRICULTURE
QUEBEC REGION, 1950-1974
(In thousands of constant 1961 dollars)

YEAR		LAND AND BUILDINGS				MACHINERY			CROP INPUTS		LIVESTOCK INPUTS			
	1 No. of Workers	2 Interest	3 Bldg. Deprec.	4 Taxes	5 Bldg. Repairs	6 Interest	7 Deprec.	8 Operating Expenses	9 Fert. and Lime	10 Other Expenses	11 Interest	12 Feed Purchases	13 Other Expenses	14 Misc. Optg. Expenses
1950	251	25	68	101	107	83	73	65	41	32	31	418	9	38
1951	231	34	71	106	132	85	74	83	44	39	49	449	10	55
1952	203	44	87	129	164	97	82	84	46	51	54	501	11	54
1953	203	46	96	138	171	100	84	96	51	48	49	439	13	73
1954	214	40	95	135	143	101	81	95	47	42	41	480	13	80
1955	172	49	119	182	173	128	102	121	58	55	48	603	18	108
1956	165	59	126	205	206	132	105	121	60	54	55	685	18	119
1957	171	64	129	212	225	122	97	100	61	57	54	573	18	113
1958	162	70	146	229	240	126	101	111	68	63	76	725	19	138
1959	155	92	161	253	307	128	104	120	71	74	87	755	22	150
1960	135	116	194	300	374	147	122	129	96	73	103	835	26	175
1961	138	107	100	312	371	143	121	131	114	73	92	736	29	184
1962	132	118	206	317	377	147	131	142	117	71	111	843	32	194
1963	124	133	225	343	396	158	153	153	116	82	108	974	40	212
1964	114	149	245	378	434	172	166	144	133	95	117	1,109	43	237
1965	116	135	237	368	420	173	166	154	146	85	114	1,136	51	239
1966	106	160	252	407	493	191	180	229	190	97	153	1,317	64	277
1967	114	153	246	398	468	184	171	212	179	88	149	1,284	64	257
1968	121	166	246	359	512	174	155	179	167	84	167	1,107	68	249
1969	107	202	278	418	625	201	175	198	196	76	238	1,224	65	273
1970	105	208	313	446	704	210	182	176	192	74	218	1,310	62	299
1971	98	172	272	508	598	213	200	198	188	207	155	1,087	68	317
1972	97	188	274	527	638	236	204	260	196	214	185	1,134	73	318
1973	88	220	306	605	777	275	218	324	175	270	283	1,645	77	331
1974	85	272	330	729	970	290	216	323	268	411	375	1,743	77	363

Source: See Appendix Table 5-A.

APPENDIX TABLE 5-D

RESOURCE INPUTS PER WORKER IN AGRICULTURE
ONTARIO REGION, 1950-1974
(In thousands of constant 1961 dollars)

YEAR		LAND AND BUILDINGS				MACHINERY			CROP INPUTS		LIVESTOCK INPUTS			
	1 No. of Workers	2 Interest	3 Bldg. Deprec.	4 Taxes	5 Bldg. Repairs	6 Interest	7 Deprec.	8 Operating Expenses	9 Fert. and Lime	10 Other Expenses	11 Interest	12 Feed Purchased	13 Other Expenses	14 Misc. Optg. Expenses
1950	251	170	99	168	81	65	175	381	88	84	56	637	71	89
1951	239	214	97	168	100	87	185	382	99	92	96	635	96	129
1952	224	252	105	181	90	107	216	408	113	98	84	653	79	138
1953	220	291	117	189	104	115	244	428	137	87	78	606	196	151
1954	253	225	108	171	89	90	226	382	130	77	62	553	105	139
1955	236	251	126	187	98	96	244	423	134	93	65	590	121	156
1956	214	324	143	206	111	117	265	458	146	114	70	747	152	185
1957	193	426	165	232	111	138	296	492	156	125	87	747	145	205
1958	177	500	200	269	132	142	322	513	186	126	132	886	173	243
1959	177	660	219	278	143	167	321	504	202	131	144	903	204	250
1960	179	672	216	284	143	175	323	501	186	136	145	849	165	258
1961	162	802	261	347	158	176	347	546	222	154	150	935	226	298
1962	158	840	269	365	164	187	371	545	242	152	180	949	207	298
1963	172	755	242	338	164	181	358	513	259	157	145	960	183	290
1964	160	855	267	363	172	204	400	569	319	183	162	1,063	249	325
1965	151	914	288	385	188	223	449	645	362	174	168	1,157	267	365
1966	140	1,111	321	418	222	277	504	717	373	200	212	1,293	373	398
1967	147	1,186	335	411	212	289	535	724	386	208	217	1,280	443	384
1968	143	1,497	380	417	199	336	564	723	444	211	267	1,171	399	393
1969	136	1,848	428	436	196	398	612	760	357	200	368	1,258	393	439
1970	132	2,018	458	410	410	399	656	800	380	205	329	1,355	376	465
1971	134	1,716	419	350	214	311	572	955	337	382	216	1,322	368	510
1972	117	2,017	473	381	285	415	702	1,156	367	468	294	1,523	504	523
1973	122	2,245	503	313	278	423	682	1,174	343	486	390	1,906	464	470
1974	120	1,907	511	473	314	515	725	1,309	455	631	436	1,907	346	473

Source: See Appendix Table 5-A.

APPENDIX TABLE 5-E

RESOURCE INPUTS PER WORKER IN AGRICULTURE
PRAIRIE REGION, 1950-1974
(In thousands of constant 1961 dollars)

YEAR		LAND AND BUILDINGS				MACHINERY			CROP INPUTS		LIVESTOCK INPUTS			
	1 No. of Workers	2 Interest	3 Bldg. Deprec.	4 Taxes	5 Bldg. Repairs	6 Interest	7 Deprec.	8 Operating Expenses	9 Fert. and Lime	10 Other Expenses	11 Interest	12 Feed Purchased	13 Other Expenses	14 Misc. Optg. Expenses
1950	401	226	69	362	40	100	425	675	22	44	42	127	10	61
1951	383	250	64	364	35	140	457	665	27	47	73	99	11	87
1952	367	293	68	414	40	160	488	711	27	49	69	81	12	90
1953	358	359	80	348	52	177	547	755	35	51	63	69	14	92
1954	338	304	80	287	45	174	607	757	29	55	59	85	16	95
1955	331	322	89	361	39	174	598	803	21	63	63	93	18	104
1956	324	391	96	383	47	190	566	835	22	79	70	96	19	107
1957	308	468	101	349	43	212	581	846	27	88	80	93	21	110
1958	300	512	118	375	51	206	578	836	30	96	113	118	23	121
1959	289	649	119	400	59	253	588	872	40	109	133	115	27	127
1960	285	728	131	463	60	277	604	886	46	116	133	111	28	134
1961	299	725	131	401	61	248	567	777	55	122	129	120	32	123
1962	299	648	116	402	64	255	572	805	60	113	136	168	29	125
1963	300	660	117	417	62	265	590	831	82	121	128	152	32	130
1964	296	826	146	410	78	288	639	861	123	133	142	168	35	152
1965	271	946	165	453	83	345	760	959	150	137	152	188	44	184
1966	240	1,181	186	532	93	472	927	1,128	225	166	215	230	55	201
1967	243	1,536	230	500	111	492	959	1,100	288	170	217	280	57	212
1968	229	1,945	252	534	120	600	1,034	1,182	338	189	258	271	54	231
1969	243	1,820	206	488	108	629	970	1,112	182	178	345	256	51	205
1970	226	2,023	215	486	112	635	1,015	1,231	138	181	362	282	60	234
1971	231	1,650	196	477	115	482	931	1,285	195	171	257	284	64	191
1972	226	1,536	175	425	125	542	958	1,408	222	171	312	306	64	252
1973	216	1,765	192	558	145	617	1,040	1,659	294	221	495	451	76	260
1974	226	2,259	190	459	164	732	1,078	1,794	367	375	531	520	65	240

Source: See Appendix Table 5-A.

APPENDIX TABLE 5- F

RESOURCE INPUTS PER WORKER IN AGRICULTURE
BRITISH COLUMBIA REGION, 1950-1974
(In thousands of constant 1961 dollars)

YEAR		LAND AND BUILDINGS				MACHINERY			CROP INPUTS		LIVESTOCK INPUTS			
	1 No. of Workers	2 Interest	3 Bldg. Deprec.	4 Taxes	5 Bldg. Repairs	6 Interest	7 Deprec.	8 Operating Expenses	9 Fert. and Lime	10 Other Expenses	11 Interest	12 Feed Purchased	13 Other Expenses	14 Misc. Optg. Expenses
1950	30	300	140	170	75	73	196	342	83	111	51	735	13	100
1951	29	336	131	157	55	95	197	327	88	113	85	739	15	133
1952	21	515	179	216	65	142	283	483	139	153	102	930	22	186
1953	21	588	200	212	82	150	310	473	159	150	98	911	27	197
1954	23	485	197	198	77	125	297	440	137	144	82	930	29	180
1955	31	376	161	147	57	95	226	357	96	117	61	688	24	137
1956	26	522	198	184	74	129	271	432	107	141	74	915	29	175
1957	23	733	245	223	76	160	314	491	126	160	88	865	33	186
1958	24	743	257	225	82	147	301	456	133	149	118	901	33	192
1959	24	977	281	241	95	175	301	461	134	156	140	975	38	201
1960	30	825	230	201	71	152	248	371	114	133	112	781	33	162
1961	27	922	260	230	80	158	274	413	119	156	123	1,008	43	197
1962	27	794	222	196	77	163	284	397	139	146	138	1,069	42	173
1963	18	1,097	310	271	71	251	430	621	207	218	193	1,550	67	255
1964	22	1,004	281	260	76	214	365	528	178	182	169	1,384	55	228
1965	22	1,058	289	258	65	241	400	574	182	156	169	1,340	65	233
1966	25	1,094	273	223	69	256	373	540	175	156	183	1,211	65	205
1967	25	1,398	315	253	83	268	396	541	176	178	193	1,323	70	239
1968	26	1,764	330	261	69	305	390	556	161	180	218	1,127	60	210
1969	23	2,316	365	307	54	404	463	703	183	182	323	1,394	64	191
1970	23	2,664	382	320	33	404	489	748	158	192	300	1,490	63	237
1971	25	2,248	428	307	78	315	456	874	192	220	200	1,520	64	305
1972	22	2,427	443	315	213	396	523	1,125	190	255	261	1,709	72	334
1973	21	2,841	496	343	273	450	563	1,287	184	315	414	2,258	76	406
1974	20	4,413	523	339	296	568	621	1,523	257	455	529	2,596	74	467

Source: See Appendix Table 5-A.

APPENDIX TABLE 6

ESTIMATES OF FARM INCOME AND FARM PRODUCTION
BRITISH COLUMBIA, 1950-1974
(Thousands of current dollars)

	Gross Farm Income	Government Payment	Farm Income	Inventory Change	Observed Farm Prod.	Weather Adjustment	Farm Prod. (Adjusted)	Operating Expenses	Adjusted Net Farm Prod.
1950	103294			-3007	100287	2595	102882	50284	52598
1951	122209	187	122022	864	122886	-832	122054	55501	66553
1952	123468	43	123425	3521	126946	-583	126363	57171	69192
1953	126882	50	126842	4068	130910	-2202	128708	59348	69360
1954	125942			2935	128877	-198	128679	62366	66313
1955	123081	86	122995	1559	124554	969	125523	64270	61253
1956	132797	146	132651	-923	131728	2	131730	69682	62048
1957	134499	7	134492	- 6	134486	-131	134355	69929	64426
1958	141522	374	141148	-665	140483	232	140715	75065	65650
1959	145755	136	145619	2982	148601	6	148607	81330	67277
1960	149090	289	148801	1912	150713	85	150798	84773	66025
1961	156079	102	155977	3743	159720	-810	158910	92635	66275
1962	170821	300	170521	1592	172113	-1480	170633	100067	70566
1963	169990	29	169961	3670	173631	2542	176173	102326	73847
1964	176710	160	176550	4317	180867	-766	180101	109342	70759
1965	189458	76	189382	5	189387	-727	188660	119389	69271
1966	218886	19	218867	-446	218421	-710	217711	136584	81127
1967	231328	7	231321	-1352	229969	3672	233641	144528	39113
1968	248647	208	248439	3728	252167	-996	251171	149425	101746
1969	249036	128	248908	2569	251477	1196	252673	162485	90188
1970	266533	829	265704	4918	270622	400	271022	173435	97587
1971	276749	240	276509	7430	283939	-1132	282807	184658	98149
1972	303600	53	303547	1342	304889	1811	306700	200497	106203
1973	402493	1706	400787	10188	410975	316	411291	249178	162113
1974	487023	1501	485522	401	485923	-650	485273	311725	173548

Sources: (1) Statistics Canada, Handbook of Agricultural Statistics, Part II, Farm Income 1926-1965, Cat. No. 21-511, Dominion Bureau of Statistics.
(2) Statistics Canada, Farm Net Income, Cat. No. 21-202, Annual.

APPENDIX TABLE 7-A

FARM PRODUCTION, WAGES AND EMPLOYMENT IN AGRICULTURE
CANADA, 1950-1974
(In thousands of current dollars)

YEAR	Gross Farm Production (Adjusted)	Net Farm Production (Adjusted)	Wages Paid to Labor	No. of Farm Labor Employed ('000)
1950	2,631,592	1,482,099	1,177,350	1002
1951	3,189,900	1,908,627	1,201,920	939
1952	2,988,050	1,646,500	1,194,875	869
1953	2,908,131	1,532,672	1,235,520	858
1954	2,845,742	1,442,118	1,277,490	878
1955	2,690,251	1,245,975	1,142,505	819
1956	2,850,828	1,298,183	1,122,765	777
1957	2,852,394	1,289,890	1,163,140	748
1958	3,199,668	1,532,209	1,152,390	718
1959	3,193,236	1,423,016	1,207,500	700
1960	3,213,201	1,387,981	1,239,645	683
1961	3,591,290	1,717,100	1,273,470	681
1962	3,625,721	1,650,250	1,254,000	660
1963	3,639,587	1,531,149	1,259,960	649
1965	3,919,275	1,648,771	1,275,750	630
1965	4,233,662	1,777,575	1,286,010	594
1966	4,575,685	1,862,805	1,267,520	544
1967	4,951,055	2,013,339	1,481,350	559
1968	5,163,328	2,122,908	1,536,990	546
1969	5,990,844	1,871,852	1,663,850	535
1970	4,704,581	1,516,907	1,665,860	511
1971	5,210,352	1,870,033	1,741,650	510
1972	5,717,169	2,123,757	1,688,310	481
1973	7,988,922	3,497,924	1,769,930	467
1974	10,300,047	4,833,494	2,244,385	473

Sources: Columns (1) and (2) are estimated from Statistics Canada data as shown in Appendix Table 6 for British Columbia. Column (3) is estimated from "Quarterly Bulletin of Agricultural Statistics," Cat. #21-003, 1954-1976.

APPENDIX TABLE 7-B

FARM PRODUCTION, WAGES AND EMPLOYMENT IN AGRICULTURE, ATLANTIC REGION, 1950-1974
(In thousands of current dollars)

	Gross Farm Production (Adjusted)	Net Farm Production (Adjusted)	Wages Paid to Labor	No. of Farm Labor Employed ('000)
1950	129,470	69,607	86,250	69
1951	146,239	79,856	76,850	58
1952	158,001	86,745	77,000	55
1953	131,240	60,671	81,760	56
1954	135,087	63,788	70,250	50
1955	130,135	56,668	67,865	49
1956	133,219	55,937	67,620	49
1957	131,872	56,620	81,090	53
1958	131,839	528,868	86,350	55
1959	137,344	54,839	95,480	56
1960	140,892	54,443	93,775	55
1961	131,515	45,717	100,375	55
1962	127,715	39,265	81,400	44
1963	132,255	40,341	64,430	34
1964	140,092	44,889	74,480	38
1965	177,022	70,161	71,060	34
1966	169,948	55,128	73,280	32
1967	154,409	38,013	75,835	29
1968	163,510	43,702	72,930	26
1969	175,717	51,595	79,560	26
1970	192,640	64,790	85,540	26
1971	170,739	39,788	78,890	23
1972	196,289	56,874	66,405	19
1973	268,392	98,321	74,400	20
1974	342,987	131,882	102,740	22

Sources: See Appendix Table 7-A.

APPENDIX TABLE 7-C

FARM PRODUCTION, WAGES AND EMPLOYMENT IN AGRICULTURE,
QUEBEC REGION, 1950-1974
(In thousands of current dollars)

YEAR	Gross Farm Production (Adjusted)	Net Farm Production (Adjusted)	Wages Paid to Labor	No. of Farm Labor Employed ('000)
1950	388,531	209,874	313,750	251
1951	457,605	254,444	306,075	231
1952	466,362	250,647	284,200	203
1953	427,825	216,622	296,380	203
1954	437,476	209,985	300,670	214
1955	426,820	189,313	238,220	172
1956	443,609	183,389	227,700	165
1957	441,733	183,203	261,630	171
1958	484,089	196,248	254,340	162
1959	481,208	177,304	264,275	155
1960	469,418	158,103	230,175	135
1961	486,222	176,175	251,850	138
1962	507,345	178,175	244,200	132
1963	519,522	169,336	234,980	124
1964	521,161	156,229	223,440	114
1965	571,079	180,290	242,440	116
1966	669,921	236,889	242,740	106
1967	684,718	219,934	298,110	114
1968	708,728	245,990	339,405	121
1969	752,161	272,547	327,420	107
1970	756,181	258,049	345,450	105
1971	752,588	232,347	336,140	98
1972	842,095	279,465	339,015	97
1973	1,120,528	405,748	327,360	88
1974	1,280,892	402,721	396,950	85

Sources: See Appendix Table 6.

APPENDIX TABLE 7-D

FARM PRODUCTION, WAGES AND EMPLOYMENT IN AGRICULTURE, ONTARIO REGION, 1950-1974
(In thousands of current dollars)

YEAR	Gross Farm Production (Adjusted)	Net Farm Production (Adjusted)	Wages Paid to Labor	No. of Farm Labor Employed ('000)
1950	776,360	400,082	313,750	251
1951	910,188	483,451	316,675	239
1952	856,495	415,850	313,600	224
1953	822,158	373,356	321,200	220
1954	313,379	347,702	355,465	253
1955	795,283	313,616	326,860	236
1956	845,741	313,726	295,320	214
1957	841,953	312,306	295,290	193
1958	958,327	391,712	277,890	177
1959	942,536	332,630	301,785	177
1960	974,243	353,031	305,195	179
1961	1,007,492	358,250	295,650	162
1962	1,057,899	392,411	292,300	158
1963	1,091,053	372,942	325,940	172
1964	1,114,105	342,605	313,600	160
1965	1,216,437	390,072	315,590	151
1966	1,429,154	518,654	320,600	140
1967	1,436,680	443,369	384,405	147
1968	1,488,320	476,334	401,115	143
1969	1,589,940	538,603	416,160	136
1970	1,598,409	503,330	434,280	132
1971	1,589,449	440,313	459,620	134
1972	1,830,686	605,430	408,915	117
1973	2,322,185	794,384	453,840	122
1974	2,847,550	1,047,003	560,400	120

Sources: See Appendix Table 7-A.

APPENDIX TABLE 7-E

FARM PRODUCTION, WAGES AND EMPLOYMENT IN AGRICULTURE, PRAIRIE REGION, 1950-1974
(In thousands of current dollars)

YEAR	Gross Farm Production (Adjusted)	Net Farm Production (Adjusted)	Wages Paid to Labor	No. of Farm Labor Employed ('000)
1950	1,234,349	749,938	461,150	401
1951	1,553,814	1,024,323	478,750	383
1952	1,380,829	824,066	495,450	367
1953	1,398,200	812,663	506,570	358
1954	1,331,121	754,330	513,760	338
1955	1,212,490	625,125	465,055	331
1956	1,296,529	683,083	490,860	324
1957	1,302,481	673,335	485,100	308
1958	1,484,698	825,731	493,500	300
1959	1,483,541	790,966	504,305	289
1960	1,477,850	756,379	557,175	285
1961	1,807,151	1,070,683	574,080	299
1962	1,762,129	969,833	583,050	299
1963	1,720,584	874,683	597,000	300
1964	1,963,816	1,034,289	618,640	296
1965	2,080,464	1,067,781	607,040	271
1966	2,088,951	971,007	570,000	240
1967	2,441,607	1,222,909	652,455	243
1968	2,551,599	1,255,136	645,780	229
1969	2,220,353	918,919	771,525	243
1970	1,887,229	593,151	727,720	226
1971	2,414,769	1,059,436	785,400	231
1972	2,541,399	1,075,785	796,650	226
1973	3,796,526	2,037,358	837,000	216
1974	5,343,345	3,078,340	1,094,970	226

Sources: See Appendix Table 7-A.

APPENDIX TABLE 7-F

FARM PRODUCTION, WAGES AND EMPLOYMENT IN AGRICULTURE,
BRITISH COLUMBIA REGION, 1950-1974
(In thousands of current dollars)

YEAR	Gross Farm Production (Adjusted)	Net Farm Production (Adjusted)	Wages Paid to Labor	No. of Farm Labor Employed ('000)
1950	102,882	52,598	34,500	30
1951	122,054	66,553	36,250	29
1952	126,363	69,192	28,350	21
1953	128,708	69,360	29,715	21
1954	128,679	66,313	34,960	23
1955	125,523	61,253	43,555	31
1956	131,730	62,048	39,390	26
1957	134,355	64,426	36,225	23
1958	140,715	65,650	39,480	24
1959	148,607	67,277	41,880	24
1960	150,798	66,025	58,650	30
1961	158,910	66,275	51,840	27
1962	170,633	70,566	52,650	27
1963	176,173	73,847	35,820	18
1964	180,101	70,759	45,980	22
1965	188,660	69,271	49,280	22
1966	217,711	81,127	59,375	25
1967	233,641	89,113	67,125	25
1968	251,171	101,746	73,320	26
1969	252,673	90,188	73,025	23
1970	271,022	97,587	74,060	23
1971	282,807	98,149	85,000	25
1972	306,700	106,203	77,550	22
1973	411,291	162,113	81,375	21
1974	485,273	173,548	96,900	20

Sources: See Appendix Table 7-A.

APPENDIX TABLE 8-A

GROSS VALUE OF OUTPUT, EMPLOYMENT AND OUTPUT PER WORKER IN AGRICULTURE, CANADA, 1950-1974

Year	Output in 1961 dollars Weather Adjusted (Millions $)	Employment (Number of Workers) (Thousands $)	Output per Worker	
			Weather adjusted in 1961 dollars (Thousands $)	Production Function Estimate (Thousands $)
1950	2,632	1,002	2,600	2,521
1951	3,190	939	2,954	2,561
1952	2,988	869	3,235	2,978
1953	2,908	858	3,494	3,443
1954	2,846	878	3,534	3,639
1955	2,690	819	3,646	3,902
1956	2,851	777	4,036	4,256
1957	2,852	748	4,181	4,476
1958	3,200	718	4,681	4,301
1959	3,193	700	4,792	4,757
1960	3,213	683	4,895	4,979
1961	3,591	681	5,274	5,362
1962	3,626	660	5,267	5,518
1963	3,640	649	5,450	6,019
1964	3,919	630	6,141	6,610
1965	4,234	594	6,612	6,724
1966	4,576	544	7,189	6,923
1967	4,951	559	7,635	7,685
1968	5,163	546	8,295	8,541
1969	4,991	535	7,987	8,850
1970	4,705	511	7,937	9,277
1971	5,210	510	8,717	9,354
1972	5,717	481	8,944	8,957
1973	7,919	467	8,841	7,398
1974	10,300	473	9,505	7,556

Source: Column (1), see Appendix Table 7-A.
Column (4), from computer print out.
Column (3) = Column (1) ÷ Column (2).

APPENDIX TABLE 8-B

GROSS VALUE OF OUTPUT, EMPLOYMENT AND OUTPUT PER WORKER IN AGRICULTURE ATLANTIC REGION, 1950-1974

			Output per Worker	
Year	Output in 1961 dollars Weather Adjusted (Millions $)	Employment (Number of Workers) (Thousands $)	Weather adjusted in 1961 dollars (Thousands $)	Production Function Estimate (Thousands $)
1950	129	69	1,950	1,947
1951	146	58	2,198	1,846
1952	158	55	1,878	2,192
1953	131	56	2,336	2,373
1954	135	50	2,699	2,444
1955	130	49	2,534	2,448
1956	133	49	2,524	2,594
1957	132	53	2,493	2,893
1958	132	55	2,338	3,026
1959	137	56	2,267	3,133
1960	141	55	2,201	3,086
1961	132	55	2,391	3,713
1962	128	44	2,905	3,976
1963	132	34	3,765	4,092
1964	140	38	3,364	4,123
1965	177	34	3,903	3,710
1966	170	32	4,300	4,453
1967	154	29	4,733	5,135
1968	164	26	5,329	5,303
1969	176	26	5,585	5,637
1970	193	26	5,448	5,309
1971	171	23	5,910	5,777
1972	196	19	7,265	5,567
1973	268	20	5,985	4,251
1974	343	22	6,083	4,577

APPENDIX TABLE 8-C

GROSS VALUE OF OUTPUT, EMPLOYMENT AND OUTPUT
PER WORKER IN AGRICULTURE
QUEBEC REGION, 1950-1974

Year	Output in 1961 Dollars Weather Adjusted (Millions $)	Employment (Number of Workers) (Thousands $)	Output per Worker: Weather Adjusted in 1961 dollars (Thousands $)	Output per Worker: Production Function Estimate (Thousands $)
1950	389	251	1,583	1,578
1951	458	231	1,730	1,530
1952	466	203	2,127	1,770
1953	428	203	2,066	2,096
1954	437	214	2,063	2,186
1955	427	172	2,530	2,382
1956	444	165	2,772	2,651
1957	442	171	2,583	2,808
1958	484	162	2,895	2,924
1959	481	155	3,062	3,284
1960	469	135	3,450	3,542
1961	486	138	3,523	3,811
1962	507	132	3,809	4,039
1963	520	124	4,177	4,380
1964	521	114	4,508	4,652
1965	571	116	4,399	4,523
1966	670	106	5,048	4,464
1967	685	114	4,793	4,836
1968	709	121	4,652	5,260
1969	752	107	5,370	5,562
1970	756	105	5,583	6,079
1971	753	98	5,537	5,877
1972	842	97	5,612	5,819
1973	1,121	88	6,402	5,030
1974	1,281	85	6,580	5,016

APPENDIX TABLE 8-D

GROSS VALUE OF OUTPUT, EMPLOYMENT AND OUTPUT
PER WORKER IN AGRICULTURE
ONTARIO REGION, 1950-1974

Year	Output in 1961 Dollars Weather Adjusted (Millions $)	Employment (Number of Workers) (Thousands $)	Output per Worker: Weather Adjusted in 1961 Dollars (Thousands $)	Output per Worker: Production Function Estimate (Thousands $)
1950	776	251	3,087	2,650
1951	910	239	3,198	2,878
1952	856	224	3,537	3,216
1953	822	220	4,120	3,932
1954	813	253	3,363	3,829
1955	795	236	3,577	4,098
1956	846	214	4,173	4,565
1957	842	193	4,488	4,722
1958	958	177	5,361	4,930
1959	943	177	5,368	5,642
1960	974	179	5,426	5,565
1961	1,007	162	6,219	6,119
1962	1,059	158	6,526	6,274
1963	1,091	172	6,183	6,733
1964	1,114	160	6,928	7,478
1965	1,216	151	7,317	7,316
1966	1,429	140	8,367	7,434
1967	1,437	147	7,946	8,198
1968	1,488	143	8,393	8,759
1969	1,590	136	8,945	9,083
1970	1,598	132	9,431	9,697
1971	1,589	134	9,167	9,918
1972	1,831	117	10,911	9,723
1973	2,322	122	10,103	8,961
1974	2,847	120	11,327	10,303

APPENDIX TABLE 8-E

GROSS VALUE OF OUTPUT, EMPLOYMENT AND OUTPUT
PER WORKER IN AGRICULTURE
PRAIRIE REGION, 1950-1974

			Output per Worker	
Year	Output in 1961 Dollars Weather Adjusted (Millions $)	Employment (Number of Workers) (Thousands $)	Weather Adjusted in 1961 dollars (Thousands $)	Production Function Estimate (Thousands $)
1950	1,234	401	2,954	2,848
1951	1,554	383	3,556	2,982
1952	1,381	367	3,721	3,618
1953	1,398	358	4,164	4,144
1954	1,331	338	4,532	4,044
1955	1,212	331	4,120	4,550
1956	1,297	324	4,669	4,890
1957	1,302	308	4,999	5,214
1958	1,485	300	5,548	5,260
1959	1,484	289	5,678	5,702
1960	1,478	285	5,686	6,067
1961	1,807	299	6,044	5,640
1962	1,762	299	5,534	5,743
1963	1,721	300	5,531	6,377
1964	1,964	296	6,556	7,069
1965	2,080	271	7,396	7,496
1966	2,089	240	7,799	7,860
1967	2,442	243	9,126	8,553
1968	2,552	229	10,652	9,836
1969	2,220	243	8,752	10,295
1970	1,887	226	8,053	10,539
1971	2,415	231	10,139	10,567
1972	2,541	226	9,348	9,772
1973	3,797	216	9,164	7,181
1974	5,343	226	9,855	7,004

APPENDIX TABLE 8-F

GROSS VALUE OF OUTPUT, EMPLOYMENT AND OUTPUT
PER WORKER IN AGRICULTURE
BRITISH COLUMBIA REGION, 1950-1974

Year	Output in 1961 Dollars Weather Adjusted (Millions $)	Employment (Number of Workers) (Thousands $)	Output per Worker	
			Weather Adjusted in 1961 Dollars (Thousands $)	Production Function Estimate (Thousands $)
1950	103	30	3,625	4,142
1951	122	29	3,785	3,917
1952	126	21	5,334	4,039
1953	129	21	5,956	4,657
1954	129	23	5,786	4,997
1955	126	31	4,209	5,179
1956	132	26	5,092	5,447
1957	134	23	5,744	5,601
1958	141	24	5,709	5,879
1959	149	24	6,131	6,682
1960	151	30	5,042	7,064
1961	159	27	5,886	7,331
1962	171	27	6,136	7,458
1963	176	18	9,539	7,597
1964	180	22	8,261	8,280
1965	189	22	7,911	8,042
1966	218	25	7,566	8,511
1967	234	25	8,374	8,932
1968	251	26	8,138	9,589
1969	253	23	8,817	9,961
1970	271	23	9,690	10,770
1971	283	25	9,108	11,512
1972	307	22	10,334	11,357
1973	411	21	11,575	10,571
1974	485	20	11,982	10,935

APPENDIX TABLE 9-A

CURRENT VALUES OF FARM CAPITAL IN CANADA,
BY ITEM, 1950-1974
(Thousands of Dollars)

YEAR	LIVESTOCK AND POULTRY (1)	LANDS AND BUILDINGS	IMPLEMENTS AND MACHINERY	TOTAL
1950	1,467,580	5,022,642	1,681,075	8,171,297
1951	2,006,491	5,512,519	1,931,880	9,450,890
1952	1,790,874	5,668,467	2,076,787	9,536,128
1953	1,556,503	6,295,977	2,257,636	10,110,116
1954	1,424,076	6,183,050	2,352,548	9,959,674
1955	1,462,727	6,567,066	2,283,627	10,313,420
1956	1,422,719	6,852,657	2,263,286	10,538,662
1957	1,512,472	6,958,491	2,371,409	10,842,372
1958	1,860,461	7,440,775	2,441,191	11,742,427
1959	1,956,443	7,842,190	2,509,654	12,308,287
1960	1,878,010	8,226,925	2,575,025	12,679,960
1961	1,990,234	8,603,397	2,565,538	13,159,169
1962	2,053,779	8,974,027	2,656,211	13,684,017
1963	2,119,933	9,639,254	2,781,770	14,540,957
1964	2,166,287	10,675,560	2,948,169	15,790,016
1965	2,137,861	11,816,736	3,263,250	17,217,847
1966	2,364,002	13,149,821	3,548,848	19,062,671
1967	2,517,816	14,828,164	3,723,206	21,069,186
1968	2,489,739	16,338,228	3,872,524	22,700,491
1969	2,955,806	16,626,354	3,925,308	23,507,468
1970	3,139,658	16,738,363	3,922,979	23,801,000
1971	3,069,499	16,911,982	3,904,900	23,886,381
1972	3,718,556	17,386,692	4,072,599	25,177,847
1973	4,880,555	20,291,321	4,348,288	29,520,164
1974	4,959,635	25,952,497	5,136,995	36,049,127

Source: Quarterly Bulletin of Agricultural Statistics, April-June 1966.
Quarterly Bulletin of Agricultural Statistics, April-June 1969.
Quarterly Bulletin of Agricultural Statistics, April-June 1974.
Quarterly Bulletin of Agricultural Statistics, April-June 1975.

(1) Includes value of animals on fur farms.

APPENDIX TABLE 9-B

CURRENT VALUES OF FARM CAPITAL IN MARITIME PROVINCES, BY ITEM, 1950-1974
(Thousands of Dollars)

YEAR	LIVESTOCK AND POULTRY (1)	LAND AND BUILDINGS	IMPLEMENTS AND MACHINERY	TOTAL
1950	71,447	233,011	62,133	366,591
1951	88,168	241,047	68,456	397,671
1952	82,528	241,269	73,940	397,737
1953	71,553	240,273	81,146	392,972
1954	63,898	238,918	85,003	387,819
1955	65,386	238,870	82,904	387,160
1956	61,699	238,097	84,813	384,609
1957	58,506	237,486	90,111	386,103
1958	64,565	236,165	91,179	391,909
1959	68,889	234,556	92,166	395,611
1960	66,747	234,126	91,616	392,489
1961	67,216	231,879	88,790	387,885
1962	66,502	227,688	92,811	387,001
1963	66,470	227,107	95,896	389,473
1964	66,490	236,438	99,267	402,195
1965	67,142	247,251	101,148	415,541
1966	70,383	267,160	106,924	444,467
1967	72,888	283,003	111,356	467,247
1968	72,942	306,227	115,978	495,147
1969	79,064	327,739	118,210	525,013
1970	81,628	344,117	118,834	544,579
1971	79,020	340,930	118,741	538,691
1972	87,525	365,055	123,771	576,351
1973	108,545	421,914	131,000	661,459
1974	120,851	537,410	152,029	810,290

Sources: See Appendix Table 9-A.

APPENDIX TABLE 9-C

CURRENT VALUES OF FARM CAPITAL IN QUEBEC,
BY ITEM, 1950-1974
(Thousands of Dollars)

YEAR	LIVESTOCK AND POULTRY (1)	LAND AND BUILDINGS	IMPLEMENTS AND MACHINERY	TOTAL
1950	269,538	752,753	189,607	1,211,898
1951	338,946	846,973	211,937	1,397,256
1952	328,942	860,893	228,588	1,418,423
1953	284,581	868,105	245,283	1,397,969
1954	258,127	896,113	251,303	1,405,543
1955	250,520	902,821	247,411	1,400,752
1956	257,156	930,828	254,403	1,442,387
1957	256,423	930,828	272,099	1,459,350
1958	303,753	952,127	287,524	1,543,404
1959	314,288	972,755	300,076	1,587,119
1960	310,684	994,054	306,381	1,611,119
1961	309,871	1,014,682	301,257	1,625,810
1962	327,668	1,004,328	322,167	1,654,163
1963	334,233	1,035,390	345,749	1,716,372
1964	322,469	1,076,806	366,111	1,765,386
1965	322,120	1,104,028	361,901	1,788,049
1966	353,474	1,159,021	373,980	1,886,475
1967	389,935	1,188,395	388,200	1,966,530
1968	395,257	1,266,355	405,017	2,066,629
1969	435,707	1,322,601	417,256	2,175,554
1970	451,506	1,388,449	427,524	2,267,479
1971	418,561	1,321,792	427,538	2,167,891
1972	499,098	1,443,397	454,320	2,396,815
1973	649,734	1,639,699	490,024	2,779,457
1974	737,091	1,892,213	571,448	3,200,752

<u>Sources:</u> See Appendix Table 9-A.

APPENDIX TABLE 9-D

CURRENT VALUES OF FARM CAPITAL IN ONTARIO,
BY ITEM, 1950-1974
(Thousands of Dollars)

YEAR	LIVESTOCK AND POULTRY (1)	LANDS AND BUILDINGS	IMPLEMENTS AND MACHINERY	TOTAL
1950	485,067	1,194,178	389,352	2,068,597
1951	682,197	1,419,364	445,278	2,546,839
1952	561,148	1,464,339	486,270	2,511,747
1953	490,068	1,600,376	519,570	2,610,014
1954	454,733	1,667,247	531,526	2,653,506
1955	459,295	1,803,294	520,991	2,783,580
1956	430,056	1,893,223	526,358	2,849,637
1957	465,308	1,984,305	556,333	3,005,946
1958	575,884	2,165,316	574,683	3,315,883
1959	593,555	2,391,292	589,969	3,574,816
1960	578,124	2,369,386	596,787	3,544,297
1961	593,722	2,572,303	579,282	3,745,307
1962	630,885	2,681,763	598,213	3,910,860
1963	622,586	2,736,493	623,084	3,982,163
1964	629,458	2,973,656	654,512	4,257,626
1965	616,873	3,125,974	710,403	4,453,250
1966	678,372	3,451,146	758,398	4,887,916
1967	731,261	3,881,140	797,591	5,409,992
1968	744,872	4,374,353	833,154	5,952,379
1969	855,239	4,968,160	855,336	6,678,735
1970	857,083	5,005,110	877,785	6,739,978
1971	796,508	5,183,419	890,037	6,869,964
1972	957,135	5,411,489	939,321	7,307,945
1973	1,240,151	6,569,548	1,012,490	8,822,189
1974	1,211,228	8,540,412	1,188,661	10,940,301

Sources: See Appendix Table 9-A.

APPENDIX TABLE 9-E

CURRENT VALUES OF FARM CAPITAL IN PRAIRIE PROVINCES, BY ITEM, 1950-1974
(Thousands of Dollars)

YEAR	LIVESTOCK AND POULTRY (1)	LANDS AND BUILDINGS	IMPLEMENTS AND MACHINERY	TOTAL
1950	588,807	2,586,270	986,337	4,161,414
1951	824,964	2,727,067	1,147,449	4,699,480
1952	754,836	2,818,534	1,225,697	4,799,067
1953	651,149	3,272,396	1,344,655	5,268,200
1954	591,439	3,050,038	1,415,540	5,057,017
1955	630,269	3,265,336	1,362,744	5,258,349
1956	618,743	3,423,231	1,325,570	5,367,544
1957	676,446	3,407,209	1,375,510	5,459,165
1958	845,637	3,662,494	1,407,442	5,915,573
1959	901,321	3,771,622	1,444,377	6,117,320
1960	847,528	4,136,328	1,494,222	6,478,078
1961	938,380	4,291,502	1,509,721	6,739,603
1962	942,830	4,556,261	1,553,225	7,052,316
1963	1,004,623	5,128,973	1,624,614	7,758,210
1964	1,054,831	5,859,109	1,732,421	8,646,361
1965	1,038,121	6,729,028	1,977,511	9,744,660
1966	1,159,063	7,544,616	2,186,002	10,889,681
1967	1,213,030	8,664,250	2,297,221	12,174,501
1968	1,164,823	9,421,074	2,381,105	12,967,002
1969	1,456,597	8,932,104	2,389,195	12,777,896
1970	1,613,360	8,818,736	2,347,000	12,779,086
1971	1,637,523	8,772,580	2,305,411	12,715,514
1972	2,011,043	8,811,413	2,385,538	13,207,994
1973	2,665,127	10,082,547	2,535,309	15,282,983
1974	2,656,036	12,773,804	3,017,612	18,447,452

Sources: See Appendix Table 9-A .

APPENDIX TABLE 9-F

CURRENT VALUE OF FARM CAPITAL IN BRITISH COLUMBIA
BY ITEM, 1950-1974
(Thousands of Dollars)

YEAR	LIVESTOCK AND POULTRY (1)	LANDS AND BUILDINGS	IMPLEMENTS AND MACHINERY	TOTAL
1950	52,721	256,430	53,646	362,797
1951	72,216	278,068	58,760	409,044
1952	63,420	283,442	62,292	409,154
1953	59,152	314,827	66,982	440,961
1954	55,879	330,734	69,176	455,789
1955	57,257	356,745	69,577	483,579
1956	55,065	367,278	72,142	494,485
1957	55,789	398,663	77,356	531,808
1958	70,622	424,673	80,363	575,658
1959	78,390	471,965	83,066	633,421
1960	74,927	493,031	86,019	653,977
1961	81,045	493,031	86,488	660,564
1962	85,895	503,987	89,795	679,677
1963	91,021	511,291	92,427	694,739
1964	93,039	529,551	95,858	718,448
1965	93,605	610,455	112,287	816,347
1966	102,710	727,878	123,544	954,132
1967	110,702	811,376	128,838	1,050,916
1968	111,845	970,219	137,270	1,219,334
1969	129,199	1,075,750	145,321	1,350,270
1970	136,081	1,181,961	151,836	1,469,878
1971	137,887	1,293,261	163,173	1,594,321
1972	163,755	1,355,338	169,649	1,688,742
1973	216,998	1,577,613	179,465	1,974,076
1974	234,429	2,208,658	207,245	2,650,332

Sources: See Appendix Table 9-A.

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