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ORGANIZATION, ADMINISTRATION AND PERFORMANCE ON RESEARCH ACTIVITIES IN TWO GOVERNMENTAL RESEARCH BODIES, 1937-1962.

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ORGANIZATION, ADMINISTRATION AND PERFORMANCE
ON RESEARCH ACTIVITIES

in

TWO GOVERNMENTAL RESEARCH BODIES

1937 - 1962

by

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INTRODUCTION

Purpose and Scope

This investigation was undertaken for the purpose of making a comparison on an objective basis, of some of the factors which illustrate the relative advantages and disadvantages of conducting research under:

- (a) A research group located within a government department subject to the provisions of the Civil Service Act, and
- (b) an independent Board reporting to Parliament through a Minister of a Department.

The bodies selected as representative of the above conditions are the Research Branch, Department of Agriculture, hereafter referred to as the Research Branch, or Branch, as an example of (a) above, and the Fisheries Research Board, hereafter referred to as the Research Board, or Board, as an example of (b). When it is necessary to refer to research or other departmental activity in a general sense, the words Agriculture and Fisheries will generally be used.

It is believed that an understanding of the research arms under consideration will be difficult to achieve unless some effort is made to understand the historical development of the organizations. Brief histories of their development

and development of their parent bodies are therefore presented.

It has been found impracticable to compare the Branch and Board in all respects owing partly to absence of all necessary data and partly to the author's unfamiliarity with the research organizations themselves. They are therefore compared on the basis of organization, expenditures, personnel policies, program control, communications and output of work completed as represented by publications which result from research activities. Some broad conclusions are finally drawn about the Branch and Board, indeed, about research under governmental auspices in general.

Within this thesis, all data will be presented by fiscal years of the Government of Canada. To avoid repetition, only the year in which March 31 falls will be stated. For example, March 31, 1961 to March 31, 1962 will be referred to as 1962.

Departments and their Research Arms

The groups selected for study cannot be considered as ideal for comparison owing to several obvious anomalies. Probably the greatest disparity arises from difference in size, which makes itself felt in all aspects of the groups' activities. The influence of size is seen in method

of organization, size of the industry served, numbers of personnel, gross expenditures, and magnitude of the communication problems.

In 1962 the value of the Canadian agricultural industry at the primary producer level was about \$3,500 million. The industry employed about 10 per cent of the Canadian labour force. The Department of Agriculture disbursed about \$287 million of which about \$27 million was spent on research. The disbursement of the Department for the purpose of this thesis includes all ordinary departmental expenditure and the large payments made to the agricultural industry in one form or another and administered by the Department.

During 1962 the fisheries of Canada produced products with a landed value of about \$128 million and directly employed less than 2 per cent of the Canadian labour force. The Department of Fisheries disbursed about \$23 million of which about \$6.5 million was spent on research.

On the basis of value of the industry and governmental expenditure, agriculture is about 27 and 12.5 times the size of fisheries respectively. On the basis of direct employment provided to Canadians, agriculture is about 5 times as large. On the basis of expenditure on research, the agriculture to fisheries ratio is about 4 to 1.

On the other hand there are some similarities between the environments for research in the two groups. A striking similarity is that the bulk of Canadian research in agriculture and fisheries is within the purview of the Federal government. This does not, however, imply that all research related to agriculture and fisheries is done in the Branch and Board. For example, some research related to grain is done in the Grain Research Laboratories of the Board of Grain Commissioners, a federal body. Research activities are conducted by the Animal Diseases Research Institute at Hull, Quebec, and seven satellite laboratories at other locations across Canada. Control of this work resides in the Production Branch of the Department of Agriculture. It should be noted, however, that the Glassco Commission recommended that all research supported by the Department of Agriculture should be administered by the Research Branch.⁽¹⁾

Fisheries research is pursued outside the jurisdiction of the Board by the Fish Culture Development Branch and the Industrial Development Service, both in the Department of Fisheries. In the case of the Development Service,

(1) Canada, Royal Commission on Government Organization, Vol. 4, Special Areas of Administration - Scientific Research and Development, Ottawa: Queen's Printer, 1962. p. 239.

it would be difficult to say with certainty what is research and what is direct promotion. The Glassco Commission noted that the Fish Culture Development Branch did not undertake long term research. (2)

In addition to activities of the Federal government in agriculture and fisheries, provincial governments through provincial departments of agriculture engage in extensive activities in these fields. This writer believes that provincial efforts are largely directed toward administration, promotion and control. There appears to be little doubt that provincial departments of agriculture are better equipped to deal with agricultural problems at the clientele level.

Private industry, generally occupying a position near the disposal end of agricultural and fisheries products, engages in some research. The applied research and development that private industry engages in so as to obtain a higher return, can hardly be placed in the same category as the more fundamental research done in government.

Another similarity between the agricultural and fisheries industries is that they are based on renewable resources. In theory, renewable resources can with good management produce in perpetuity. One might reason that

(2) Ibid., p. 241.

any expenditure made for constructive purposes such as research will ultimately produce a return to the nation. Permanence of renewable resource industries necessitates efficient long range planning. It influences the outlook of scientific personnel who can plan professionally rewarding long term projects and lifetime careers.

Basic Concepts

There is a divergence of opinion among scientists and administrators in government and industry as to how the various forms of research should be defined. The definitions as set out in one authoritative publication⁽³⁾ appear to have gained a wide measure of support among eminent scientists. The definitions appear eminently suitable for consideration of research in its broad sense, that is, when the overall spectrum of research is under discussion. However, for purposes of this thesis, a slightly simplified definition which has gained wide support has been adopted.⁽⁴⁾ By these definitions, research may be of three types: basic, applied and developmental.

(3) Office of the Minister for Science, Report of the Committee on the Management and Control of Research and Development, London: Her Majesty's Stationery Office, 1961, p. 26.

(4) See Rosser, F.T., The Administrator's Personnel Function in a Scientific Research Programme, Conference on Industrial Relations Aspects of Productivity, Queens University, May 24, 1962, p. 2.

Basic research is that research which is pursued for the purpose of discovering previously unknown scientific knowledge. No application for this new knowledge is envisaged but the research is pursued for its own sake.

Applied research is that research which is pursued for the purpose of discovering ways of applying new knowledge to some practical purpose.

Developmental research is that research which is pursued for the purpose of making the results of applied research into economically useful or saleable products. Developmental research, commonly referred to as 'development' will be of minor interest in the remainder of this thesis.

Any research group, whether established under the auspices of a government department, under the sponsorship of private industry, or under some co-operative arrangement, has definite overall objectives. In the final analysis, the ultimate objectives of natural resource orientated research groups are practical results which can be applied to improve the industries which are dependent upon the resource.

As in any other governmental endeavour, research activities must be programmed and budgeted before the funds required will be provided. Departmental programmes are assessed by Treasury Board and recommended to the Government

which approaches Parliament for the necessary funds. Parliament votes funds for programmes it approves, expecting a return to the nation from the investment made. However, Treasury Board, and Parliament have insufficient time and expertise to adequately assess scientific programmes. In the first instance then, reliance must be placed upon detailed advice from scientists when programmes are considered. In the second instance, the same scientists must be relied upon to use judgment when allocating resources and supervising research programmes.

Herein lies the first difficulty relative to allocation of resources available for research. It is desired to achieve maximum value for a given resource allocation, but how is value to be measured? Estimation of value becomes extremely difficult or impossible with respect to results of basic research and applied research of long duration. Further, long term research pays no immediate political dividends.

There is always a conflict between the claims for basic and applied research. The consensus of informed scientific opinion appears to be that all applied research ultimately rests on a foundation of basic research without which the opportunities for applied research would soon dry up. Yet despite the dependence of applied research upon basic research, funds for the former are more readily

available. Development leads to immediate profits; therefore funds are readily forthcoming. Nevertheless, governments and educational institutions in our society feel a responsibility to enter non-compensatory yet necessary fields of research. The result therefore is that universities are generally involved in basic research, government bodies in basic and applied research, and private industry in applied research and development. The distinction is not as clear cut as this statement would indicate except that Universities do adhere to their role more closely than the other groups. Government and industry must do basic research as an aid to their applied research programs. The need for government to undertake basic research has been adequately stated by Swaine: ⁽⁵⁾

It should be realized that Government departments, faced with great problems which require scientific research for their solution, cannot wait until university laboratories in the course of their research in pure science finally undertake the necessary fundamental research.

The reason why industry engages in basic research has been well stated by Mr. Malcolm H. Hebb of General Electric Company ⁽⁶⁾ and many others. Some of the

(5) Chemical Institute of Canada, Research in Canada, Papers given at the Symposium of the Chemical Institute of Canada, Quebec City, 1945. p. 51.

(6) Ibid, p. 22.

accomplishments of industrial basic research laboratories have had far reaching effects. Nevertheless, an ultimate practical application is expected for all research conducted in industry.

The Departments of Agriculture and Fisheries are faced with unusual situations where the private sectors of these industries are in the hands of numerous small owners who have not the means to do research. The need for governmental Agriculture and Fisheries groups to engage in basic and applied research is therefore not questioned. The points to be decided are how much effort to apply and how to apportion this effort for the maximum long term return. Only the highest quality of each is desired but good quality basic research is more costly and more risky than good quality applied research.

The tools at the disposal of research directors are personnel, equipment and supplies. The basic quality of the tools will determine the quality of the results, but there is strong agreement among scientists that the most important single tool is the creative scientist. How the research efforts are administered in the Branch and Board will therefore occupy most of this thesis after a few more basic concepts are discussed.

A major consideration which comes to the forefront when scientists and research are discussed is the degree

of freedom which should be given research scientists. On one hand, there is the constantly expressed view of scientists themselves. This view holds that scientists are unusual individuals who have an intense interest in certain fields. This intense interest will produce outstanding results in a free environment, which can only be achieved when all administrative matters are attended to by specialized personnel. Proponents of this view can point to discoveries which have transformed society, thereby more than compensating for the greatest portion of research which has proven fruitless. There appears to be firm proof, freely attested to by scientists in other jurisdictions, that the very best research is done in the universities where freedom is virtually complete.

Yet another point of view holds that more control should be placed upon scientists to ensure a wise expenditure of the taxpayer's money. A logical development from this point of view would be a minimum of basic research and a maximum of applied research at the taxpayer's expense. Firm controls over public expenditures would in effect control the scientists. Basic research in the sense used here would be within the province of educational institutions supported by government and private philanthropy.

The ideal situation is probably between these extreme views. Perhaps enough basic research should be

financed by public bodies to provide the needed base for applied research, ensuring at all times that applied researchers will not run out of newly discovered facts. It is hoped to develop some thoughts along this line when the data have been examined.

ORGANIZATION

Department of Agriculture

Authority for establishment of a Department of Agriculture is to be found in Section 95 of the British North America Act, 1867. Following the provisions of the Act, an existing Bureau of Agriculture which was formerly established by the Legislature of the Colony of Canada in 1852, provided a nucleus from which a department was formed.

The original Department bore little resemblance to the Department today. What is apparent today grew up as functions potentially beneficial to the nation were assigned to it by Parliament under its statutory authority. Growing functions are indeed responsible for departmental growth as described briefly below.

In 1869 an Act was passed to control introduction of contagious diseases from abroad to Canadian livestock. In 1884 the first entomologist was appointed to investigate the effect of crop destroying insects. In 1886 Parliament passed an Act respecting experimental farm stations and as a result, the Department of Agriculture had to be organized into two branches to ensure adequate administration. Known as the Experimental Farms Branch and the Veterinary

Branch, they were equipped to supervise all of the activities under the purview of the Department at that time. In 1890 the first Dairy Commissioner was appointed to aid farmers in the improvement of butter and cheese and in the better feeding of dairy cattle.

From 1890 to 1920 the Department of Agriculture gradually expanded its activities as legislation was enacted by Parliament to control, regulate, or develop those parts of Canada's agricultural industry which appeared to require governmental attention. As activities were extended, similar and expanding functions were gathered into new branches. In 1905 the seed and livestock divisions were severed from the Dairy Branch and formed into separate branches. The Entomological Branch and the Fruit Branch were established in 1914.

From 1914 to 1937 there was a continuing extension of activities undertaken by the Department. Notable enlargement of activities took place in areas related to grading of agricultural products such as eggs, swine, fruit, vegetables, meat of all types and canned vegetables. During this period a new wheat rust research laboratory was established and legislation governing various forms of farm assistance was passed as a result of the serious drought conditions on the prairies in the 1930's.

By 1937 growth of agricultural activities had reached a level where it was deemed desirable to re-organize the Department of Agriculture on a more logical, functional basis. Four main functional groups designated as branches were consequently established. The Marketing Branch assumed control over all functions related to marketing; the Production Branch assumed control over all functions related to production; the Experimental Farms Service assumed control over all experimental farms and the Research Service assumed control over all research in the natural sciences. A schematic diagram of departmental organization as it appeared before 1937 is illustrated in Figure 1. The effects of the re-organization of 1937 were not effective until about 1939. Therefore, Figure 2 illustrates the organization for 1939.

From 1937 to 1945 the Department continued to exercise its functions under the organizational groupings as established after 1937. During these years, however, further legislative action, largely related to war conditions, added to the burden carried by each of the branches.

Legislation was passed in 1939 to assist farmers with wheat marketing under the Wheat Co-operative Marketing Act. The Prairie Farm Assistance Act was passed in the same year to provide cash payments to farmers whose grain yields

Source: Annual Report, Department of Agriculture, 1937.

Figure 1. Organization, Department of Agriculture, 1937.

Source : Annual Report, Department of Agriculture, 1939.

Figure 2. Organization, Department of Agriculture, 1939.

fell below a certain level. During the war years considerable regulation of agriculture was imposed for the purpose of adjusting agricultural production to meet prevailing war conditions. A prominent legislative instrument of the period was the Wheat Acreage Reduction Act, passed in 1942 and continued to 1943 until acreage was reduced to a level deemed to be satisfactory.

Freight assistance on western feed grains was also instituted as a war measure to encourage movement of prairie grain to the Atlantic Provinces and British Columbia for cattle feeding. The prospect of peace resulted in the Agricultural Prices Support Act of 1944 to maintain the income of farmers during periods of expected price instability. In 1949 another Agricultural Products Marketing Act was passed to further assist farmers in marketing of produce.

New additions of responsibility to the Department of Agriculture's already heavy commitments were superimposed upon the existing structure of the Department until a further re-organization became inevitable. Effective in April, 1959, departmental re-organization provided for a re-grouping of departmental sub-units into new branches concerned with broadly based lines of activity. The organization plan which was adopted in 1959 is still in effect within the department.

A Research Branch resulted from a joining of the Experimental Farms Branch and Science Service group; Marketing Services and Production Service branches were combined into a Production and Marketing Branch; other services were combined into an Administrative Branch. An Assistant Deputy Minister was appointed to head each branch.

Examination of the continuously growing activities of the Department of Agriculture during the period from 1937 to 1959 indicates that the Department was orientated towards its clientele and therefore, deeply involved in activities of a promotional character. The experimental farms acted as clearing houses for much of the technical information.

The re-organization of 1959 appears to recognize the need for a change in direction of effort within the federal department. This became more pressing as in recent years provincial departments have become more active at the clientele level. In the federal department, union of the Experimental Farms Service and the Science Service indicates a trend toward more research of a fundamental type in the institutes and farms. Presumably provincial agricultural departments are closer to the practical conditions in any case and are better equipped to handle the contacts at the local level.

Since the re-organization of 1959 only minor organizational changes have occurred in the Department. Perhaps the most important was severance from the Department of all activities related to forestry when the Department of Forestry was established in 1962. Organization of the Department of Agriculture as of 1962 is illustrated in Figure 3 and a more detailed organizational chart of the Research Branch is illustrated in Figure 4.

Research Branch

The Research Branch of the Department of Agriculture carries on a broad program of basic and applied research related to agricultural problems. At the time of writing the applied aspect appears to be dominant. To fulfill its role, the Branch operated in 1962 nine research institutes, nine research stations, twenty-seven experimental farms and a number of sub-stations. In 1962 the total number of units of all levels stood at 72. Because of Canada's vastness and wide range of soils and climate, agricultural research facilities are widely dispersed throughout the nation, to serve the diverse conditions encountered.

Research activity is divided into four major areas: animals, soils, crops, and crop protection. Each of these program areas is controlled by a Program Director who is concerned with overall co-ordination and direction of research in his area. The research institutes are

Source : Annual Report, Department of Agriculture, 1962.

Figure 3. Organization, Department of Agriculture, 1962.

Source: Adapted from, Annual Report, Department of Agriculture, 1960.

Figure 4. Organization, Research Branch, Department of Agriculture, 1960.

Source: Adapted from, Annual Report, Department of Agriculture, 1960.

Figure 4. Organization, Research Branch, Department of Agriculture, 1960.

subdivided into groups which concentrate on problems related to animals, dairy technology, entomology, food research, genetics and plant breeding, microbiology, plant research, soils, entomology research for biological control and pesticides.

Within the Research Branch the Administrative Division attends to all the administrative functions of the Branch. Acting as staff groups are three service divisions in the fields of analytical chemistry, engineering research, and statistical research. Administering the research laboratories, research stations, and experimental farms, are permanent staff personnel who attend to management details.

Department of Fisheries

Legislative jurisdiction over fisheries was allotted to the Federal Government by the British North America Act under Section 91, sub-section 12 which provided for federal jurisdiction over "Sea Coast and Inland Fisheries".

By various co-operative arrangements between the federal and provincial governments, administrative responsibilities for inland fisheries are exercised by provincial governments. The Province of Quebec has, following a reference to the courts,⁽⁷⁾ administered its salt water

(7) 35 DLR, 1.

fisheries. Detailed investigation of the reasons is beyond the scope of this thesis.

Reporting to Parliament through the Minister of Fisheries, the Department is concerned with maximum development of Canada's fishery resources, establishment of quality standards to promote optimum utilization of fish resources, policing of fishing grounds, and public relations programs to increase fish consumption and to make fishery regulations more readily acceptable.

Nature has endowed Canada with the most prolific fishing grounds in the world on the Atlantic and Pacific — coasts. The greater part of these resources are in international waters. These circumstances have forced Canada into a position where extremely heavy responsibilities are imposed upon her for preservation of the fishery resources against future need. Canada has therefore joined numerous International Fisheries Conservation arrangements with other interested nations, many of which are considerably more powerful and wealthy.

The Department of Fisheries, despite its growing responsibilities, has grown gradually without major upheavels in its organizational structure. Organization of the Department as of 1937 is illustrated in Figure 5. There was considerable growth in the Department during the immediate post war period, then again in the late

Source: Compiled from Annual Report, Department of Fisheries, 1937.

Figure 5. Organization, Department of Fisheries, 1937.

1950's. The organization as of 1962 is illustrated in Figure 6.

Fisheries Research Board

The scientific arm of the Department of Fisheries is the Fisheries Research Board⁽⁸⁾ which can trace its origin to the Canadian Marine Biological Station, established in 1898. Management of the Canadian Marine Biological Station was entrusted to the Dominion Commissioner of Fisheries and eight university professors, serving without remuneration. Funds in the amount of \$7,000 were provided for in the 1898-99 Supply Bill to meet the costs of the group. It operated from various temporary quarters until 1912 when it was replaced by the Biological Board of Canada.⁽⁹⁾ By 1937, three biological research stations were established, one each at Halifax, N.S.; Prince Rupert, B.C.; and Grand Riviere, Quebec. Organization of the Fisheries Research Board as of 1937 is illustrated in Figure 7 and as of 1962 in Figure 8.

The present Fisheries Research Board of Canada was established by the Fisheries Research Board Act, 1937.⁽¹⁰⁾

(8) See Kask, J.L. The Fisheries Research Board of Canada, A Short History and Some Thoughts on Organization and Management, Ottawa: Fisheries Research Board, 1961.

(9) Established by the Biological Board Act, 1912, c. 6, s. 1 (amended 1923, c. 35; 1930, c. 4; repealed 1937, c. 31.)

(10) c. 31, s. 1 (amended 1947, c. 61, s. 1, 1952-53, c. 37).

Source: Organization of the Government of Canada, 1962.

Figure 6. Organization, Department of Fisheries, 1962.

Source: Annual Report, Fisheries Research Board, 1937.

Figure 7. Organization, Fisheries Research Board, 1937.

Source: Fisheries Research Board

Figure 8. Organization, Fisheries Research Board, 1962.

Re-organization in 1937 involved recognition of the enlarging scope of fisheries research activities in Canada. Organizational changes since 1937 have been minor, all implemented with a view toward making fisheries research more effective. Some of the developments are discussed.

In 1942 the Prince Rupert technological station was moved to Vancouver. In 1944 a biological station was established in Winnipeg to enlarge research studies related to freshwater fish. In 1947 an eastern biological research group was established at McGill University, Montreal, and in the same year oceanographic research institutes were established at St. Andrews, Nova Scotia, and Nanaimo, British Columbia. In 1949 when Newfoundland joined Canada, the biological group at St. John's, Newfoundland, was taken over and in 1951 a technological research group was established there.

Prior to 1953 the activities of the Fisheries Research Board were directed by a Chairman and a Vice-Chairman elected from members of the Board, all of whom served without salary. An amendment to the Fisheries Research Board Act, assented to in 1953, provided for a full-time Chairman appointed by the Governor-in-Council or for an Acting Chairman appointed by the Minister of Fisheries. The Chairman or Acting Chairman was designated as the

chief executive officer of the Board with authority to supervise and direct the work of the Board.

The Board is concerned with three broad categories of research: fishery biology, fishery technology, and oceanography. Fishery biology is related to studies of the life histories and population dynamics of the principal food fishes of Canada with the object of discovering how to exploit Canadian fisheries resources to their maximum extent. Work related to fishery biology is directed from the stations at St. John's, Newfoundland; St. Andrews, New Brunswick; Montreal, Quebec; London, Ontario; and Nanaimo, British Columbia. All are concerned with salt water fish except the station in London, Ontario, where freshwater fish are under study and in Montreal, Quebec, located in McGill University, where Arctic fisheries are under study.

Fishery biology is scientific research work in the pure sense. Personnel engaged in this type of work are highly specialized scientific personnel who are primarily interested in basic research.

Fisheries technology studies are related to methods of catching, storing and preserving fish. These studies result in development of new equipment to improve the performance of fisherman and new processing techniques to improve the competitive position of Canadian fishermen.

Technological research is controlled from three technological research stations: Halifax, Nova Scotia; Grand Riviere, Quebec; and Vancouver, British Columbia; and from two technological research units, one each at St. John's, Newfoundland; and London, Ontario.

Fishery technology studies are more closely related to applied forms of research. Many of the personnel employed on fishery technology studies are Professional Engineers who are practical in outlook and fully aware of the economic implications of technological changes.

Oceanography studies are related to the biological, chemical, and physical aspects of the marine and freshwater environments within which fish and other aquatic organisms thrive. Since 1947 the Board has been associated with other governmental groups engaged in oceanographic studies through an interdepartmental Joint Committee on Oceanography. In 1959 this body was re-organized as the Canadian Committee on Oceanography (CCO). The oceanographic research group of the Board operates on both the east and west coasts in close co-operation with interested Canadian universities.

Oceanographic research as conducted by the Board is properly within the area of basic research. In this case, however, the connection with applied research is becoming close. Applied research in the oceanographic field

can best be illustrated by activities of the Department of Mines and Technical Surveys which among other things, produces charts of the ocean bottom.

The Board further serves as Canada's research body for international research obligations assumed by virtue of Canada's membership in various International Fisheries Commissions. As of 1963 Canada was a member of five Commissions of which various other interested countries are members. In addition, staff members of the Board served as scientific consultants to Canadian Commissioners on the International Pacific Halibut Commission and the International Pacific Salmon Fisheries Commission. It has been reported⁽¹¹⁾ that more than half of the research which was underway in 1961 was in some manner connected with Canada's obligations under international arrangements. These wide activities in three oceans, carried on by the Board and the international commitments toward international Commissions, represent a heavy burden on the Board.

(11) Fisheries Research Board of Canada, Chairman's Report to the Board, 1961, (Confidential), Ottawa: December 1, 1961.

COMPARATIVE DATA

Expenditures

As was illustrated earlier, agriculture is a major Canadian primary industry. The values of agricultural products produced in Canada are tabulated in Table 2 and illustrated graphically in Figure 9. In addition the expenditure by the Department of Agriculture and, for the same years, expenditure on research activities are plotted on Figure 9.

The values as shown in Table 2 and 4 do not correspond to those shown in Canada Year Books and other sources for statistical data. An attempt was made here to bring statistics of value of agriculture and fisheries to a common base. For example, value of feed grain may be included with statistics of crop production. Some of the feed grain produced may be consumed by feeder cattle and the meat produced may be added to the total, resulting in duplication. In this thesis the value of agricultural produce which was utilized on the farm in the production of other agricultural produce was eliminated from the total. The comparable data in fisheries are landed values of the fish products caught. The value of the fisheries, as shown in Table 4 are about half of that commonly accepted inasmuch as fishery statistics in the public image generally

Expenditure, Department of Agriculture and Agricultural Research
Millions of Dollars, Scale: 1" = \$50 million.

Source: Table 3.

Figure 9. Value of Agricultural Production; Departmental and Research Expenditure, 1937-62.

TABLE 1

Expenditure - Departments of Agriculture and Fisheries
and their Research Arms. (Adjusted) 1937-62.

Year	Agriculture		Fisheries	
	Total, Department(2) \$million	Total Research(2) \$million	Total, Department \$million	Total, Research \$million
1937	9.5(3)	2.4	1.7	0.2
1938	33.1(4)	2.5(5)	1.8	0.2
1939	42.6(6)	3.3	2.0	0.2
1940	17.1(7)	3.3	3.0(8)	0.2
1941	13.0(9)	2.9	1.8(10)	0.2
1942	38.7(11)	3.0	1.8(12)	0.2
1943	58.4	3.2	1.9	0.2
1944	110.3	3.5	2.0	0.2
1945	104.6	3.9(13)	2.6	0.3
1946	110.4	4.2(14)	3.6	0.5
1947	95.5	5.5	3.8	0.7
1948	79.6	7.1	4.3	0.8
1949	61.8	8.6	5.4	1.2
1950	73.6	10.4	7.6	1.3
1951	141.4	12.8	9.0	1.8
1952	67.1	14.0	8.7	1.7
1953	106.7	15.1	10.8	2.0
1954	108.4	15.5	9.3	2.1
1955	81.8	16.8	11.2	2.3
1956	88.2	18.0	12.4	2.6
1957	84.6	19.5	13.8	3.5
1958	94.7	22.0(15)	16.4	5.0
1959	165.8	23.6	17.5	5.0
1960	181.4	25.7	19.8	4.8
1961	264.9	26.2	19.2	4.8
1962	287.7	26.8	23.1	6.3

Notes to accompany Table 1

- (1) Adjusted from Public Accounts, 1937-62.
- (2) Excludes expenditures on forestry research where possible.
- (3) Includes net expenditure of \$0.8 million on western drought.
- (4) Includes net expenditure of \$24.1 million on western drought.
- (5) For 1938 and 1937, it was found impossible to gather together all research services which ultimately formed the Research Branch.
- (6) Includes special expenditure less receipts - net of \$33.1 million.
- (7) Includes special and war expenditure of \$5.3 million.
- (8) Includes special expenditure of \$0.7 million.
- (9) Includes special war expenditure of \$4.5 million.
- (10) Includes special war expenditure of \$0.2 million.
- (11) Includes war expenditure of \$30.3 million.
- (12) Includes war expenditure of \$0.1 million.
- (13) For years prior to 1945 inclusive it was not possible to separate expenditures related to forestry research.
- (14) Estimated expenditures on forestry research were deducted from published total expenditure of the Research Branch and its predecessors for 1945 and later years. It was not found practicable to account for capital expenditures on behalf of forestry.
- (15) Science Service and Experimental Farms Service combined for 1958 and prior years.

TABLE 2

Statistical Data - Department of Agriculture

Year	Gross Value (\$000,s)	Total Employees, Department	Total Employees, Research	Employees % Research
1937	721,014	2,633	-	-
1938	782,804	2,926	-	-
1939	864,929	3,122	853	27.3
1940	938,898	3,362	952	28.3
1941	952,188	3,110	876	28.2
1942	1,583,400	3,202	871	27.2
1943	1,399,781	3,303	955	28.9
1944	1,782,537	3,326	958	28.8
1945	1,585,234	3,195	981	30.8
1946	1,905,525	3,535	1,101	31.2
1947	2,008,087	3,833	1,311	34.3
1948	2,395,881	5,381	2,330	43.3
1949	2,247,267	5,914	2,496	42.2
1950	2,509,932	6,667	2,805	42.2
1951	3,176,511	7,078	3,098	43.8
1952	3,355,103	6,888	3,017	43.8
1953	2,995,921	7,320	3,430	46.9
1954	2,341,285	7,544	3,466	46.0
1955	2,738,139	7,679	3,557	46.3
1956	2,992,393	6,807	3,185	46.8
1957	2,523,770	-	-	-
1958	2,823,832	7,413	3,499	47.2
1959	2,801,444	7,562	3,513	47.5
1960	2,998,571	7,703	3,619	46.8
1961	2,707,404	8,223	3,752	45.6
1962	3,505,457	7,981	3,402	42.7

Sources: Gross Value - Dominion Bureau of Statistics.
 Other Data - Canada Year Books and Departmental
 Sources.

include added value as a result of further processing.

Examination of Departmental expenditures as reported in Public Accounts produces a dilemma. The question arises whether all of the money disbursed by the department can rightfully be considered as expended by the department in its role of controlling, promoting, regulating and conducting research on agricultural problems. There are expenditures related to relief, war adjustments, and various support programmes to consider. The Public Accounts of Canada clearly reveal that the Canadian Parliament has given careful and generous consideration to the welfare of the agricultural industry. Payments on various programmes of this type have generally exceeded the ordinary expenditures of the Department.

In this writer's opinion, payments of a nature described above may properly be considered under a general classification of subsidies. It should be noted that ordinary departmental expenditures exceeded subsidies for 1937 to 1941 inclusive. From 1943 to 1962, inclusive, subsidies exceeded ordinary expenditures except during 1952.

In this thesis, the view is taken that all departmental expenditures must be considered as expenditures of the department because it is impossible to remove expenditures which should rightly be classed as subsidies. It is recognized, however, that extraordinary expenditures,

TABLE 3

Expenditures - Department of Agriculture and Research Branch
as Percent of Industry Value, 1937-62.

Year	Value \$million(1)	Departmental Expenditure \$million(2)	Expenditure Research \$million(2)	Departmental Expenditure as %of Farm Value	Research Expenditure as %of Farm Value
1937	721	9.5	2.4	1.3	0.33
1938	783	33.1	2.5	4.2	0.32
1939	865	42.6	3.3	4.9	0.38
1940	939	17.1	3.3	1.8	0.35
1941	952	13.0	2.9	1.4	0.30
1942	1,583	38.7	3.0	2.4	0.19
1943	1,400	58.4	3.2	4.2	0.23
1944	1,783	110.3	3.5	6.2	0.20
1945	1,585	104.6	3.9	6.6	0.25
1946	1,906	110.4	4.2	5.8	0.22
1947	2,008	95.5	5.5	4.8	0.27
1948	2,396	79.6	7.1	3.3	0.30
1949	2,247	61.8	8.6	2.7	0.38
1950	2,510	73.6	10.4	2.9	0.41
1951	3,177	141.4	12.8	4.5	0.40
1952	3,355	67.1	14.0	2.0	0.42
1953	2,996	106.7	15.1	3.6	0.50
1954	2,341	108.4	15.5	4.6	0.66
1955	2,738	81.8	16.8	3.0	0.61
1956	2,992	88.2	18.0	2.9	0.60
1957	2,524	84.6	19.5	3.3	0.77
1958	2,824	94.7	22.0	3.3	0.78
1959	2,801	165.8	23.6	5.9	0.84
1960	2,989	181.4	25.7	6.1	0.86
1961	2,707	264.9	26.2	9.8	0.97
1962	3,505	286.7	26.8	8.2	0.76

- (1) Rounded off to the nearest \$1 million from data supplied by the Dominion Bureau of Statistics (See Table 2).
- (2) For period before 1959, Forest Entomology deducted and Experimental Farms Service combined with Science Service, except 1937 and 1938 for which it was impossible to combine research functions.

Source: Table 3.

Figure 10. Departmental and Research Expenditure as Per Cent of Industry Value, Agriculture, 1937-62.

even though administered by the department, are the result of political decisions. Indeed, departmental ordinary expenditures must be increased because of the added burden of administering programmes placed under the department's jurisdiction by Parliament.

Despite the decision to include all funds disbursed by departments, adjustment in total expenditure records had to be made in an attempt to present a more accurate statement. Table 1 and explanatory notes have been included to illustrate the judgments applied.

The data shown in Table 3 are further plotted in Figure 10 which shows percentages of industry value which were expended in ordinary departmental expenditure and on research. It will be noted from Table 3 that total departmental expenditure represented 1.3 per cent of the value of the agricultural industry in 1937. There was a rapid increase in relative departmental expenditure through the years so that by 1962 it represented 8.2 per cent of industry value. The percentage expended by government is affected by the prices received for farm products. During the unusually difficult period in 1938 and 1939, low agricultural prices tended to show increased relative expenditures by the department. The high level of subsidies during the war also increased the relative departmental expenditures. The highest values of expenditure

by the Department expressed as per cent of industry value were reached in 1961 and 1962. Table 3 and Table 1 illustrate the effect of political decisions related to maintenance of a vigorous agricultural industry.

Insofar as research is concerned, the relative increase in expenditure has been uniformly upward. In 1937 research expenditure represented 0.33 per cent of agricultural industry value. The succeeding war years led to reductions of expenditures on research, reaching a low point of 0.19 per cent in 1942. From a relative expenditure on research of 0.19 per cent of agricultural value in 1942, the increase has been generally upward, reaching a peak of 0.97 per cent in 1961. In 1962 the percentage expended on research was double that spent for this purpose in 1949.

Considering the Department of Fisheries on the same basis as the Department of Agriculture, the landed value of the fish catch and the comparable expenditure on the Department of Fisheries and the Board are illustrated in Table 4 and Figure 11. Expenditures of the Department and Board expressed as percentages of the landed value are illustrated in Table 5.

It will be noted from Table 5 that expenditures by the Department reached a low value of 3.8 per cent of the gross landed value of the fishing industry in 1944.

Source: Table 5.

Figure 11. Value of Fisheries Production; Departmental and Research Expenditure, 1937-62.

TABLE 4

Statistical Data - Department of Fisheries
and Fisheries Research Board, 1937-1962

Year	(1)Gross Landed Value(\$000's)	(2)Total Employees, Department	(2)Total Employees Board	Employees %Board
1937	23,193	309	-	-
1938	22,810	301	-	-
1939	21,932	325	-	-
1940	23,630	312	-	-
1941	34,378	289	-	-
1942	41,735	332	-	-
1943	48,713	318	-	-
1944	52,078	364	83	22.8
1945	62,761	374	116	31.0
1946	67,162	361	150	41.5
1947	57,516	350	-	-
1948	75,375	533	-	-
1949	67,458	569	222	39.0
1950	82,191	883	360	40.8
1951	88,527	962	360	37.4
1952	92,746	1,031	-	-
1953	89,832	1,875	364	19.8
1954	97,542	1,847	368	20.0
1955	90,891	1,875	402	21.4
1956	105,957	1,832	394	21.5
1957	94,277	-	-	-
1958	116,530	1,715	479	28.0
1959	105,534	1,839	543	29.6
1960	100,488	1,883	540	28.7
1961	110,232	1,989	578	29.1
1962	127,646	1,967	591	30.1

(1) Source: Dominion Bureau of Statistics.

(2) Source: Canada Year Books and Annual Reports,
Fisheries Research Board.

TABLE 5

Expenditures - Department of Fisheries and Fisheries Research Board
as Percent of Industry Value, 1937-1962.

Year	(1) Landed Value \$million	(2) Departmental Expenditures \$million	(2) Research Expenditures \$million	Departmental Expenditure as % of Landed Value	Research Expenditure as % of Landed Value
1937	23.2	1.7	0.2	7.3	0.9
1938	22.8	1.8	0.2	7.9	0.9
1939	21.9	2.0	0.2	9.1	0.9
1940	23.6	3.0	0.2	12.7	0.8
1941	34.4	1.8	0.2	5.2	0.6
1942	41.7	1.8	0.2	4.3	0.5
1943	48.7	1.9	0.2	3.9	0.4
1944	52.1	2.0	0.2	3.8	0.4
1945	62.8	2.6	0.3	4.1	0.5
1946	67.2	3.6	0.5	5.4	0.7
1947	57.5	3.8	0.7	6.6	1.2
1948	75.4	3.3	0.8	5.7	1.1
1949	67.5	4.4	1.2	8.0	1.8
1950	82.2	7.6	1.3	9.2	1.6
1951	88.5	9.0	1.8	10.2	2.0
1952	92.7	8.7	1.7	9.4	1.8
1953	89.8	10.8	2.0	12.0	2.2
1954	97.5	9.3	2.1	9.5	2.2
1955	90.9	11.2	2.3	12.3	2.5
1956	106.0	12.4	2.6	11.7	2.5
1957	94.3	13.8	3.5	14.6	3.7
1958	116.5	16.4	5.0	14.1	4.3
1959	105.5	17.5	5.0	16.6	4.7
1960	100.5	19.8	4.8	19.7	4.8
1961	110.2	19.2	4.8	17.4	4.3
1962	127.6	23.1	6.3	18.1	4.9

(1) Source: Table 4.

(2) Source: Public Accounts.

In other years between 1937 and 1962, expenditures were considerably higher. From 1949 to 1962 relative expenditures increased from 8.0 per cent in 1949 to a peak of 19.7 per cent in 1960, and to a level of 18.1 per cent in 1962.

Expenditures by the Fisheries Research Board were at their lowest level relative to the value of the fishery industry in 1943 and 1944 when they were 0.4 per cent of landed value. In all years prior to 1947, expenditures were less than 1 per cent of landed value. During the 1950's the expenditures rose steadily continuing until 1962 when they reached 4.9 per cent of landed value, a peak for Board expenditures. Figure 12. graphically illustrates the expenditure by the Board and Department, expressed as a percentage of landed value.

If a comparison is made of headquarters administration expenditure as a percentage of total expenditure, it might be expected that this comparison may show differences in overhead costs under the two types of organization. Data of this type are not available for the Board before 1959; therefore only expenditures since 1959 are compared and illustrated in Table 6 and 7. It is interesting to compare this with another independent agency, the National Research Council, illustrated in Table 8, and with the Department of Mines and Technical Surveys, illustrated

in Table 9. There is no definite conclusion that can be reached relating to expenditures on headquarters administration in the government department as compared with a group which can operate independently.

TABLE 6

Research Branch - Headquarters Administration Expenditures
as Percent of Total Expenditures, 1959-62.

Year	H.Q. Admin. \$million(1)	Total, Branch \$million(4)	%on H.Q. Admin.
1959	1.3(2)	23.6	5.5
1960	1.0(3)	25.7	3.9
1961	1.1(3)	26.2	4.2
1962	1.1(3)	26.8	4.1

- (1) Excludes grants-in-aid, normally included within the same vote in the Estimates.
 (2) Includes Ottawa Services Section and Scientific Information Section.
 (3) Excludes Ottawa Services Section, Includes Scientific Information Section.
 (4) Includes certain capital costs of facilities used for forestry research.

Source: Public Accounts.

TABLE 7

Research Board - Headquarters Administration Expenditures
as Percent of Total Expenditures, 1959-62.

Year	H.Q. Admin. \$million	Total Expen. \$million	%on H.Q. Admin.
1959	0.18	5.0	<u>3.6</u>
1960	0.16	4.8	3.3
1961	0.19	4.8	4.0
1962	0.20	6.3	3.2

Source: Public Accounts.

Source: Table 5.

Figure 12. Departmental and Research Expenditure as Per Cent of Industry Value, Fisheries, 1937-62.

TABLE 8

National Research Council - Headquarters Administration
Expenditures as Percent of Total Expenditures, 1959-62.

Year	H.Q. Admin. \$million(1)	Total N.R.C. \$million	%on H.Q. Admin.
1959	1.3	25.4	5.1
1960	1.3	31.5	4.1
1961	1.4	34.4	4.1
1962	1.4	38.8	3.6

(1) Includes Patent Service.

Source: Public Accounts.

TABLE 9

Department of Mines and Technical Surveys - Headquarters Admin-
istration Expenditures as Percent of Total Expenditures, 1959-62.

Year	H.Q. Admin. \$million(1)	Total M.T.S. \$million	%on H.Q. Admin.
1959	0.63	43.8	1.4
1960	0.73	36.8	2.0
1961	0.90	39.8	2.3
1962	1.15	67.6	1.7

(1) Does not include administrative units within branches.

Source: Public Accounts.

Budgeting is yet another area where differences between a government department and an independent agency would be expected to appear. The Department of Agriculture followed, at least until 1962, the recognized departmental procedure of budgeting. Budgeting starts with the usual approval of the establishment in about October. Following examination by a committee of Treasury Board, the total

budget is completed. The Department has no doubt recognized the limitations of this budgeting method as it has in 1964 become one of four departments which are developing a new method of budgeting based on program plans as suggested in the Glassco Report.

The Fisheries Research Board appears to have always used a programme system of budgeting. When Advisory Committees review programmes in each of the regions, they recommend projects for the following year. During the Annual Meeting of the full Board, recommendations of the Advisory Committees are considered; then a budget is prepared. The influence of the Department of Fisheries is felt during the budgeting phase by the presence of a senior Department of Fisheries official on the Board. When the operating budget has been prepared, the gross sum requested is presented as a single vote with the Department of Fisheries Estimates. Capital expenditures are presented as a separate vote. Rarely does the Fisheries Research Board appear in Supplementary Estimates and Further Supplementary Estimates. Once the estimates have been approved, the Board appears to meet its obligations without further control by the Department of Fisheries except for such advice as may be submitted by Board members who are also in the Department.

Personnel

It might be expected that the proportion of a department's financial resources which is assigned to research would be reflected in the growth of personnel employed in departmental research arms as compared with general growth in departmental personnel. Personnel employed on general departmental establishment and in the research units are shown in Table 2 for agriculture and Table 4 for fisheries.

In 1937 the Department of Agriculture had 2,633 employees on strength. It is not known with certainty how many of these were employed in research units as previously defined. However, in 1939, out of a departmental strength of 3,122 employees, 853 were employed in units which, it is believed, ultimately formed the Research Branch. Except for a slight drop from 3,362 employees in 1940 to 3,110 in 1941, growth in departmental personnel has been steadily upward until 1947 when personnel on strength reached 3,833. A relatively sharp rise occurred in 1948 to 5,381 from 3,833 in the previous year. Growth has since 1948 been upward until the strength in 1962 stood at 7,981. The peak year for employment in the department was 1961 when there were 8,223 on strength.

Growth of research units in terms of personnel has outpaced the general departmental growth. From 853 employees in 1939 the number grew steadily until

1941 when there was a slight drop from 952 to 876. Growth resumed in 1943 but on a modest scale during the war years. The post-war period witnessed initially a sharp rise to 2,330 in 1948 from 1,311 the previous year. Then the number generally increased each year to a level of 3,752 in 1961. The drop to 3,402 in 1962 is probably due to the effect of the 1959 re-organization which may have resulted in considerable streamlining.

An interesting observation is the relative growth of the research arm of the Department as compared with growth of the Department itself. Illustrated in Figure 13 are total employment of the Department of Agriculture, total employment for the combined research groups, that is, Experimental Farms Service and Science Service, and percentage of employees engaged in the research units as compared with total employees in the Department.

A similar analysis of employment in the Department of Fisheries and Fisheries Research Board is made in Figure 14. It will be noted, however, that employment data for some years are missing for the Fisheries Research Board. The record of employment in the Department of Fisheries is fairly complete. From an employment of 309 in 1936-37, the increase in departmental employment has been fairly uniform until a peak of 1,989 was reached in 1961. A noticeable increase occurred between 1951 and 1952;

Source: Table 2.

Figure 13. Analysis of Employment, Department of Agriculture 1937-62.

Source: Table 4.

Figure 14. Analysis of Employment, Department of Fisheries, 1937-62.

that is, from 1,031 to 1,875. Records indicate a drop of 22 in employment between 1961 to 1962.

The Fisheries Research Board employed a total of 83 persons in 1944, the earliest year for which data are available. From 1944 the rise has been uniform but slow, reaching a peak of 591 in 1962. The percentage of personnel engaged in fisheries research as compared with total employees in governmental activities related to fisheries reached high levels in the post war period.

On the basis of comparison of research personnel against Departmental personnel, the Research Board has lagged far behind the Research Branch and its predecessors. This in itself does not conclusively prove that growth could not have been equal. It may well indicate that the magnitude of the problems encountered in fisheries research are of a different order from those in agriculture. On the other hand, because of the lesser financial importance of fisheries to the Canadian economy, the Board may have been unable to obtain the resources it would like to command.

There is a marked difference in methods of engaging professional personnel to staff the Branch and Board. The former uses the normal Civil Service competition procedure to fill vacancies which are filled on a permanent basis. The latter appears to have wide

flexibility when engaging personnel and fixing their remuneration. The Board could make wider use of the term appointment as is done in the National Research Council but it does not appear to do so.

Comparison of personnel turnover for a long period is difficult to make owing to absence of such data for the Research Board. Re-organization of research activities in agriculture since 1959 may have further accentuated turnover in the Research Branch. For the years between 1955 and 1962, tabulation of permanent personnel as compiled from Board records indicates that separations in 1955 numbered 9 professionals for a loss of 2.2 per cent. The appointments for that year numbered 15 professionals. In 1962, retirements numbered 11 for a loss of 2.1 per cent. Appointments of professionals during 1962 numbered 19.

Data on Research Branch personnel are more readily obtained owing to retention of basic employment data on punched cards. Records of 1955 indicate 26 separations for a loss of 0.73 per cent. Appointment of professionals during 1955 totalled 55. The comparable separation records for 1958, 1960 and 1962 indicate losses of 0.83, 1.66, and 2.9 per cent respectively. Appointments during the same years were 40, 41, and 47. Prior to 1959 appointments generally exceeded separations

but since 1959 separations exceeded appointments by a wide margin. The shift in personnel may be related to re-organization of agricultural research activities. If this is so, turnover should stabilize when the major changes have been completed.

It is interesting to compare the manpower turnover in 1962 for the Branch and Board with that of a chemical company in the United States during the same year.⁽¹²⁾ The private company had a turnover rate of 3.0 per cent monthly in all its divisions against a turnover of 2.3 per cent monthly in its research divisions. During the same year, the turnover for all of the United States chemical industry was 2.1 per cent monthly.

Reasons for separation of professional agricultural research employees are shown below for 1960 and 1962.

Cause	1960	1962
Deceased	3	1
Superannuated (age)	13	23
Superannuated (ill health)	1	-
Resigned to accept outside employment	28	27
Resigned to return to studies	3	10
Separated for other reasons	12	12
Total	60	73

(12) Schumacher, Joseph, C., Salary Administration of Scientific and Engineering Personnel in an Atmosphere of Increasing Competition, Research Management, VI, No.5, 1963, p. 364.

At best, however, study of separation data for the Branch and Board are somewhat inconclusive owing to absence of data for the latter for a period when the former was undergoing re-organization. From the limited information available, it does appear that on a percentage basis, personnel separations in the Branch have in recent years increased quite rapidly as compared with the Board.

From interviews with senior personnel in the Research Branch and Research Board it appears that both groups have now reached a decision to recruit professional research personnel at the Ph.D. level for permanent employment. Exceptions may be made for certain applied research activities where engineering degrees are most desirable. Exceptions may also be made if professionals hold Masters Degrees and are actually working toward their Doctorates.

The question may be profitably investigated as to the academic qualifications held by scientists in the Branch and Board. To some extent both groups are competing for the same personnel, at least in fields such as chemistry, biology and pathology. Comparative data for several years of degrees held, may offer some indication of skill levels in the Branch and Board. The years 1955 to 1962 were selected for comparison.

Data for the Research Board were taken from Annual Reports of the Board and data for the Research Branch were

TABLE 10

Professional Research Staff, Degrees Held, Selected Years.

Year	Ph.D.			Masters			Bachelors			Total
	Agriculture	Fisheries	Agriculture Fisheries	Agriculture	Fisheries	Agriculture Fisheries	Agriculture	Fisheries	Agriculture Fisheries	
1955	222	43	360	44	249	43	831	130		
1957	196	58	352	53	255	37	803	148		
1958	217	61	350	47	249	32	816	140		
1959	223	66	346	45	232	40	801	151		
1960	213	77	234	43	225	42	672	162		
1961	221	69	227	37	217	30	665	136		
1962	223	82	211	54	208	47	642	183		

taken from printed records produced in the departmental data processing unit. The numbers may not agree with those shown in the Estimates. ~~In all instances,~~ short term appointments were omitted insofar as this was possible. The results appear in Table 10.

From Table 10 it will be noted that the number of professional staff in the Research Branch has decreased from 831 in 1955 to 642 in 1962. This can be accounted for by movement of some professionals to non-research employment within the Department and by non-replacement of separated professionals.

From Table 10 it is apparent that professional personnel engaged in research on behalf of the Research Board increased from 130 in 1955 to 183 in 1962, an increase of about 30 per cent.

On the basis of percentage of professional personnel with various degrees as compared with total professionals employed, the graphic presentations of Figures 15 and 16 result.

Analysis of Figures 15 and 16 indicates that the quality of research personnel is constantly improving in both research groups. The writer does not wish, however, to minimize outstanding contributions made in the past — to scientific knowledge by professional personnel with modest academic qualifications. The compilations of

Source: Table 10.

Figure 15. Analysis of Degree Levels,
Research Branch, 1955-62.

Source : Table 10.

Figure 16. Analysis of Degree Levels,
Research Board, 1955-62.

Figures 15 and 16 do, however, show that the number of researchers with higher degrees is generally increasing while the number with lower degrees is proportionally decreasing.

On the basis of degree levels, the professionals in the Research Board appear on the average to be more highly qualified. It should be noted, however, that exceptional stability of personnel in this group tends to ultimately raise the level of qualifications for the work undertaken. Many of the professionals in the Board start their professional careers with summer employment on the Board's projects. They appear to return in succeeding years with higher academic qualifications.

Summer employment and professional development also occurs to some extent in the Research Branch. However, a large percentage appear to leave for employment outside the government service as illustrated on page 43.

The question often arises as to the salary levels which can be implemented inside and outside the Civil Service Act. The point is often made that organizations which must act within the Civil Service Act are handicapped by salary restrictions when competing for professional personnel. In the tables that follow, numbers shown on the establishment, taken from the Estimates, may not correspond

to those actually employed owing to vacancies and the like.

Estimates for 1955 and 1956 show the following range of salaries for typical positions in the Department of Agriculture.

	1955 \$	1956 \$
Director, Science Service	10,000	-
Associate Director, Science Service	8,250	-
Agricultural Research Officer 11	8,100	7,600-8,200
Agricultural Research Officer 8	6,660	6,120-6,840
Agricultural Research Officer 6	5,980	5,460-6,180
Agricultural Research Officer 4	4,960	4,680-5,400
Agricultural Research Officer 1		3,360-4,620
Chief, Bacteriology Division (44 on divisional strength)	7,500	8,000
Chief, Botany and Plant Pathology (346 on divisional strength)	9,000	
Chief, Entomology (400+ on divisional strength)	6,000-9,000	
Agricultural Research Officer Grade 11	8,100	
Agricultural Research Officer Grade 9	6,420-7,200	

In the Experimental Farms Service for the same years, some of the salaries were:

Director, Experimental Farms	9,500	10,500
Experimental Farms Service Chiefs, Research Division, Group 3		7,700- 8,600
Branch Experimental Farms, Substations, and Illustration Stations: Operations and Maintenance		
		1956 \$
Agricultural Research Officer, Grade 9		6,420-7,200
Superintendents, Grade 5		6,120-6,840
Superintendents, Grade 3		5,460-6,180
Superintendents, Grade 1		4,680-5,400
Animal Pathology (115 on divisional strength)		
Chief, Research Division, Grade 4		8,000-9,000
Agricultural Research Officer, Grade 10		7,300

Before 1962 the system of classifying professional and supervisory personnel was changed to reduce the number of classes. The classification during 1962 and numbers in each major classification in the Estimates are assessed later in Table 11. The professional staff at Headquarters, however, was:

Research Branch, Headquarters

No.	Classification	Salary Range \$
1	Senior Officer 3	16,500-18,000
1	Senior Officer 2	15,500-16,500
2	Senior Officer 1	14,000-15,000
9	Chief, Research Division, Agriculture	12,500-13,500
1	Research Officer, Agriculture, 5	9,940-11,200
7	Research Officer, Agriculture, 4	8,120- 9,800
2	Research Officer, Agriculture 3	6,840- 7,860
3	Research Officer, Agriculture 2	5,940- 7,140
1	Research Officer, Agriculture 1	4,380- 5,880

Now consider the following Minutes taken from the
Executive Actions of the Chairman, Fisheries Research Board,
 December 16, 1954.

Salary increases effective January 1, 1955	From	To
Newfoundland Fisheries Research Station: Assistant Scientist	3,600	3,750
Newfoundland Technological Unit: Senior Scientist	6,000	6,200
Atlantic Biological Station: Senior Scientist	6,600	6,800
Atlantic Fisheries Experimental Station: Senior Scientist	6,000	6,200
Associate Scientist	4,950	5,150
Assistant Scientist	3,900	4,050

Salary increases effective January 1, 1956:	From \$	To \$
Newfoundland Fisheries Research Station: Senior Scientist	6,200	6,400
Atlantic Biological Station: Senior Scientist	6,800	7,000
Atlantic Oceanographic Group: Associate Scientist	4,750	4,950

And the following increases voted for the top officials such as Directors of decentralized research units, including two at a slightly lower Principal Scientist level:

Vancouver Technological Station: Principal Scientist	7,700	7,950
Headquarters, Director	9,000	9,900
Nanaimo, Biological Station, Director	8,750	9,500
St. Andrews, Biological Station, Director	8,500	9,100

Effective July 1, 1962, the following salary increases in the Research Board are noted:

Nanaimo, B.C.:	From \$	To \$
Director	14,700	15,200
Principal Scientist	13,100	13,600
Senior Scientist	10,000	10,500
Associate Scientist	7,900	8,500

In the Estimates for 1962, distribution and salaries of the Board's professional personnel at headquarters were:

	Salary Range
Chairman	\$14,500
2 Directors	13,000-14,000
2 Principal Scientists	10,500-12,500
1 Admin. Officer 7	9,940-11,200
2 Admin. Officer 2	6,000-6,660

It is difficult to objectively compare salaries of senior personnel owing to varying degrees of responsibility. A Director of a Fisheries Biological Station would be the senior individual fully responsible for a decentralized unit. It is true that an Advisory Committee would meet annually to consider and recommend on programmes for that station. One would hardly expect much direction from a small and fully occupied headquarters staff. The number at a station may be in the order of 40.

A Chief of Division in the Research Branch would have a much larger group to supervise. The administrative task would be formidable but on the technical side, there would be considerable guidance from Associate Directors and Directors in the Programme Directorate.

Comparing salaries of a Chief of Division, Research Branch with a Director of a fishery research station, the scale for 1962 would be \$12,500 to \$13,500 for the former against \$13,000 to \$14,000 for the latter. The salary for

the latter is about \$500 a year greater, which does not appear too far out of line when one considers the greater responsibility (despite lesser establishments) which accompanies decentralization.

At the level immediately below Director of a fisheries research station, there is that of Principal Scientist at \$10,800 to \$12,500. The comparative position immediately below Chief of Division, Research Branch is Research Officer, Agriculture, 5, at \$9,940 to \$11,200. The spread is about \$1,000 in favour of fisheries. There appears to be some advantage to employment in the Board at a level immediately below the senior official responsible.

On an overall basis, salaries of all the personnel, exclusive of headquarters, were weighted to obtain an average salary for all professionals in the two groups. The weighted average salary for professionals in the Research Branch appears in Table 11 and the weighted average salary for professionals in the Research Board appears in Table 12.

From the Estimates it is noted that total employees of the Research Board, including all seasonal and the like, were shown as 758. Professionals as shown in Table 12 indicate 199 on strength, giving a ratio of professional to non-professional of 1 to 3.7. It is interesting to note that the Glassco Commission indicated a ratio of professionals to non-professionals in the Research Branch of 1 to 2.2.

TABLE 11

Weighted Average Salaries of Professionals, Headquarters Excluded, Research Branch.

No.	Title	Salary \$	Median \$	No. X Median
11	Chief, Research Division, A.1	12,500-13-500	13,000	143,000
11	Chief, Research Division, A.1	11,000-12,500	12,000	132,000
20	Research Officer, A.5	9,940-11,200	10,570	211,400
152	Research Officer, A.4	8,120-9,800	8,960	1,361,920
289	Research Officer, A.3	6,840-7,860	7,350	2,124,150
424	Research Officer, A.2	5,940-7,140	6,540	2,772,960
1	Research Officer, A.1	4,380-5,880	5,130	5,130
			7,440	6,750,560

Source: Estimates, 1962.

TABLE 12

Weighted Average Salaries of Professionals, Headquarters Excluded, Research Board.

No.	Title	Salary \$	Median \$	No. X Median
6	Director	13,000-14,000	13,500	81,000
21	Principal Scientist	10,500-12,500	11,500	241,500
48	Senior Scientist	8,300-10,000	9,150	439,200
83	Associate Scientist	6,450-7,950	7,200	597,600
32	Assistant Scientist	4,760-6,200	5,480	175,360
9	Junior Scientist	3,760-4,560	4,160	37,440
			7,900	1,572,000

Source: Estimates, 1962.

From Tables 11 and 12 it appears that professionals in the Research Board are paid higher salaries than in the Research Branch. The difference is in the order of \$460.00. Weakness of some of the assumptions made must be pointed out. It was assumed that professionals in any given category were paid the median for that category. If personnel turnover is high, the average salary paid would actually be lower than the median for that category. This factor would tend to assume lower than actual salaries for the Research Board. Another anomaly which cannot be fully accounted for is the scale of salaries paid to senior personnel of long service. It is quite likely that senior personnel are near the top of the scale whereas junior personnel are near the bottom of the salary scale. This writer does not believe it possible to accurately take these factors into account, without a detailed study of individual salaries.

Both the Research Branch and Research Board use the facilities of the Pay Research Bureau of the Civil Service Commission when recommending salary scales. A close perusal of the non-professional classes (and some of the professional classes), in the two bodies indicates that the Research Board has much greater flexibility when paying professionals of the same classification and non-professionals in different regions of Canada. In the

records of the Research Board this advantage is particularly noticeable in the clerical classes and in ships crews on the East and West Coasts of Canada where there are striking contrasts in salary levels.

Publications

It is believed that a means of measuring performance of a research group is to consider the work actually completed. Research work of the Research Branch and Research Board is finally reported upon in a variety of publications. Publication of results of research in journals with a high reputation is eagerly sought by scientists. Less technical material may be included in generalized summaries. Considerable published material which is prepared specifically for the clientele served is based, ultimately, upon research but the content may not represent any new scientific advance.

Scientific results from the Research Branch, are, if of sufficiently high calibre, published in the Canadian Journal of Agricultural Science and in Proceedings of professional societies. Editorial Boards, comprised of eminent scientists, judge the merits of papers presented for publication. Anyone who is not trained in the particular discipline involved is not competent to judge the merits of the scientific work accomplished but acceptance of the work for publication by leaders in the discipline

is an indication of its merit. Apart from this measure of quality it is difficult for an outsider to assess the merit of material which is not accepted for publication in a scientific journal, even though this material may represent good work which is not quite up to the exacting standards required by Publication Boards.

Another difficulty arises when attempts are made to assess the performance on research work as represented by publications. For example, the annual report of the Department of Agriculture for 1937 indicates that two publications were published that year by the Experimental Farms Branch and 14 volumes of the Canadian Insect Pest Review were published by the Science Service, Entomological Branch. Publications by other branches were not listed. In 1938 the Annual Report indicates that the Experimental Farms Service produced 5 publications and the Science Service 3, in addition to 12 volumes of the Canadian Insect Pest Review. This number of publications is hardly representative of the research work of an active department so one must suspect that most research reports were kept in manuscript form and, therefore, not reported in the Annual Report. In succeeding years few publications were reported. Further, war conditions may have seriously curtailed civilian agricultural research work.

Commencing in 1947 a new method of classifying

publications was adopted and continued to 1950. Numbers of scientific publications as reported in annual reports for 1947 to 1950 were:

Year	Experimental Farms Service	Science Service
1947	none reported	167
1948	5	186
1949	28	220
1950	23	240

Publications of the Experimental Farms Service reported upon soil surveys and other results of studies on the experimental farms. Publications of the Science Service reported upon the numerous scientific studies undertaken by the Service. An example of distribution of Science Service publications between the various research divisions is illustrated by the list of 1947 which is reproduced below. The distribution between various disciplines of scientific publications in other years to 1950 follows the same general pattern.

Science Service Publications, 1947	
Animal Pathology	21
Bacteriology	23
Botany and Plant Pathology	50
Chemistry	14
Entomology	53
Plant Protection	<u>6</u>
TOTAL	167

Commencing in 1951 yet another method of classifying publications was adopted by the research units of the Department of Agriculture. Further changes in classification were adopted in 1955 and 1960. As far as possible, reports since 1951 which can be considered research reports have been compiled into Table 13. Also shown in Table 13 are the total numbers of employees in the research groups and the ratios of publications per employee in the groups.

Some of the publications of the Department of Agriculture which were not included in Table 13 are based upon research but because of their tone are designed for dissemination of information to a clientele. Others are designed for dissemination of information between scientists. Among the latter may be included the Canadian Insect Pest Review, the Lighter, and others which will be discussed more fully within a section on communications.

The most desirable destination for research papers from the Research Board is one of the reputable scientific journals or Proceedings of scientific conferences. Information on original research will probably be published in the Journal of the Fisheries Research Board of Canada, or in the Bulletin of the Fisheries Research Board of Canada. The former appears to convey a higher prestige value. Other publications which appear under the

TABLE 13

Publications, Research Branch and its Predecessors,
Compared with Total Employees, 1951-62.

Year	Publications(1)	Total Personnel(2)	Publications per Employee
1951	149	3,098	0.05
1952	183	3,017	0.06
1953	263	3,430	0.08
1954	286	3,466	0.08
1955	323	3,557	0.09
1956	265	3,185	0.08
1957	311	-	-
1958	367	3,499	0.10
1959	500	3,515	0.14
1960	632	3,619	0.18
1961	603	3,752	0.16
1962	679	3,402	0.20

(1) From Annual Reports and other departmental sources,
writer's compilation.

(2) From Table 2.

sponsorship of the Board are progress reports for the various research stations and numerous bulletins for use of fishermen. Only Journal and Bulletin articles are considered as research reports.

As in the Department of Agriculture, classification of publications in the Fisheries Research Board is changed from time to time. From a count of Journal and Proceedings publications as reported in the Board's annual reports, the analysis of Table 14 has been produced. It was not possible to calculate an employee-publication ratio in the Board for 1957 owing to absence of some data.

There does not appear to be any appreciable difference in publication-personnel ratio between the Research Branch and Research Board from 1951 to 1959. It is, however, worthy of note that the ratio for the Research Branch since 1959 as compared to its predecessor units is considerably higher. This may be related to better control under a new form of organization, or it may be due to reduction of non-active professional personnel following re-organization. A full investigation of this phenomenon is beyond the scope of this thesis.

TABLE 14

Publications, Research Board as Compared
with Total Employees, 1951-62.

Year	Publications(1)	Total Personnel(2)	Publications per Employee
1951	11	-	-
1952	28	364	0.08
1953	22	368	0.06
1954	56	402	0.14
1955	41	394	0.10
1956-57	48	-	-
1958	43	479	0.09
1959	74	543	0.14
1960	58	540	0.11
1961	73	578	0.13
1962	68	591	0.12

(1) From Annual Reports, writer's compilation.

(2) From Table 4.

Programme Control

Research programmes may be initiated in several ways in the Research Branch. Investigations may be initiated at the request of other parts of the Department of Agriculture or by the Programme Directorate. Many projects originate in a research station, as will be illustrated by an example.

A local farmer may notice some unusual problem with his crop. When provincial authorities are consulted they may enlist the aid of the nearest Department of Agriculture research station. A preliminary investigation is made by a Branch scientist who is knowledgeable in the field and approval for further investigation is obtained from the head of the station. If the situation appears to warrant it, a project outline is prepared for submission to the local Director who, if he approves the proposed action, may contact Ottawa for authority to proceed. A preliminary survey is made to determine if there is a logical way to attack the problem. Only up to \$100 can be spent in the field without further reference to Ottawa.

When it is decided in the field that a problem exists and that investigation by the Research Branch is desirable, a project outline is drawn up for submission to the Director-General in Ottawa. The Director-General has readily available the advice of the Programme Directorate,

comprised of himself and the Directors and Associate Directors, all of whom are prominent scientists in specific fields of research. This group of 18 officials advises the Director-General on the research programme.

The Glassco Commission did not believe the Programme Directorate to be a suitable permanent arrangement when it said: (13)

Clearly an arrangement by which fifty four units report to a single office, which is in turn advised by a committee of eighteen Branch scientists, cannot be a satisfactory permanent organization.

In fact, all eighteen committee members are not competent in all fields, therefore the specific project under study is thoroughly investigated by the Associate Director or Director who is competent in the particular field. The Associate Director's recommendation is considered by the Committee which weighs the specific project as opposed to pressing requirements in other fields.

When a project has been approved, a file on it is immediately established. Work proceeds as planned and the research officer is expected to report upon it according to a standard method at least once a year. The medium for conveying the report is a form which serves as a heading sheet. Space is provided on the form for comments by the Associate Director who has the project under surveillance. Copies of the Associate Director's comments are sent to the research officer who may discuss them

(13) Glassco Report, Vol. 4, p. 239.

freely. There is no restriction whatsoever upon a scientist as to where he obtains his information or advice but the final report on his project goes to his own Research Director. There are certainly some situations where a scientist has unwarranted enthusiasm for a specific project. As free a rein as possible is given to enthusiasm but a pervasive control is exercised by financial allotments.

Some projects are of brief duration whereas others are long. Many projects are seasonal. It is rare for a scientist to work full time on a project unless the subject is unusually urgent. An attempt is made to balance scientific effort of each scientist between basic and applied research. As a result, scientists normally have one to 7 or 8 projects in active status.

Ultimately projects either end abruptly or taper off when the essential problem for which the project was initiated is solved. Authority is then requested to discontinue the project. The proposal to discontinue follows the same channels as other reports, that is, through the Associate Director who reviews the proposal to discontinue and submits a recommendation to the Director.

Even projects which were completed many years ago can be resurrected for any purpose. The file on a project is never destroyed as the information may be useful on a future project. There is also a permanent

punched sheet record of the project bound into an annual volume for quick reference.

The problem of programme planning in the Research Board is similar to that in agriculture but of course on a smaller scale. The Fisheries Research Board has both advisory and executive functions. Meeting as it does periodically, the Board cannot give adequate attention to programme control without delegation. As a result, operations of the Research Board are completely decentralized.

In each station, the Director supervises the work of the station, acts as adviser to its scientists, and is responsible for the administrative functions of the station. An administrative assistant, also a scientist, may carry part of the burden. The situation could occur where the Director, no matter how broad, may not be competent enough to counsel scientists in highly specialized work.

The problem of directing diverse, highly specialized research programmes has therefore been met by appointment of Advisory Committees. At a meeting of the Board, the following minute was passed and later approved by the Governor in Council on August 18, 1954:

11. (1) There shall be:

- (a) an Eastern Advisory Committee for the Maritime Provinces, Newfoundland, Quebec and the Eastern Arctic,

- (b) a Central Advisory Committee for the Great Lakes area, Ontario, Manitoba, Saskatchewan, Alberta, and the mainland area of the Northwest Territories, and
- (c) a Western Advisory Committee for British Columbia, the Yukon Territory, and the Western Arctic,

for the purpose of giving guidance to the Board in relation to scientific investigation conducted or controlled by the Board in its area.

Further sections of the By-Laws define the method of appointment of Advisory Committees, procedures of action and meeting. Advisory committees were given authority to call, with the approval of the Chairman of the Committee, upon outside advisers to advise with respect to any scientific investigation under jurisdiction of the Board. These provisions go a long way towards making up for any lack of specific specialized competence by Directors of research stations.

Programmes of the Board may originate in many different ways. Representatives of the fishery industry may make representations to the Board, but a problem would infrequently become that acute before the Board's own scientists would take some action. Projects may suggest themselves as a result of information which comes to light during other work of the Board. They may result from requests by the Department of Fisheries, or from one of

the Board's scientists who sees a need for it. The interaction of all interested parties takes place and a firm start is made when a research worker and his Research Director make concrete proposals. The appropriate Advisory Committee examines the proposals and makes recommendations to the Board.

Advisory committees meet a minimum of twice a year; once in their respective regions to assess programmes and performance, and once at the time of the Board's Annual Meeting to present recommendations to the Board. While programmes and performance are under review in the Region, the Advisory Committee discusses programmes and plans with the scientists involved, with the Research Directors of stations, and with such specialists in the subject matter that the Advisory Committee wishes to call upon. Members of the advisory committee themselves provide a broad background of knowledge and information upon which to draw.

When the Board approves a programme, the required personnel and facilities are provided for in the Board's budget. As work on the project proceeds, the Research Director keeps informed on progress and the Advisory Committee makes reviews at least annually. As little interference as is consistent with control is exercised upon the scientist. Formerly, progress was reported upon in the regional Progress Reports, a series now discontinued.

Now, when projects are complete or when progress has been worthwhile, although incomplete, a report is written to disseminate the knowledge. If it is deemed worthwhile and if it meets the standards imposed by critical senior scientists, publication may be in one of the scientific journals. Other reports may be retained in manuscript form for use in the Board's work.

The Glassco Commission examined the research effort in both the Research Branch and the Research Board. It commended the Research Branch for the quality of its research but drew attention to the imbalance between the effort in various areas of research and the relative value of the sections of industry which benefit from such research. A similar criticism was made about the Research Board but the research here could not be so closely allied to segments of the industry. It was shown instead as an imbalance in certain specialized research. The charts shown in Figures 17 and 18 were reproduced from Volume 4 of the Glassco Report. It should be noted, however, that the Glassco Commission took no account in these charts of the interdependence of animals, soils and crops. For example, research on crops which increases the yield of feed grains is a benefit in returns from superior animals.

One may wonder why there should be such an imbalance in effort when the relative values of the industrial

Source: Glasco Report

Figure 17. Areas of Research in Man-Years,
Agriculture, 1952-61.

Source: Glassco Report

Figure 18. Distribution of Research Expenditure, Fisheries, 1952 - 62.

sectors are so well known, or where all areas of research are desperately struggling for a just share of resources. This writer suggests that the situation may be partly due to some of the following causes:

- (1) continuing development of certain arms which were of paramount importance in the past and where outstanding success has attracted funds,
- (2) pressure of scientists for their main areas of interest: scientists with greatest prestige can dominate where there are no dissenting laymen's voices,
- (3) need for research in certain areas to be on a large scale in order to achieve success; large scale can only be maintained at the expense of other worthy research, and
- (4) reluctance to terminate programs which should be terminated because of the effect on morale.

It is often suggested that presence of a prominent scientist in a certain area of research tends to stimulate and attract junior personnel toward that area of research. In the Research Branch there are many scientists who are world famous in the area of crops. In the Research Board, exceptional competence in fishery biology is a parallel. This writer suggests that the long tradition of eminence in crop research within the Research Branch and in fishery biology in the Research Board, is probably the major reason why there is an imbalance of effort.

There probably is pressure by scientists for their main areas of interest. One may claim that final control

is held by Treasury Board which recommends allotment of financial resources. Control by Treasury Board may work on an overall basis, but how can Treasury Board discuss programmes with scientists on an equal footing? If a research group has a preponderance of scientists in a certain discipline, it is reasonable to expect a greater weight of programme proposals in this discipline. The solution to this problem, that is, apportionment of resources, can probably be met by introducing a greater weight of layman's opinion into programme planning. Suitable sources for such personnel to assess apportionment of effort in the Research Branch would appear to be nominees from farmers associations, from senior economists in the Department of Agriculture, and from other groups which are competent in financial matters. Suitable sources for candidates to serve with the Research Board would appear to be representatives of fishermen's associations, economists from the Department of Fisheries, and other financial advisers. In no case should the weight of layman's opinion be brought to bear upon the actual scientist and his work. Direction and supervision in this area can only be left in the hands of scientists. Deciding where to put the emphasis is an entirely different matter. When scientists have exclusive control of all aspects of research, from selection of areas where emphasis should be put to controlling the

actual work, they are in effect judging in their own case.

The British Committee on the Management and Control of Research and Development gave intense thought to the problem of conducting research, managing the research workers and ensuring that the effort is expended in the most fruitful areas. The Committee took the view that Directors should be given as much freedom as possible in determining the basic research programmes of their establishments and that a wide measure of freedom should be delegated to the research workers. A rigorous review of progress should be made to an agreed schedule and management should meet its responsibility and terminate projects that appear unlikely to succeed.⁽¹⁴⁾

The Committee unequivocally supported a system of review of a research establishment's work by use of outside experts when it said:⁽¹⁵⁾

The freedom given to the Director and his senior staff in determining the content and reviewing the progress of programmes of basic research makes it essential, in our view, to arrange for an independent review to be made from time to time by outside experts in the work covered by the particular establishment.

Review of the methods of programme control which are in effect within the Branch and Board, indicates that the Board adheres more closely to the proposals of the Committee on the Management of Research and Development.

(14) Office of the Minister for Science, Report, p. 31.

(15) Ibid., p. 32.

The Board's regional Advisory Committees appear to be far enough removed from the actual work to express an outside expert's opinion. This same function is performed to some extent by the Programme Directorate in the Branch, but membership of the Directorate is more closely involved with programme formulation. Both the regional Advisory Committees and the Programme Directorate are, however, to some extent disqualified for the review function envisaged because of their involvement in original planning.

Communications

Because of the nature of the organization in the Research Branch, two parallel streams of communication exist; one through the programme portion of the organization and the other through the administrative. The programme portion has, as was seen during the discussion on programme control, a chain of communication from the individual scientist through the station head to the Director of Research.

The administrative side of the organization concerns itself with finance, personnel, operating facilities and all auxiliary staff functions. Communication along the administrative side is maintained by correspondence, directives, and progress reports of the stations.

Internal communication between scientific workers and others who are not engaged on the same project, is

maintained by house organs which appear at specific intervals. During 1962 not less than fourteen of these house organs were regularly published.

Most frequently published is a weather bulletin which appears weekly and is based upon information obtained from the Department of Transport. Twice monthly a fly-leaf type of publication entitled Highlights which lists the salient information on Branch activities is widely circulated within the Branch. Monthly publications include the Entomology Newsletter, comprised of two or three small pages, the Insect Pest Review, and others. Publications which are widely circulated in the Department are prepared quarterly for distribution by the Research Institutes which are concerned with forage, soils, and cereals. These quarterly publications outline the current research activities in the various institutes.

Annual reports are required of all leaders of research projects as was described in the section on programme planning. Research Directors also prepare reports for perusal by the Executive Committee. In addition to these reports, chairmen of Research Committees prepare Annual Reports to the appropriate Councils. Illustrative of this series is the Annual Report of the Committee on Horticultural Research, sponsored by the Canadian Horticultural Council. In reality, this report is a complete

review of the scientific work conducted at the various experimental farms and other research establishments of the Department of Agriculture.

Communications between departmental research personnel and agriculturists in Canada are maintained by a large number of publications written in non-technical language. All of these publications are based ultimately upon research conducted at the Institutes and Experimental Farms. A catalogue published annually lists all publications which are available either through departmental sources or through the Queen's Printer.

Finally, an Annual Report is prepared in the Department and signed by the Minister under covering letter to the Governor-General. Like any departmental report, the Annual Report of the Department of Agriculture reviews the state of all federal governmental activities related to the industry; and reviews the industry itself. The Annual Report is probably the most widely distributed report of the Department.

The communications system within the Research Board resembles that which may be found in a private corporation. The main system centres around a regular series of reports. Most frequently prepared is a bi-monthly report to which contributions are made by every station and sub-station and by the office of the Chairman. Highlights of

all activities during the previous half-month are discussed in the report and notes concerning staff, visitors, or any other items of interest are included. The bi-monthly report therefore serves as a progress report on research activities and as a house organ.

Another report which is published whenever sufficient material has accumulated is entitled: Executive Actions of the Chairman. This report is mimeographed and distributed to all research stations. Items covered are salary revisions, appointments, separations, and other executive actions taken by the Chairman since the previous report was prepared.

Reports of Advisory Committees are prepared for consideration by the Board during its Annual Meeting. These reports are not widely distributed as they often deal with confidential material. Main items covered are proposed programmes, progress and suggestions for reducing, expanding, or terminating specific research activities.

The Chairman further reports to the Board annually under confidential listing entitled: Chairman's Report to the Board. In this document all activities of the various stations are reviewed as are programmes, proposals, and staff relations. The Chairman in his report always makes specific recommendations for consideration by the Board. His recommendations cover such matters as purchase of

vessels, expansion of facilities at the various stations, and his suggestions as to where the Board should place greater emphasis when consideration of competing demands is underway.

In addition to the frequent reports as outlined above, the Annual Report to the Minister by the Fisheries Research Board is prepared to fulfil statutory requirements. As in any other governmental Annual Report, the report of the Board presents a complete summary of all its work during the previous fiscal year and gives a clear indication of the direction in which the Board's effort is moving. It further reviews the state of the fishing industry.

As in the Research Branch, the Research Board is faced with a constant problem of disseminating its scientific knowledge to non-scientific personnel in the industry who can utilize this knowledge at the practical level. Co-operation of the Department of Fisheries was enlisted to formulate a programme whereby the results of major research could be re-published in less technical language. A series of bulletins attempts to fill this role but results through the years have not been completely satisfactory. The existing barrier is recognized and further attempts at surmounting it have been made by enlargement of the technological activities of the Board; by institution of open houses at the various stations; and, in co-operation with

the Department of Fisheries, presentation of non-technical radio broadcasts to industry.

When the internal written systems of communication within the Research Branch and Research Board are compared, this outside observer is impressed with the simplicity and adequacy of the latter. The Glassco Commission felt that in the Research Board there was inadequate contact between scientists working in decentralized units to the point where scientists in one establishment did not know what scientists in other establishments were doing. There appears to be little ground for this complaint unless the scientists themselves are so wrapped up in their own work that they take little interest in that of others. If this is the reason, it becomes a problem of motivation by some means other than reports which already exist. The Board itself has recognized the difficulty of stimulating its research personnel to take a greater interest in its overall work. A series of annual conferences were held in Ottawa; attending were research personnel from the widely dispersed stations, representatives from the Department of Fisheries and from interested educational institutions.

It is true that communication within the Research Branch is a more complex problem than in the Research Board owing to complexity of the Branch. It appears to this writer that a regular system of, say, freely-available

monthly reports, all prepared to the same format, would be excellent and cost less than the variety of organs now published by the various groups. There would appear to be little need for extensive polishing of the internal reports envisaged. The scientists and their immediate superiors would do all technical editing and a small editorial group could handle production in a uniform manner.

CONCLUSIONS

Organization

Throughout their history, the Science Service and its predecessors which now comprise the Research Branch, appear to have been organized on a functional basis. The original Experimental Farms Service was of necessity organized on an area basis. Throughout the numerous expansions in the Department of Agriculture and the Research Branch, the dominant organizational pattern has been functional.

The Research Board and its predecessors appear to have always been decentralized on an area basis. Decentralization is to be expected owing to the marked differences between the Atlantic, Pacific, and inland fisheries. Despite a dominant area form of organization, there has been a functional separation between the biological and technological sections in the regions, giving the impression of small isolated units acting more or less independently.

The critical factors in the organizational structure of the Branch were noted by the Glassco Commission when it recommended establishment of regional laboratories for conduct of agricultural research and for supervision of sub-stations.⁽¹⁶⁾ The Commission recognized fragmentation within the structure of the Research Board; fragmentation caused by separation of biological and technological

(16) Glassco Report, Vol. 4, p. 241.

stations under jurisdiction of the Board.⁽¹⁷⁾ The Commission did not include explicit recommendations for close combination of biological and technological units into combined regional units. There is, however, an implicit suggestion to this effect in the Commission's review of the Board's organizational structure.

Growth and Expenditure

Both the Research Branch and Research Board appear to be undergoing steady growth which appears to accompany all governmental activities. There are, however, differences in rates of growth of the two bodies. The Research Branch has grown, as measured by personnel on strength, from 980 in 1945 to about 3,400 in 1962, an increase to $3\frac{1}{2}$ times its size over a 17 year period. During the same period, value of agricultural production has increased from \$1,600 million to about \$3,500 million or $2\frac{1}{5}$ times.

Comparable growth in personnel within the Research Board between 1945 and 1962 has been $5\frac{1}{2}$ times while the landed value of fish products increased from \$63 million to \$127 million, an increase to twice its value. On this basis, the Board has grown more rapidly than the Branch, while the fishing industry which ultimately justifies fishery research, has lagged behind agriculture. The increase in lower value groundfish returns relative to total fish following the addition of the large Newfoundland

(17) Ibid., p. 243.

fisheries to the Canadian total may be a factor which causes a lag to appear.

Expenditures on headquarters administration are about 4 per cent of total expenditures in the Branch and Board. However, it is known that the calculation for the Branch is less accurate than for the Board owing to the difficulty of apportioning certain costs for the former.

Personnel

Over the few years which could with reasonable validity be used for comparison, there appears to be no appreciable difference in research personnel turnover between the Branch and Board. The higher turnover in the Branch may reflect re-organization and re-orientation of effort which has not stabilized since 1959. Despite a brief and sharp increase in personnel turnover within the Branch in 1962, both the Branch and Board show remarkable stability of personnel as compared with a research group in private industry. Unfortunately, it was not possible to find data for a private research group in fisheries or agriculture. Low personnel turnover in the Branch and Board may be due to the limited opportunity for a challenging career in agricultural or fisheries research elsewhere than in government. There is little doubt that government provides the opportunity

for independent research to a higher degree than industry does. Not all research scientists wish to achieve the freedom to conduct research which is available in educational institutions because of the burden of teaching which this entails. It is therefore logical to expect low turnover in governmental scientific personnel.

The continual improvement in qualifications of research personnel in the Branch and Board is worthy of note. Within the Branch, personnel with Doctorates has not increased; personnel with Masters and Bachelors degrees has dropped appreciably, leaving a much larger proportion with the higher qualifications. In the Board, the number of research personnel with Doctorates almost doubled between 1955 and 1962; number with Masters degrees increased about 25 per cent, and with Bachelors degrees about 10 per cent, resulting in a significant relative gain in personnel with higher degrees.

Salaries show a slight advantage in favour of Board personnel, reflecting the relative freedom it has to fix salaries to correspond with its recruitment needs. When one considers the greater degree of security under the Civil Service Act, one must conclude that the relation between salaries in the Branch and Board is satisfactory.

The practice of making term appointments which may or may not be renewed, as adopted by the National

Research Council has not been widely used in the Board although adequate authority exists for it. Term appointments are not normally made in the Branch. The device of term appointment ensures a constant stream of new personnel with new ideas for application to basic research and is a protection against obsolescence in personnel. Such a system must, however, be accompanied by a higher salary scale and more freedom as compensation for the disruption which will occur when the term ends. It is significant that the National Research Council strongly favours the system yet appears to attract highly talented scientists.

Communications and Programme Control

Communications in the Branch and Board are largely determined by the degree of centralization or decentralization in effect and by the size of the units involved. The greater degree of centralization in the control function within the Branch leads to a more rigid system of communication related to programme. Internal communication related to dissemination of information is difficult within the Branch owing to geographical dispersion of the numerous units. A variety of house organs have therefore evolved to meet the Branch's needs. The Board on the other hand, has adopted a regular system of internal reporting which closely corresponds to that which may be found in a private corporation. The regularity and

economy of this system has much to commend it and may well be considered for the Branch if regional laboratories are established as recommended by the Glassco Commission.

Programme control as implemented in the Branch leads to a concentration of decision making power at headquarters. Advice on proposals and assessment of results are also from headquarters. On the other hand, the Regional Advisory Committees of the Board are able to review and assess the problems peculiar to specific regions. Final Board decisions based upon this advice are made at headquarters. A weakness in the Advisory Committees is that the same groups initially approve programmes and later assess them.

Neither the Branch nor the Board has instituted assessment of its work by independent experts who have had no prior contact with the programmes. It appears desirable to introduce such reviews by independent experts, possibly drawn from the National Research Council, from the industry served, and from scientific institutions overseas, possibly in the Commonwealth.

Performance

Measurement of performance in research activities appears to be almost impossible. A person who is unfamiliar with the disciplines involved, can only use

some tangible measure of results, such as acceptable scientific reports and compare them to total expenditure or personnel employed, or some other factor. Publication per employee was used as an index of performance here.

Except for a recent sharp rise in publications per employee in the Branch since 1959, there is little difference in the index for the two bodies since 1951. In 1959 both the Branch and Board produced scientific publications representing original research to a ratio of 0.14 publications per employee. Since 1959 the ratio for the Board has remained relatively stable at a slightly lower ratio. The ratio for the Branch appears to have increased about 40 per cent between 1959 and 1962. Whether this high index value will be a permanent feature in the Branch can only be determined after the Branch has absorbed the effects of its re-organization and has continued its work under stable conditions for a period of years.

Other means of assessing the results of research effort in the Branch and Board were examined but no satisfactory objective method could be developed. For example, it is well known that development of rust-resistant strains of wheat within the Department of Agriculture has had an impact upon the Canadian economy. Other well known successes have produced superior hogs; have introduced crops that were normally considered unsuitable for Canadian conditions; have resulted in measures for control of insect pests.

Research within the Research Board has resulted in improved techniques for preserving fish, in new methods of processing to produce fish flour, fish oils and other products and in superior technology for catching fish. A wealth of data have been gathered to provide a scientific basis for fishery regulations which are designed to ensure maximum yields without depletion of the resource.

The conditions which would exist if no research were conducted cannot be simulated. We may or may not have a viable fishing industry unless the research upon which conservation regulations are based had been financed. We may or may not have had complete crop failures in our agricultural industry if disease resistant varieties of seed had not been developed. The days required between seeding of grain and its maturity, constantly shortened by research, has had an impact upon the northward spread of the agricultural industry.

There appears to be no certain way of accurately assessing the real returns for the effort expended on research in agriculture and fisheries.

Provided that management of the financial and other resources expended upon research is sound; that impartial review of performance is periodically made; that full accountability is adhered to; there appears to be no significant difference whether a departmental or independent type of body is selected to conduct research.

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