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

by

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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.

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LIST OF TABLES

APPENDIXES AND APPENDIX TABLES

TABLE OF CONTENTS

PAGE

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