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ANALYZED



Two Blades of Grass:

The Challenge Facing Agriculture

ANALYZED

"And he gave it for his opinion, that whoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together."

Jonathan Swift in Gulliver's Travels. Voyage to Brobdingnag, Chapter 6.

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Erratum

Page 5, paragraph 1, lines 7-8: For "Report No. 11" read "Report No. 12".

October 1970.

The Right Hon. Pierre Elliott Trudeau, P.C., M.P., Prime Minister of Canada, House of Commons, Ottawa 4, Ontario.

Dear Mr. Prime Minister,

In accordance with sections eleven and thirteen of the Science Council Act, I take pleasure in forwarding to you the views and recommendations of the Council as they concern policies for the development of the agricultural sciences, in the form of a report entitled "Science Council Report No. 11–Two Blades of Grass: The Challenge Facing Agriculture".

You will note that the report does not contain any specific recommendations on the future scale of Canadian agricultural research effort. The Science Council is at present assessing the contributions which science can make to the development of all of Canada's natural resources, and it is hoped that there will emerge from this study a coherent set of recommendations covering the scale of research appropriate to each of the resource areas.

The Science Council has already published a background study on agricultural science in Canada. That report specifically discussed ways in which change in emphasis could be achieved within Canada's agricultural research program by reallocation of present resources. In the present circumstances of financial constraints, it seems obvious that most, if not all, of the recommendations in this report which concern reorganization and reorientation of effort will have to be implemented by such a process of reallocation.

Yours sincerely,

O. M. Solandt, Chairman, Science Council of Canada.

Precis

Canada's agricultural community has two overriding problems:

-the need to be competitive in the market place, at home and abroad;

-the need to lighten the load of poverty which is the lot of nearly a quarter of the nation's farmers.

To tackle these effectively, Canada must recognize that they are distinct and that agricultural policy will help in the first case, but it is social policy that is needed in the second.

Agricultural research aimed at improving the competitive position of Canadian farmers has traditionally dwelt upon the biological problems of production; in the future, it must be equally concerned with the effects of economic and marketing policies and with the distribution, transportation and processing of produce.

The Science Council proposes that a much-needed national view be superimposed on the planning and direction of the total agricultural research program; this could be effected by the creation of an Agricultural Research Co-ordinating Council, with broadly representative membership and a wide mandate to set objectives and to allocate priorities within the overall program.

Among the specific objectives of such a Council would be:

-improvement in the assessment of ongoing programs;

-improvement in setting of priorities;

-improvement in the degree of collaboration among government, university and industrial research organizations;

-improvement of the linkage between research and extension services;

-stimulation of research in university and industrial settings, including where necessary the reallocation of the existing resources provided to agricultural research.

Table of Contents

Introduction	11
Canadian Agriculture	13
Economic concerns	14
Environmental concerns	15
Social concerns	16
Goals for Agriculture	19
Economic goals	20
Environmental goals	20
Social goals	20

Agricultural Policy and Science	21	
Domestic outlook for Canadian farm products	22	
Canadian agriculture in world trade	23	
The need to be competitive	24	
Obstacles and opportunities	25	
Agricultural policy and science	26	

Agricultural Research in Canada: Some Questions, Concerns and Proposals	
Why do agricultural research in Canada?	30
What constraints are imposed on agricultural research?	30
What are the facts about today's situation?	30
What conclusions can be drawn from today's situation?	33
What would be a better state of affairs?	34
How would today's arrangements be affected ?	35
How to bring about change	38
International Trade and Aid	39

International trade	40
Food aid	41
International aid	41
Epilogue	43

Appendices	45
Publications of the Science Council of Canada	60

Introduction

In its four years of operation, the Science Council of Canada has focused its attention on many aspects of mission-oriented research and on the application of science to the solution of economic and social problems. During this period the Council has become increasingly aware of the interaction of science with public policy, and of the responsibility which scientists must bear for the health of the activity which their research is designed to support. In no field examined by the Council to date have these two problems been more acute than in the case of agricultural research and development (R & D).

In 1966, the Science Secretariat established a study group to investigate the state of Canadian agricultural R & D. Given the state of knowledge of matters of science policy at that time, it seems inevitable in retrospect that the terms-ofreference given to that study group would limit its view of the problems of Canadian agricultural R & D. The report by the study group, now published as Special Study No. 10, "Agricultural Science in Canada" by B.N. Smallman et al., provides many useful statistics on Canadian agricultural R & D per se. The numerous recommendations made were considered in developing the subsequent chapters of this report.

Public policy on agriculture was recognized as a major area for study when in 1967, on the recommendation of the Minister of Agriculture, the Cabinet agreed to the establishment of a Task Force on Agriculture. The Task Force was requested to make comprehensive assessment of agricultural goals and policies, and to make recommendations concerning the agricultural policies required to achieve long range national and agricultural goals, taking into account the interests of farmers and consumers. The very comprehensive report of the Task Force, "Canadian Agriculture in the Seventies", was published early in 1970. Its numerous recommendations, dealing primarily with government organization and policies as

they relate to subsidies, tariffs, and marketing in the interest of attaining national goals, have also been considered in this report.

The two reports (the Study Group Report and the Task Force Report) have provided information for an evaluation of the interaction of science and public policy. The problems emanating from this interaction, and many others, stand as a challenge to Canadian agricultural research and to the scientists engaged in it. It is the hope of Science Council that this report will illuminate some of the ways in which this challenge can be met.

Canadian
Agriculture

Economic Concerns

The Task Force described Canadian agriculture as a large, complex industry which included far more components than just the farmer. Under their definition, the total agricultural system includes the following mutually dependent parts:

"Manufacturers, distributors, and sellers of farm and agribusiness input products and services; farms, farmers, and farm labour; farm product marketing boards and sales agencies; farm product transporters, handlers and storage agents; food product distributors, wholesalers, and retailers; other food outlets such as institutions, hotels, restaurants; consumers; governments; research and educational institutions and the many organizations representing farmers, agribusiness, researchers and others involved in agriculture." (See page 4, Task Force Report)

The primary objectives or functions of this system "which weaves in and out of the entire economy is to process, manage, regulate and study the flow of resources from farm inputs to the final consumer. The central purposes are to satisfy the food wants of consumer and to provide adequate income and security for all who own and/or work in these organizations."

While in general agreement with the Task Force on both the definition and the function of Canadian agriculture, the Science Council must emphasize that, rather than being one complex industry of mutually dependent parts, agriculture is a complex of many independent and often competing industries. The problems of any one industry often have little or no bearing on the problems of another, and the necessary research or technological information required must emanate from vastly different kinds of scientific research programs. Often the only common linkage, even at the farm level, is a dependence on the use of soil: the problems of the apple producer in

B.C. have little in common with those of the wheat farmer on the Prairies, of the dairy farmer in Quebec, or of the sugar refiner in the Atlantic Provinces. The diversity and extent of agricultural operations in Canada are shown on the map appended to this report.

Having defined agriculture and outlined its primary objectives, we should assess its relative importance in the Canadian economy. Agriculture is considered by many to be in a state of crisis and to be a relatively declining industry, and considerable evidence has been published to that effect for the farm sector. In the twenty year period from 1948 to 1968, the following changes have taken place: farm population has declined from 2.9 million to 1.7 million; farm employment has declined at an average annual rate of 3.5 per cent; net income from farm operations has remained relatively constant, at approximately \$1.7 billion; the farm sector of the Gross Domestic Product has declined from 12 to 4 per cent. If farm suppliers and processors and distributors of foods and fibres are included, a much larger proportion of the Gross Domestic Product is accounted for, but even this larger proportion has been declining during the past two decades.

Despite the foregoing, there can be no doubt that agricultural output is expanding. The volume of agricultural production has grown at an annual rate of almost 3 per cent compounded over the past two decades (in index number terms, from 101 in 1947 to 173 in 1968). This expanded production was achieved in the face of considerably reduced employment by a substantial increase in capital investment (in farm machinery in particular). Gross capital stock in agriculture increased at an annual rate of close to 4 per cent over this period. The total agricultural land area (about 174 million acres) has remained fairly stable for the last twenty-five years. Cash receipts from farming have also increased substantially -for example, they increased from \$2.4 billion in 1948 to \$4.4 billion in 1967

and 1968.

To provide a realistic concept of the size and scope of Canadian agriculture, the Task Force summarized the key indicators of the dimensions as follows:

"Production sector: includes an occupied farm land area of 174 million acres; a farm population of around 2 million; approximately 400 000 farms, 500 000 farm workers. In 1968 farmers paid about \$185 million in taxes on land and buildings.

"Supply sector: in 1968 farmers spent around \$425 million on farm machinery, \$212 million on fertilizers, \$55 million on pesticides, \$568 million on feed and \$245 million on new construction. Many other millions of dollars were spent on electricity, telephones, gasoline, banking services, etc.

"Marketing and Processing sector: firms processing farm products only into basic foods and feed had sales of \$4 800 million and paid \$665 million in salaries and wages to 146 000 employees in 1966. This does not include wineries, breweries, distilleries, tobacco manufacturers nor the retailers and traders in processed products.

"Food Consumers: in 1968 about 21 million consumers spent \$8 500 million on food and another \$2 500 million on tobacco and alcoholic beverages. "Government: The Canada Department of Agriculture employs more than 12 000 persons, full-time; operates more than 200 separate establishments; provincial departments of agriculture employ in excess of 30 000 persons with a combined budget in excess of \$200 million. "The figures speak for themselves in indicating that it is almost impossible to over-emphasize the economic and social importance of agriculture to all Canadians." (See pages 4 and 5, Task Force Report)

The Science Council is in agreement with this assessment by the Task Force. Canadians have benefited from increased efficiency in agriculture. In 1968 Canadians spent 21 per cent of their personal incomes on food compared with 25 per cent during the period 1945-49. The retail value of food produced in Canada was \$6.2 billion in 1968, and this is expected to rise to \$11.3 billion (in constant dollars) by 1980.

One indication of the breadth of agriculture is the number of export commodities which it produces. The Task Force report indicated that more than 200 export commodity items were identified by the Dominion Bureau of Statistics (DBS), and in 1967-68 the value was \$1.33 billion U.S. (Their list excluded whiskey, breakfast cereals, pickles, soups and other products which should have been considered.) Using a broader definition of agriculture, the number of agricultural export commodity items would be considerably higher.

Environmental Concerns

Since cultivated plants and domestic animals form an important living part of the ecosystem, along with other renewable resources, their role in determining the quality of our environment is of some significance. The preparation of the land for agricultural production required the removal of the natural vegetation over large areas, which often produced marked environmental changes such as soil erosion, inadequate windbreaks, and the loss of natural habitat for wildlife, some of which had valuable economic functions (e.g. pollinating insects for cross fertilized plant species). Natural water reservoirs are often destroyed, with resultant deterioration of the environment. The accumulation of plant nutrients in our aquatic environment from fertilizers and sewage may cause rapid eutrophication of our fresh water lakes. The use of fungicides, herbicides and insecticides may also increase the toxic levels of our fresh water resources. Agriculture therefore is very intimately involved in environmental quality management, and the objective of ensuring a safe and esthetically pleasant

environment should have a high priority.

Agriculture must also be concerned with optimal land utilization. Canada devotes approximately 174 million acres or 4.3% of her total surface to commercial agriculture, compared with the total world use of about 3.5 billion acres or 9.3% of total land surface. Hence Canada controls about 5% of the world's agricultural land. Canada could increase her acreage in agricultural production by the end of the century by a further 20-30 million acres principally by expanding the use of fringe areas in the Peace River District and elsewhere. Any attempt to bring about such an increase will pose many major problems. First, the climatic conditions are severe, the frost-free period very short, and the range of choice of crops narrow. Second, the soil is less fertile than land now in agricultural use and would require heavier expenditures on fertilizers than is the case elsewhere. Third, Canada's transportation system is not currently designed to serve the fringe areas. It is therefore in Canada's best interest to carefully husband the land resources already devoted to agriculture, rather than making an immediate move to using less attractive land. As the world's population expands, more food will be needed; Canada should seek to contribute to the expansion of output, more through the improved application of technology to prime land than through attempts to cultivate her virgin fringe areas.

The necessity of conserving good agricultural land for food production was stressed at the Resources for Tomorrow Conference.* The combination of an increasing population and an increasing urbanization of the population has resulted, and continues to result in, a loss to agriculture of some of its most productive land. In the metropolitan areas of London, Winnipeg, Toronto-Hamilton, and Montreal, there was in the five-year period from 1951-56 an average loss of 382 acres of farm land for each 1 000 increase in population. During this same period there was a loss of 1 000 acres of farmland for each 1 000 increase in population in the metropolitan areas of Ottawa and Quebec. We have no reason to believe that the losses of agricultural land to urbanization are any less serious today than they were two decades ago. This rape of our soil resources will cease only if governments take action as we suggest governments must-no single private developer can afford unilaterally to move off prime land while his competitors remain.

The pressures for and problems of multiple use of our land resources are increasing, and are of concern to all of Canada's resource industries. This topic is being developed further by the Science Council.

Social Concerns

Agriculture along with the other renewable resources are the most important enterprises in vast areas of low population density in Canada. In addition to supplying food locally for those living in these developing areas, agriculture also provides important opportunities for employment. Thus, it serves as a major developing and unifying force within the nation's structure.

It is a documented fact that there is a substantial number of people, usually considered to be a part of the agricultural industry, who for a number of reasons operate farms which are not commercially viable. Their annual income is usually low and it is unlikely that improvement could be brought about by changes in their agricultural operation.

It is imperative that this group of nonviable "farmers" should be considered as being separate from the people involved in commercial agriculture, and their problems isolated, diagnosed and treated accordingly. As indicated in the Task Force Report, there are really two components to the non-viable group of farmers, the larger component being older farmers. The Science Council is in agreement with the Task Force that this group should not be moved out of agriculture completely;

^{*} Resources for Tomorrow, Supplementary Volume. Queen's Printer, Ottawa 1962.

rather they should be helped to develop other skills which could become a source of supplementary income. Moving these people off the farm would only exaggerate their difficulties and transfer the problem from a rural area to the urban environment, where there are already serious social problems. For most of the younger but smaller group of non-viable farmers, it would be in their best interest to be retrained and redeployed, but this would be predicated on job availability and on the assumption that they could indeed be absorbed by industry.

Nevertheless, one of Canada's serious problems is the mal-distribution of population and industry throughout the country. Although it may be considered more efficient to concentrate industry in few locales in Canada, we are perhaps paying too high a price for that efficiency in terms of crowding, environmental deterioration and the impeding of the development of all of Canada.

An earnest attempt could be made, in terms of incentives, to redistribute certain industries which could operate relatively efficiently in rural settings, and thereby redistribute populations to carefully chosen locations in underpopulated areas. This would provide a means whereby the non-viable "farmer" in the younger sector could more readily adjust and obtain employment, and whereby the older nonviable "farmer" could supplement his meager income and increase his "agricultural" income by virtue of the need to supply food to an increased population in the immediate vicinity of his small farm.

Goals for
Agriculture
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In its Reports No. 4 and No. 9*, the Science Council identified a series of goals which appeared to contain the main aspirations of most Canadians. Within the framework of these goals, the agricultural goals emerge under three broad categories:

- 1. Economic
- 2. Environmental
- 3. Social

Economic Goals

The major goals of a national economic policy for Canada were listed by the Economic Council of Canada in its First Annual Review, "Economic Goals for Canada to 1970", as:

- 1. full employment
- 2. a high rate of economic growth
- 3. reasonable stability of prices
- 4. a viable balance of payments

5. an equitable distribution of rising incomes

These goals, which are all part of the general aim for national prosperity, apply equally to individual industries be they agriculture, forestry, steel or chemical.

In the pursuit of these goals, the main agricultural thrust and aim should be towards:

a) an economic and stable domestic food supply;

b) a maximum competitive position in international markets, consistent with the income and welfare of all stake-holders involved in the agricultural industry.

A productive and prosperous agricultural industry contributes directly to the achievement of the major economic and social goals of the nation. Conversely, the welfare of the agricultural industry depends heavily on the degree to which other industries and sections of the economy contribute to the attainment of these national goals. The Science Council has proposed, in its Report No. 9, that Canada recognize the maintenance of the quality of man's environment as an explicit national goal.

As a major user of land and water, and as a major user of a wide variety of chemicals (herbicides, fungicides, insecticides, fertilizers, etc.) Canadian agriculture has as an important responsibility and goal the maintenance and the improvement of the quality of the natural environment. A high rate of economic growth may not be as highly desirable if the land, air and water components of the environment suffer deterioration in the process.

Social Goals

The provision of social justice in Canada has been identified by the federal government as one of its priority objectives.

The Task Force identified in agriculture "a bottom stratum of about 100 000 (farm families) who live in poverty". For this group in particular the goal should be to improve the conditions of rural life and to remove threats to both physical and mental well-being. There must be improved policies and programs for those persons who have no opportunity of becoming efficient and viable commercial producers. But, as stressed in the previous chapter, this is a problem separate from those facing the commercially viable producers or facing those capable of becoming viable.

^{*} Science Council of Canada, Report No. 4. Towards a national science policy for Canada. October 1968. Information Canada, Ottawa.

Science Council of Canada, Report No. 9. This land is their land. October, 1970. Information Canada, Ottawa.

Agricultural
Policy
and Science

There can be no doubt that at present Canadian agriculture faces many difficult problems. The lagging export sales and the growing inventory of wheat during recent years have had an adverse effect on the prairie economy. There appears to be no easy solution for the underlying problems of the dairy industry in Eastern Canada. The growing cost-price squeeze is of serious concern to most commercial farmers. Chronic poverty and social dislocation in many rural communities in Canada can no longer be ignored. Perhaps the most insidious problem of all is the growing lack of confidence which many farm people are beginning to show in their industry.

These are serious problems, and substantial public effort is being made to resolve the difficulties. There is however a real danger that this preoccupation with the immediate problems will blind us to the longer-run opportunities available to Canadian agriculture.

The opportunities may be seen in the potential growth of markets for Canadian agricultural products. Another six million food consumers will have been added to the Canadian population by the end of the present decade. This growing consumer population, together with an estimated 50 per cent increase in disposable income, will increase substantially the market for farm products.

However, the domestic market for Canadian farm products is only a part of the picture. Canadian agriculture faces a growing international market as well, and it is in this area that the greatest potential exists. During the next decade world population will have increased by 700 million persons, all potential customers for food products. There is no guarantee that Canadian farmers will share in this expanded world demand, but failure to take advantage of these opportunities would be damaging indeed to the future welfare of Canadian agriculture.

Domestic Outlook for Canadian Farm Products

The largest part of the total demand for Canadian farm products is the domestic market. It is estimated that the total expenditure on food by Canadian consumers will rise from \$6.2 billion in 1964-66 to approximately \$11.3 billion (constant dollars) by 1980. Nearly 40 per cent of this projected increase will be due to the expected increase in population; the remainder will be attributable to the change in mix and the consequent higher value of food products consumed per capita at the retail level.

The largest increase in domestic consumption of Canadian farm products will occur for meats, poultry, oils and fats, fruits and vegetables (see Table 1). For example, for the period 1964-66 to 1980, it is estimated that beef consumption will increase by 64 per cent; oils, fats and vegetables by 55 per cent; cheese by 109 per cent; pork by 33 per cent and poultry by 75 per cent. Food consumption increases of this magnitude cannot but have a stimulating effect on the Canadian agricultural economy.

The Science Council is aware that these projections are concerned with conventional agricultural products. Agriculture as a whole, and the organizations recommended later in this report in particular. must have a continuing awareness of the potential development of unconventional synthetic foods, of their possible effects on the agricultural economy and of the need for "defensive" research in this area to ensure that the Canadian producer is not caught unaware of developments which could pose a threat to his traditional markets. It is often overlooked that many synthetic foods themselves are based on agricultural products, such as soya beans; perhaps the main threat which they pose is of much heightened competition among various components that go to make up Canada's complex agricultural industry.

Table 1-Total Food Consumption Outlook for Canada, 1964-66 to 1980

Commodity	Unit of Measurement	Average (millions of pounds)		1980 as % of 1964-66
		1964-66	1980	
Cereals	Retail Weight	3 006	3 543	117.9
Sugars & Syrups	Retail Weight	2 189	2 905	132.7
Pulses & Nuts	Retail Weight	200	234	
Oils & Fats	Retail Weight	639	990	155.0
Fruits	Fresh Equivalent	3 606	5 1 1 0	144.4
Vegetables	Fresh Equivalent	3 358	5 210	155.1
Potatoes	Fresh Equivalent	3 063	3 829	125.0
Dairy Products	Retail Weight	7 557	8 855	115.8
Meats	Carcass Weight	2 934	4 382	149.3
Poultry	Eviscerated Weight	729	1 276	175.0
Eggs	Fresh Equivalent	623	748	120.1
Total		27 904	37 181	133.2

Source: Demand-Supply Projections for Canadian Agriculture–1980, Report prepared for the Federal Task Force on Agriculture by the Economics Branch, Canada Department of Agriculture, Ottawa.

Canadian Agriculture in World Trade

On a per capita basis, Canada ranks as the third largest agricultural trading nation in the world, exporting almost three times as much per capita as the United States. Canadian agriculture has a vital stake in the growing world demand for food, a fact that has been largely overlooked in the assessment of the future prospects for the industry; worse still, frequently ignored in the formulation of many domestic policies for agriculture.

An examination of several major farm commodities will illustrate both the problems to be tackled and the opportunities to be exploited through appropriate policies for agriculture.

Wheat is by far the most important Canadian agricultural export. Beyond the 160 million bushels of wheat used annually in Canada for human consumption and livestock feed and seed, the remainder of the crop must be sold in export markets. During the past quarter century, Canada has had some spectacular ups and downs in its export sales of wheat. In spite of recent difficulties, however, the slow upward trend in world wheat trade should not be ignored (Table 2). In fact, world wheat trade has more than doubled during the past 25 years. During the same period of time Canada's wheat exports have increased, but not as rapidly as the world volume of trade. During the period 1950-54 Canada shared nearly 31 per cent of the world trade in wheat, compared with only 21.6 per cent during the period 1965-68.

The picture was even more disturbing for Canada's coarse grains export trade. During the period 1956-67 world exports of coarse grains more than doubled, while

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Period	Carryover (Canada)	Canada– Shipments of Wheat and Flour	World Shipment of Wheat and Flour	Canada's Shipment as % of World Shipment
	m	illion bushels		
1945-49	80	252	878	28.7
1950-54	389	300	968	30.9
1955-59	630	286	1 249	22.9
1960-64	492	405	1 776	22.8
1965-68	629	434	2 007	21.6
Source: Grain Tra	ade Year Book, 1968-69. Wini	nipeg Grain Exchange.		

Canadian exports of coarse grains actually declined. In fact, Canada's share of world export trade in coarse grains declined from 8.2 per cent to 2.9 per cent during the evelen-year period. The implications of this trend are obvious for Canadian agriculture.*

One of the brighter aspects of Canada's agricultural trade during recent years relates to the rapeseed industry. Not only has world trade in rapeseed increased, but Canadian exports of this crop have increased very significantly during ecent years. It should be noted, however, that even with rapeseed, Canada's export trade has not increased as rapidly as the world trend.

The Task Force projected a large increase in demand for red meats, a significant proportion of which will occur in North America, primarily in the United States. There appears to be a real market potential in the United States for Canadian feeder cattle. The Task Force has estimated that Canada should be able to export 500 000 head of feeder cattle annually to the United States without any significant disruption of the market. Of all the cattle on feed in the United States, only about 4 per cent are imported. (Roughly 3% are from Mexico, 1% from Canada.)

Several general conclusions may be drawn from the above examinations of selected agricultural commodities in Canada:

1. While there is considerable year-toyear variation in the export trade of most agricultural commodities, there appears to be a general upward trend in the volume of export trade in the world.

2. While Canada's export trade in many of the major agricultural commodities has increased, it has not kept pace with the growth in the world volume of trade for the corresponding agricultural products. Expressed more bluntly, Canada's share of the world agricultural trade has tended to decline. 3. As a proportion of world trade in agricultural produce, Canada's exports, with the exception of wheat, are relatively small. This suggests that substantial increases could occur in the export trade of Canada's agricultural commodities without causing a significant disruptive effect on the world trading pattern.

4. As a proportion of total agricultural production in Canada, exports rank high and are significant to the Canadian economy while often being small in terms of total world production. For example, a doubling of barley exports from Canada would not represent a large increase in terms of world trade in feed grains, but the consequence for Canadian farmers would be significant indeed.

The Need to be Competitive

It is far from clear why Canadian agriculture has not been able to maintain its share of the world trade for many agricultural commodities. What seems beyond dispute, however, is this:

1. World trade is increasing for most farm products;

2. the potential benefits to Canadian agriculture of a greater share of this world trade could be enormous;

3. the continuing need for competitive efficiency in the export markets of the world cannot be over-emphasized.

There are many obstacles to be overcome in expanding the markets for Canadian agricultural commodities. Traditional importing countries have increased the barriers to trade and have instituted heavily subsidized domestic policies for their own agricultural producers. Nations competing with Canada for world agricultural markets have resorted to subsidized export prices, long-term credit and other similar devices in the attempt to gain a larger share of the world trade in agricultural products.

If these policies are continued, there is little doubt that Canada will have to respond with similar policies and programs. In the final analysis, however, competitive efficiency represents the only

^{*} It is gratifying to note a very significant increase in wheat and barley exports for the crop year 1969-70.

durable foundation on which to build a long-term viable policy for Canadian agriculture. Competitive efficiency applies not only to farmers but to the whole system involved in the production, processing, transportation, marketing and exporting of agricultural commodities.

In the past, agricultural policies have been aimed primarily at increasing the productivity of primary producers. Canadian farmers as a whole have had a remarkable performance, insofar as their productivity has been concerned. This thrust must be continued.

The conventional analysis of labour productivity trends in Canadian agriculture and manufacturing are indicated in Table 3, which suggests that net output per man in agriculture for the period 1946-1964 increased at an annual rate of 5 per cent, compared to 2.6 per cent for the manufacturing sector of the economy. (One may question the degree of accuracy attainable in such an analysis, however, since the varying contributions from a variety of sources of input are not considered. For example, increasing mechanization has led to a reduction in the absolute numbers of the farm labour force and to a consequent apparent increase in the labour productivity on the farm, but this ignores factors such as the labour involved in producing the machinery and fuel used.)

Table 3- Trends in Real Gross Domestic ProductPer Man Employed in Canadian Agriculture andManufacturing, 1935 to 1964PeriodAgricultureManufacturing

1025 20	01	02
1933-39	01	0
1940-44	114	94
1945-49	98	96
1950-54	146	109
1955-59	184	127
1960-64	218	145
Growth Rates	per cent	
1935-64	4.3	2.2
1946-64	5.0	2.6

The two-blades-of-grass philosophy which has dominated agricultural research and extension programs in Canada for the last 50 years, and which has permitted farmers to make remarkable progress in their production performance, must continue to be an integral part of agricultural policy for the future. However, the competitive efficiency of farmers must be matched with an equally effective performance in all other sectors of the agricultural industry. It makes no sense for farmers to grow two blades where one grew before if the processing, marketing, transportation and pricing sectors of Canadian agriculture are designed to handle only one blade. Competitive efficiency must characterize all aspects of the agricultural industry.

Obstacles and Opportunities

The Task Force Report notes that several policy roadblocks and obstacles will have to be removed if the income of farmers and the general performance of the Canadian agricultural industry are to be enhanced. In the grain industry, for example, it appears that the major problems have been associated with pricing, marketing, transportation and trade policies, and not primarily with the productive performance of the farmer. This is not to suggest that farmers have reached the ultimate in productive efficiency. Rather, there appear to be many policy bottlenecks which will have to be eliminated if the productive potential of the Canadian farmer is to be fully exploited. The Task Force noted that policies such as the Temporary Wheat Reserves Act, the Prairie Grain Advance Payments Act, the Wheat Board grain delivery quota system and the pricing practices followed have tended to force the grain industry into a surplus management function, rather than to develop an aggressive sales and market promotion program. In general, much of Canadian agricultural policy appears to be defensive rather than aggressive in nature.

There are encouraging signs, however, that steps are being taken to modify or eliminate some of the policies which have prevented farmers from taking full advantage of the opportunities available to them. Referring again to the grain industry, several major policy changes have been made recently which appear to have had a beneficial effect on expanding sales of grain. In March 1969, the Government of Canada approved a program to expand long-term credit facilities for Canadian wheat and flour exports, particularly to developing countries. The more flexible pricing policy for barley has resulted in a very substantial increase in barley exports during the crop year 1969-70. There have been substantial changes made in the delivery quota policy for grains. Significant changes have been made in the grain storage and transportation policies, and there are indications that further major changes will be made in the near future.

The revolution in the baking industry which created the demand for high protein hard wheats of maximum protein uniformity has serious implications for Canada's wheat grading system. It is urgent that a protein system of grading for wheat be established as soon as possible if Canada is not to lose more of her share of the traditional wheat export markets of the world.

Considerable progress is being made in tackling the fundamental problems of the Canadian agricultural industry. Many serious and difficult problems remain, however, and substantial research and background studies will be required before appropriate policies and programs can be developed. There is a clear need at this time for a much closer integration between the policy needs of Canadian agriculture and the objectives of agricultural research and development.

Agricultural Policy and Science

One of the important areas of concern in the development of a national policy for Canadian agriculture relates to the role and objectives of agricultural research and development. Some of the more general objectives of research as they relate to the development of a sound agricultural industry in Canada may be noted.

The Task Force recommended that the two-blades-of-grass philosophy, which has had a profound influence on agricultural research in Canada, must be continued. Competitive access to the export markets of the world will be determined to a large degree by the progress made in agricultural research and development in Canada. If the productive efforts of Canadian farmers are not backed up by an aggressive and highly imaginative program of research in the physical and biological sciences, it is certain that our farmers will find it increasingly difficult to compete in international markets.

However, many of the benefits associated with production research will not be realized unless a very substantial increase takes place in the resources devoted to research as it relates to the complex economic problems of the Canadian agricultural industry. A greatly expanded research effort is required in areas such as farm management, marketing, pricing, transportation and international trade. Higher yielding grains and livestock lose their significance if inadequate pricing or marketing policies prevent the Canadian farmer from competing in international markets. The Science Council concurs in this assessment.

Another area which requires more research involves the general sociological aspects of the rural community. The technological advances in Canadian agriculture have had a profound impact on rural institutions and on the lives and livelihood of rural people.

Canada does not appear to have adequate policies to deal with the rapidly changing social structure of the rural community or with the people stranded in agriculture by technological change. Given the importance of the problems to be tackled, it is remarkable that so few sociologists in Canada are directing their research efforts towards the rural community. The Task Force and the Smallman Committee reports both stress the lack of research effort in this area. The recommendations of both groups to increase research in this area are in keeping with the goals for Agriculture outlined in this report.

Agricultural research administrators in Canada face difficult problems in determining the proper deployment of research resources. Continuous evaluation of agricultural research must be made if the funds made available are to be spent in areas which promise to yield the greatest benefits to the agricultural industry. The Task Force posed the following questions:

-Are the objectives of Agricultural research in Canada clearly defined ?

-Are the current priorities relating to allocation of research funds fully justified ?

-What criteria should be used in setting these priorities ?

-Is there a proper balance among the various disciplinary components of the overall research system ?

-Is there sufficient integration among the various research disciplines ?

-Are the research institutions responsive to the changing needs of the agricultural industry?

Later in this report, the Science Council recommends the establishment of an "Agricultural Research Co-ordinating Council". Part of the overall responsibility of this Co-ordinating Council would be to determine the priorities, the action programs and the policies required to resolve the questions posed by the Task Force.

Agricultural
Research
in Canada:
Some Questions,
Concerns
and Proposals

Why do agricultural research in Canada?

Canada supports agricultural research for three main and interdependent reasons:

-to improve the efficiency of production and distribution of food and fibre in Canada so that Canadians will be well fed at minimum real cost, and so that the country's agricultural products will enjoy a clear competitive advantage in world markets;

-to add to the sum total of knowledge and understanding of the elements of the Canadian agricultural scene, these elements including: soils and soil nutrients; plants, animals, and the environment and climate in which they grow; pests, disease organisms and weeds; the economic, social and political environment; and

-to provide a coupling device to the sources of advance in agricultural science and technology abroad.

What constraints are imposed on agricultural research?

To use the jargon of today, agricultural research should be mission-oriented; it should seek to provide knowledge which is relevant to the needs, felt or perceived, of Canada's agriculture.

To be "relevant", the research program will be constrained by the facts of agricultural life, i.e.:

-by the plants, animals, soil conditions, pests and climatic conditions which are met by Canada's farmers;

-by the demands of the processing, transportation, distribution and marketing systems which take farm produce from the farmer to the consumer, in Canada or elsewhere;

-by the realities of today's economic system, with production divided among 400 000 farm units, and of today's divisions of constitutional responsibility for agriculture between the federal and provincial levels of government;

-by the availability of trained manpower, and the state of advancement of the many scientific disciplines which contribute to the agricultural research program;

-by the competitive nature of world trade; and

-by the existence of poverty on one quarter of the nation's farms.

The spectrum of activities which has been established through the years to cope with these factors extends from the most erudite scientific research through developmental and testing activities to the fields of education, extension and distribution. However, as recent studies have indicated, the balance of the overall research program is heavily weighted towards the scientifically interesting production problems of the commercial farmer, while the complex and intransigent problems associated with rural poverty have suffered neglect. Economic and marketing problems, similarly, have received only marginal attention at the research level.

What are the facts about today's situation?

In Canada, agricultural research is conducted

-by the Canada Department of Agriculture (CDA) in over 60 different units, variously described as research institutes, regional research stations, sub-stations, experimental farms and research services, spread across the length and breadth of the land.* (Appendix A provides some information on the geographical distribution, relative sizes and research interests of these establishments.);

-by universities, in seven faculties of agriculture and three colleges of veterinary science;

-by the provincial government departments and agencies, the largest being in Ontario and Quebec; and

-by a small number of industrial enterprises, principally in the meat packing

^{*} The complexity of the CDA organization and program is described at length in a brief prepared by the department for the Special Committee of the Senate of Canada on Science Policy. (See Proceedings, Vol. 10, Nov. 21, 1968)

business.

There is not available a single set of comprehensive statistics, maintained consistently over a set of years, which would allow adequate assessment of trends. What is available is a fairly comprehensive collection of data for fiscal 1967-68, prepared by Smallman and his Study Group and supplemented by the CDA Brief to the Senate Committee on Science Policy, together with fragmentary information on other years from other sources.

From analysis of the statistical picture, it appeared to the Science Council that it should be concerned with the balance of the overall program, on the one hand among the various broad disciplinary groups, and on the other among the various sectors of the economy. It was felt that a system in seemingly appropriate balance would indicate the existence of good co-ordination, while conversely, major imbalances would indicate the existence of problems.

It should be noted that the Council has abandoned as meaningless in this case any attempt to describe a distribution of effort among "basic research", "applied research" and "development", since no useful data exists.

Smallman has reported that the division of man-years of professional effort in 1967-68 across the total agricultural science program (which included activities which he defined as "research", "development" and "service") in Canada was as shown in Table 4.

Smallman also provides information on the distribution, by disciplines within sectors of performance, of expenditures on R & D-i.e. exclusive of expenditures on "Service". (See Table 5.)

A major feature shown by this simple analysis is the marked concentration on the natural sciences, and the almost vanishingly small amounts allocated to sociology. It is the opinion of the Science

Table 4-Allocation of Time of Professional Staff, All Disciplines, by Sector of Performance and Category of Activity (Man-Years)

Sector	Activity					
	Research	Development	Service	Total		
Federal	935	175	154	1 264		
Provincial	132	62	108	302		
University	469	55	105	629		
Industry	51	87	17	155		
Total	1 587	379	384	2 350		

	Natural Sciences \$'000	Engineering \$'000	Economics \$'000	Sociology \$'000	Total \$'000	Total, as a % Distri- bution
Federal	35 074	962	3 466	114	39 616	53.0
Provincial	5 021	943	1 937	0	7 901	10.6
Industry	2 509	2 282	673	0	5 464	7.3
University	18 993	1 061	1 010	623	21 687	29.0
Total	61 597	5 248	7 086	737	74 668	
Total, as a % distri- bution	82.5	7.0	9.5	1.0		

lable	5–Total	Expenditures on A	Agricultural R	& D by	7 Disciplin	es within	Sectors	of Performanc	e

Source: Science Council of Canada. Special Study No. 10, Agricultural science in Canada, Tables 1, 2, 3, page 38. Of the \$21 687 000 devoted to agricultural research in the universities, \$7 872 000 was provided as direct grants for the support of research from all sources (viz. federal, provincial, industrial, foreign, others). The remaining \$13 815 000 is Smallman's estimate of the indirect support provided by the universities in the form of salaries for investigators and supporting services. Of the \$7 872 000 in direct grants, \$5 700 000 was spent by faculties of agriculture and colleges of veterinary science, the remaining \$2 166 000 being spent in other faculties for research described by Smallman'as "agricultural".

Council that the problems facing the commercial farmer are squarely the responsibility of the agricultural research organizations discussed in this document; the problems of rural poverty and of the non-viable farmer should be tackled by agricultural agencies at the government level in concert with the other sociallyoriented departments of government. It seems obvious that better collaboration in this important area should lead to greater levels of interest in these acutely human problems.

Two sets of data are available to indicate the gross trends in spending by the CDA. The department's brief to the Senate Committee on Science Policy provides a resumé of expenditures in the period 1962-69. (See Table 6)

It is noted that CDA's evaluation of its own expenditures on R & D in 1967-68 is significantly higher than those reported to Smallman.

The Dominion Bureau of Statistics, in reporting on Federal Government Expenditures on Science (1963-71)* provides the data on CDA expenditures shown in Table 7.

The DBS attributes the apparently large discrepancy between their data and that of CDA for 1967-69 to a revised procedure for the allocation of indirect costs; the bureau also indicates "current expenditures" on agricultural "science" by NRC as follows:

1968-69	1 256 000
1969-70	1 308 000
1970-71	1 368 000

Given the internal conflicts demonstrated in this collection of statistics, only the most global trends can be deduced with any certainty. It seems reasonable however to state that:

1. growth of the CDA in-house research program has been slowed down and stopped by the federal program of austerity;

2. NRC provides about twice as much direct support of university agricultural research as does the CDA;

* Dominion Bureau of Statistics. Catalogue No. 6602-512, Advance Statements 1, 2 and 3.

Fiscal Year	Intramural R & D	Scientific Information	Support of R & D in Universities	Other* Support of R & D	Total
1962-63	28 982 234	703 012	147 037		29 832 283
1963-64	30 232 530	709 047	124 862	85 000	31 151 439
1964-65	30 897 261	829 132	144 645	47 500	31 918 538
1965-66	35 116 289	916 554	145 000	20 000	36 197 843
1966-67	38 002 256	1 127 671	443 766	9 668	39 583 361
1967-68	42 499 354	1 430 384	624 750	28 000	44 582 488
Source: Canad *The "Other S	lian Department of Support" is an annu	Agriculture. Brief to ual grant to the Agric	the Senate Committe ultural Economics R	e on Science Police (esearch Council)	cy, Table 2.6a. CDA does not

Table 6-Total Spending on Scientific Activities by Functions

Table 7-Total Expenditures on R & D by the Canadian Department of Agriculture

Fiscal Year	Intramural	Extramural	Total
	\$'000	\$'000	\$'000
1967-68	50 900	600	51 500
1968-69	56 410*	796	57 206*
1969-70	60 947	798	61 745
1970-71	59 084	800	59 884

32

3. the level of CDA's support of university research has been, at best, modest.

It is reasonable to ask what form of co-ordination exists in the national agricultural research program-the answer is very little. One major committee exists, the Canadian Agricultural Services Coordinating Committee, consisting of the federal and ten provincial deputy ministers of agriculture, the deans and principals of the Faculties and Colleges of Agriculture and Veterinary Science, one representative each of the Agricultural Research Institute of Ontario, of the Quebec Agricultural Research Council, of the NRC and of DBS, and eight senior officials of CDA. However this body meets only once per year and has no staff.

What conclusions can be drawn from today's situation?

The major features which emerge from the analyses of the current situation in agricultural R & D (by Smallman, by the CDA and by the Science Council were as follows:

-the bulk of the funds for agricultural **R** & **D** are controlled by the federal government, principally through the CDA; the provincial government agricultural agencies have direct control over little more than 10 per cent of the total;

-the overall co-ordination of agricultural research lies in the hands of the Canadian Agricultural Services Coordinating Committee, which has no Secretariat and no direct control over funds. It may have some influence over CDA's university grants program, but the pitifully small size of these grants gives little evidence of this. CASCC has been a rather ineffectual body;

-the Canada Department of Agriculture has conducted research for more than 100 years; during that long history the only recorded external evaluation of the research program was that conducted by the Glassco Royal Commission on Government Organization, in the early 1960s. The establishment of a formalized system to provide the benefits of regular informed criticism of program content and direction is long overdue;

-the production research activities are internally reasonably well co-ordinated within the Research Branch of CDA, but there is little or no effective co-ordination of these efforts with the economics and marketing programs undertaken in other parts of CDA, particularly in the Economics Branch of the department; the economic research appears to be largely irrelevant to the major issues, and the marketing research to be too little and too late;

-there is little co-ordination of the agricultural research programs in the universities with the CDA program. The provincial agricultural services co-ordinating committees are effective to a degree but they lack the power to make changes in programs, largely because they have no funding authority;

-agricultural research by industry is almost non-existent in Canada, as documented by Smallman *et al.*, and indicated in Tables 5 and 6 above. What little there is is principally in the meat processing industry. A significant expansion of research performed in the agricultural sector of Canadian industry is urgently needed, but there should be no illusions about this being an easy task; the industries involved are largely foreign-owned and to date have in most cases lacked any commitment to doing research in Canada;

-extension is the responsibility of provincial departments of agriculture (CDA, the main performer of research, has no statutory responsibility in this area), but there are frequent gaps between production research and extension. Despite the lack of formal responsibility, CDA has found it necessary to allocate a significant proportion (around 5%) of its total research effort to extension services on a necessarily informal basis, but the situation is far from satisfactory;

-in past years, adjustment of the emphasis of the federal research program in agriculture was made possible because of the growth, in budgets and manpower,

of the agencies involved (the CDA's **Research Branch**. Economics Branch and the Animal Diseases Research Institute of the Health of Animals Branch). In recent years, under austerity budgets, this flexibility has disappeared. In common with all government departments. these agencies have experienced and still do experience great difficulty in terminating on-going programs whose priority has diminished. Impediments to such adjustments are many and long-standing, and involve manpower policies and investments in facilities. However, despite the difficulties involved, the Science Council considers that by retraining of personnel, particularly at the management level, many of the problems can be overcome and desirable adjustments made even without growth.

What would be a better state of affairs?

In any large research system-and this is what Canadian agricultural research is or should be-the most important single characteristic which the system must possess is the ability to change with changing times, needs and goals. Without such flexibility, any system will become increasingly irrelevant, carried away by its own momentum. It is not enough that the components of the system perceive the need for change individually; it is the whole system which must adapt in concert. It appears to the Science Council that the single gap most in need of filling in Canadian agricultural research is at the level of national co-ordination of the various efforts which are now mounted separately at the federal, provincial, university and industrial levels. (As always, Science Council would stress that co-ordination does not mean the establishment of a single monolithic agency, a solution which would be as unacceptable as it is unnecessary.)

The critics of Canadian agricultural research can bring out a long list of complaints about details of today's research program, such as: "too much basic

research and not enough development". "too much on strawberries and not enough on beef cattle", "too much in B.C. and not enough in Quebec", "too many entomologists and not enough cereal breeders", "not enough research on the transportation of agricultural commodifies". All these comments have been made at one time or another and may have been valid. The rarely-discussed danger inherent in the present system, with its autonomous and uncoordinated parts, is that these parts may over-react individually to produce a situation in which exactly the opposite criticisms are true. The Science Council would argue that what is needed is a co-ordinated system which will make all the component parts aware of the way the full system is going, and by so doing, provide the needed checks and balances which will counteract any tendency to wild oscillations in the research program as a whole. Change must come, but the system as a whole must know where it is going. And co-ordination can only come from a knowledge of what the parts are doing.

In its Report No. 4*, The Science Council discussed some general principles for the organization of research within government, which can usefully be extended to cover the case of agricultural research. In particular the Council is still convinced that

"all of the scientific programs of government should be subject to a regular "technical audit" by an appropriate body which should include the users of the information generated by the program. These users will come from government departments, universities and industry".

The Science Council would suggest that the co-ordination which is sought for the national agricultural research program and the informed scrutiny of inhouse programs discussed above could

^{*} Science Council of Canada, Report No. 4. Towards a national science policy for Canada, pp. 26-27. October, 1968. Information Canada, Ottawa.

both be provided by the creation of a Research Co-ordinating Council modelled after the Defence Research Board and reporting through its Chairman directly to the Minister of Agriculture.

The component parts of such a body (which this report will refer to as the Agricultural Research Co-ordinating Council or ARCC) would be:

-a Council consisting of representatives of the agricultural interests of Canada-federal departments, provincial governments, universities, agricultural organizations and industry, chaired by a full-time chief executive officer;

-an adequate Secretariat or Headquarters staff to service the Council and act as liaison between the Council and the operating research groups;

-in-house research facilities, being those already run by the CDA.

It would be essential that the ARCC be given control of the major sources of federal government funds expended for agricultural research.* The Council would be responsible for planning, budgeting, and allocation of these funds, whether for support of federal, university or industrial research projects.

A key element of the co-ordination of agricultural research would be the relationship between federal and provincial activities and the use of funds by both levels of government. It is the opinion of the Science Council that the ARCC should seek to co-ordinate the use of federal and provincial funds by entering into specific agreements with the provinces, singly or collectively, in which both parties would contribute to the joint program. These contributions would usually be in kind, with no transfer of funds between the two levels of government taking place. Such agreements might, for example, cover improved co-ordination of research with extension services.

Any success which could be achieved by establishing an ARCC would be entirely dependent on the people who make up the organization and on the way in which they operate. The effectiveness of this body would in large part determine the effectiveness of the whole agricultural research enterprise in Canada. Much thought and discussion will therefore have to go into drafting initial terms of reference. To contribute to this process the Science Council has set out, in Appendix B, possible guidelines for both membership and terms of reference. (It will be noted that there is a close similarity between the ARCC and the Agricultural Research Board recommended by Smallman and his Study Group.)

There can be no absolute guarantee that any given structure will prove superior to any other; there is however, the knowledge of the degree of success achieved in other fields of government science using a "Research Board" style of structure, which couples the advantages of appropriate freedom for the individual scientist with the informed review and advice of an external board.

How would today's arrangements be affected ?

Government Operations

The research operations conducted inhouse by the ARCC should be located in research centres distributed throughout the country, supervised by a research manager who would be responsible to the Co-ordinating Council through its Secretariat. The Research Manager would budget for funds according to programs submitted by him to the Secretariat and approved by the Council. He would use the money to carry out the approved plan, and his progress would be reviewed periodically for the Council and programs changed in accord with the review. The research centres would be largely autonomous with respect to "how" the research is carried out, but would be guided by the ARCC as to objectives.

There are three chief considerations which would enter into the decision on the nature and number of ARCC Research Centres. These are: geographical or

^{*} The only exception would be NRC funds for agriculture, which are discussed later in this report.

political distribution, program and crops, and disciplines.

A series of central research centres should be placed strategically across the country and associated with one or more universities. (The details of this association, which must be a binding one and must have a legal status, would have to be worked out by ARCC with the universities.) Such centres would vary in size and program complexity, depending upon the research plans for which they would be responsible; they would operate such satellite stations as would be necessary to carry out the program plans which they would direct towards agreed-upon objectives; they would include in their programs everything from research in depth to extension, and would utilize all disciplines required, from atmospheric physics to zoology.

In planning the program objectives for each research centre, ARCC would recognize that Canada must have a high degree of expertise in many areas, that all centres cannot be active in all fields, and hence, that there must be a degree of specialization. To achieve this it would be necessary to assign to each centre one, two, or at the most three, areas of specialization in addition to the programs which are their responsibility. One could view the expected program of each centre as designed to ensure that there was a level of expertise on a broad front which was sufficient to cope with the problems of the region served by the centre; upon this would be superimposed some peaks of real excellence in specialized areas, which had been developed to serve a national role. One example might involve a research centre and its associated university groups specializing in plant breeding and genetics, while maintaining additional programs outside the areas of specialization on topics such as horticultural crops, new crop introductions, regional soil management, improvement of extension services, etc. In some cases the need will be felt to create "satellite" stations for particular purposes. The Science Council would emphasize that

the location of such satellites should be determined by ecological rather than political boundaries.

The success of this proposed organization would be entirely dependent upon the make-up and mandate of the suggested ARCC. The effectiveness of this body would determine the effectiveness of the whole enterprise.

University Research and Education Much of the university research in support of agriculture should be funded by the "Agricultural Research Co-ordinating Council". The direct support should be in the form of contract research, and the nature of this research should be such that it complements the programs carried out by the "research centres", or vice versa. In coming to this conclusion the Science Council was aware of the many administrative difficulties, relating for example to publication rights, patent ownership, etc., which have to be faced in reaching agreement on a universitygovernment contract, but the Council is convinced that these difficulties can be overcome by reasonable discussion.

In addition to the contract research at the universities, a system of grants should be maintained which will enable university personnel to carry out research independent of any governing body outside the university. These grants should be administered by the appropriate granting councils.

Obviously, the university has the sole responsibility for education at both undergraduate and postgraduate levels, and for research associated with education. It is to the advantage of the educational process that students have access to the best brains and facilities available. Therefore, the staff of the research centres would be encouraged to participate in the teaching and graduate student supervision of its associated university, and the centres' facilities should be made available to support university research and training. The research centres' staff must recognize that this contribution to the educational process is part of their

responsibility. We do not, in Canada, have so much talent nor so many sophisticated facilities that we can afford not to make maximum use of them.

It is expected that the agricultural industry, which includes increasing numbers of large commercial farms, will steadily increase the demand for university-trained personnel. It is to be hoped and expected that agricultural graduates, including those with advanced degrees, will eventually permeate throughout the agricultural industry, and that they will not assume that only research or teaching can provide a satisfying career. Looking at the farm sector component, in which at present there are approximately 300 000 commercially-viable farms, and considering an average working life of a farm operator to be 40 years, approximately 7 500 farms must change ownership annually. Because of the increasing complexity of modern day agriculture, it should be an object of policy that a growing percentage of new farm owners be university-trained. In some cases, courses may be in need of re-orientation, to provide emphasis on the practical problems of farm management. As the number of farms decrease and the individual farm size increases, the percentage of farm owners with university training should increase correspondingly so that a sustained demand for university graduates to man this component of the agricultural industry could be expected for several decades. The worldwide technological revolution in agriculture is likely to continue, and Canada can maintain its competitive position only if those who man the industry are in the forefront of this development.

Sustained but controlled growth in the existing seven Faculties of Agriculture and three Veterinary Colleges in Canada should be encouraged to provide the required qualified manpower. The reports by both Smallman and the Federal Task Force have stressed the necessity of increasing the level of research at the universities. It is the opinion of the Science Council that the ARCC should have a fundamental commitment to ensuring the health and vitality of the research programs in the faculties of agriculture and veterinary science. This is a role for which the CDA has assumed little responsibility. If this situation is to be improved, then for the next few years all new money for agricultural research in the universities should be allocated to ARCC.* The requirements of NRC for its support of university-based agricultural research will need to be reassessed as the ARCC grows in strength. In particular it would be expected that future major negotiated or strategic development grants for agricultural research would be awarded only by the ARCC.

Research by Private Industry

The "Agricultural Research Co-ordinating Council" should encourage research by private industry by means of contracts. These contracts would be similar to university contracts and should also complement the research being done at the "centres" and universities. The evidence presented by Smallman *et al.* demonstrates the current low level of industrial involvement in agricultural research and argues the case for expansion of this involvement; the presence of industrial representatives on the ARCC will be important if moves to encourage such expansion are to meet with success.

It is *important to note* that under our proposal all the research carried out by the centres, university contracts and private industry contracts would be coordinated and funded by the Agricultural Research Co-ordinating Council (ARCC). Funding by NRC of grants to individual professors of agriculture would continue, but would represent a progressively diminishing proportion of total expenditures.

The discussion of the organization of agricultural research presented in this report has assumed that it is not the

^{*} In recent years CDA has provided between \$600 000 and \$800 000 p.a. to university research in agriculture, while NRC has provided about \$1.5 million p.a.

intention of the federal government, at least in the short term, to integrate its activities in agriculture into the recently announced Department of Environmental Affairs and Renewable Resources. In other studies now in progress, the Science Council is considering the level of integration which would be desirable in the management of all of Canada's natural resources, and the means by which such integration could be achieved. Pending the outcome of such investigations, the Council believes that the organization which it is proposing for agricultural research would have inherent in it the flexibility required to let it adapt to any foreseeable changes.

How to bring about change

If Canada's agricultural research organization is to be changed to the model which the Science Council has proposed, the following measures would have to be taken:

1. An "Agricultural Research Coordinating Council" should be established, with appropriate membership (including a full time Chairman) and terms of reference, and the CASCC phased out.

2. A Secretariat should be appointed to provide headquarters staff for the ARCC.

3. The present distribution of institutes and stations should be used as a starting point to organize the "research centres".

4. Contracts should be drawn up by the ARCC with existing research groups at universities and elsewhere: for example, cereal quality program in Manitoba, soil program in Saskatchewan, poultry nutrition at the University of British Columbia, pestology program at Simon Fraser University, animal diseases at Saskatoon and Guelph.

5. A progressive program should be instituted to eliminate or adjust present Research Branch programs and stations, which may be considered obsolete in the light of university contracts and industry contracts and in the light of the overall review of priorities. 6. Arrangements should be made with provincial governments to establish closer liaison of their extension activities with the research centres in their particular regions.

7. Agreements should be drawn up with universities which will spell out the relationship of each research centre to the surrounding universities.

8. Over a period of time the research presently supported by provincial and other funds should be integrated with the research programs conducted by the "centres" in that particular province.

9. Funding procedures should be amended. The Agricultural Research Co-ordinating Council should be responsible for the allocation of funds to all federal government agricultural research; it should also become the principal source of contract funding for university and industrial research in agriculture.

It is apparent that no attempt has been made to describe all the detailed action required to transform the present situation into the ideal or utopian one. The Co-ordinating Council and its secretariat will have this to do as its initial operation.

Essentially, the move is one of centralization of broad planning and funding, combined with decentralization of the research operations. It is intended that *how* research centres, university or industry conducts its research, which is directed towards agreed upon goals and objectives, should remain the prerogative of the establishment.

International
Trade
and Aid

International trade and aid interact closely in today's world; changes in policies for the one will often have far reaching effects on the other. Nowhere are these interactions more complex than in the area of agriculture.

International Trade

The following excerpts from the Task Force Report place this subject in perspective:

"International trade in agricultural products is of vital importance to the Canadian Economy. Agricultural exports account for about 15 per cent of Canada's total exports." (Task Force Report, p. 41)

"Agricultural industries of efficient producing countries everywhere are confronted by a jungle of laws and regulations (in importing and exporting countries) aimed largely at raising the level of prices and incomes of farmers. The regulations take the form of tariffs, price support, production-control programs, import quotas, levies, export subsidies, credit for surplus disposal, state trading and international commodity agreement." (Task Force Report, p. 43)

It is in these areas that the 200-odd separately identifiable agricultural commodities frequently strongly interact, or should be encouraged to interact.

"One might illustrate from the Canadian dairy industry if Canada faced fewer trade restraints against those products for which she has a clear competitive advantage (wheat, oilseeds, live cattle, cheddar cheese, some fruits and vegetables and some meats) there would be no arguable basis for our 40-year virtual ban on butter imports and our present costly dairy subsidy program." (Task Force Report, p. 43)

There is evidence in the Task Force Report that Canada's attitude to the marginal practices of other countries

competing with Canada for world markets has been much too passive. This reinforces the overtones of the "OECD Reviews of National Science Policy-Canada (1969)", that Canada is the most passive of OECD countries in her relations with other countries.

An aggressive policy in agricultural trade, making full use of and demands on the science supporting agriculture in Canada, is essential.

While agreeing substantially with the recommendations for action by the Task Force on International Trade (p. 59 and 60), the Science Council recommends that some additional important facets should be given emphasis:

1. Research should be directed specifically toward examining the potential for the development of products not now competitive to a point where Canada has a clear competitive advantage.

2. Products that fail to meet the tests of international competition should be continued only if there are demonstrable domestic reasons for so doing.

3. Products that do meet the tests of international competition should be given full support by all agencies of Government. Recommendations 5, 6, 7, 8 and 9, of the Task Force* are germane and, in addition, have an immediate call on the research community to solve problems as they arise, and ongoing defensive research to ensure a competitive position.

4. Most of the scientific knowledge necessary to bring Canadian grades and grading practices into an international competitive position already exists; all that is required is the will to change.

5. Marketing expertise supported by good market research is critical, but is in its infancy in Canadian agriculture. It is stressed that in developing this area prior. ities must be clearly established and maintained, and the quality of the research kept at a high level. This means that the competence needed will be built

* See Appendix IV (quote from p. 434 of Task Force Report).

up slowly. There is no room for the mediocre in this area.

Food Aid

The giving of food to a needy country, as a form of international aid, is not productive but will at times be most necessary. It is suggested that the emphasis should be either to build through technical assistance the indigenous agriculture to the point of reasonable self-sufficiency, or to develop the economy in other ways to the point where a country can purchase the food it needs, or, as is more frequent, a combination of the two.

Therefore whenever food aid becomes necessary, concomitant assistance in either or both of these other directions should be offered.

International Aid

Agriculture is one of the more important areas of activity for international aid to under-developed countries, and Canada should contribute its share.

Because most of the under-developed countries lie in the tropics or semi-tropics, the species of crop plants, the diseases and pests that plague animals and plants, and the problems of soil management and of climate, differ from those found in temperate and northern climes, where Canada has developed its agricultural expertise. Thus, the direct results of most Canadian research will not be relevant to the problems of the developing countries, nor can their needs be met by exporting farming technology from Canada, as it will almost certainly be useless.

Nevertheless, the basic principles behind soil testing, crop improvement, disease and insect control, etc. are applicable or relevant in all parts of the world. This knowledge is vested in the technical and scientific personnel of the agricultural community, and it is through the secondment of these people that Canada can provide its most effective aid.

Therefore, as the aid will in large measure depend upon the employment of

Canadian scientific personnel, it will require the close co-operation of the Agricultural Research Co-ordinating Council on the one hand, and CIDA and IRDC on the other. There are many pitfalls along the road to effective scientific aid and these must be avoided. Because of the environmental adjustments which are necessary, a high degree of selectivity of scientists for these missions must be exercised, and Smallman *et al.** may well have overstated the size and nature of Canada's proper contribution.

There is another side to this coin. It is to be expected that successful aid to the developing countries will on occasion make them self-sufficient in agricultural product areas in which they previously imported from Canada. This is to be welcomed, but at the same time the communications between those scientists working abroad and the Agricultural Research Co-ordinating Council must be well maintained so that the "defensive research" to develop alternative markets or products is undertaken *before the crisis of temporary regional surplus arises.*

^{*} Science Council of Canada, Special Study No. 10. Agricultural science in Canada, Chapter VII. August, 1970. Information Canada, Ottawa.

Epilogue

Looking beyond the short-term crisis facing aspects of Canadian agriculture, the long term view is one of increasing demand both at home and abroad. The world has a finite area of productive land which it must use to feed an inexorably growing population. Coupled to this growth are changing trends in food demand; as a nation develops, its demand for high protein foods such as wheat or meat grows, and former dietary habits are cast aside. The often-discussed "Green Revolution" has done much to increase the food-producing capacity of many tropical nations, but even the most optimistic outcome of the introduction of new crop varieties would still leave large and growing shortfalls between locallygrown supply and demand in these countries. Nations like Canada will have the opportunity to compete for many years to come in growing export markets for high protein foods; a dedication to being a food-exporting nation could bring a much-needed stability to Canada's agricultural industry.

To be able to become a consistent exporter of food (as opposed to one who exports only in years of unplanned surplus), Canada's agricultural industry must have a continuing concern for the improvement of its productive capacity and its ability to sell and move its products; any improvement will be highly dependent on the results of agricultural research. Without a vigorous and wellorganized agricultural research community, there can be little certainty in the future of the nation's agriculture.

Appendices

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Appendix A

Organization of the Canadian Department of Agriculture Research Branch

Notes taken from the Proceedings of the Senate of Canada Special Committee on Science Policy, No. 10, November 21, 1968, pp. 1115-1120 inclusive.

1. Organization of the Canadian Department of Agriculture Research Branch (Population: 3 440*)



*Population for each establishment includes full time and seasonal-August 1, 1968



2. Work of the CDA Research Branch

1(1) Research Station–St. John's West, Nfld.

Population 53

Soil Science, Animal Science, Field Crop and Peat Soil

Reclamation, Potato Breeding, Vegetable Crops-entomology, nematology, pathology, horticulture

Administration, Farm Operations, Support Services

1(2) Research Station-Charlottetown, P.E.I.

Population 92

Crop Protection-potato and vegetable diseases, forage diseases, potato fungicides, potato insects, vegetable insects, forage insects

Genetics and Plant Breeding-cereal breeding, cereal diseases, special crops, dairy cattle

Soils and Plant Nutrition-forage nutrition, plant physiology, pasture and corn nutrition, vegetable nutrition, chemistry and soil fertility, forage crop management

Administration-office services, agricultural services, building and maintenance, library

Exp. Fur Ranch, Summerside, P.E.I.– Nutrition, Breeding, Pathology, Administration, Farm Operations

1(3) Research Station–Kentville, N.S. Population 174

Entomology-winter moth and laconium scale, predator populations, ecology of mirid pests, orchard tortricides, apple maggot, selective pesticides, toxicology, mites, aphids of apples and vegetables, small fruit pests

Chemistry-fertility and nutrition, pesticides

Plant Pathology-tree fruit diseases, storage diseases, fruit and vegetable diseases, physiology of parasitism in vegetable diseases

Crops-weed control, vegetable crops, field and forage crops

Plant Physiology-storage, post harvest physiology, tree fruit nutrition, electronic maintenance development Processing-biochemistry, commercial processing techniques, food technology Small Fruits-plant breeding, economic botany, genetics and cytology, ornamentals

Poultry-genetic environment,embryology and behaviour in egg production stocks, genetic environment and physiology in broiler stocks, poultry house operations

Tree Fruit-growth and development, breeding, orchard operations Administrative Support-secretary, statistician, administration, library Exp. Farm, Nappan, N.S.-Animal nutrition and management, pastures, forage physiology, cereal, forage crop management, soil fertility, dikeland studies, blueberries, administrative and stenographic, statistical, farm operations.

1(4) Research Station–Fredericton, N.B. Population 157

Animal Nutrition-meat animal nutrition, calf nutrition, pig nutrition, dairy cattle nutrition

Agricultural Engineering and Field Cropsharvesting and storage engineering, cereal crops, forage crops

Plant Pathology-aphid borne virus, potato virus, potato common scab, potato leafroll virus, late blight in potatoes, verticillium wilt, spindle tuber virus, biochemistry

Plant Physiology and Entomology-small fruits, vegetables, blueberry insects, apple maggot control, potato physiology, analytical chemistry, herbicides, aphidology

Potato Breeding-potato breeding, potato quality, potato cytogenetics, potato genetics

Soils-soil chemistry, potato nutrition and management, potato nutrition, soil physics, soil capability

Administration-office services, building, vehicle & equipment maintenance, agricultural services, farm labour services

(1)5 Research Station-Quebec, P.Q.

Population 126 Cereal Crops-oats and barley Forage Crops-grasses and legumes, plant pathology, plant physiology Vegetable Crops-potatoes, plant physiology Soils-soil genesis, microbiology, fertility,

Soils-soil genesis, microbiology, fertility, drainage

Administration-office services

Exp. Farm, La Pocatiere–Cereal crops, forage crops, field crops, horticultural crops, soil fertility, animal science, administration, support services

Exp. Farm, Normandin, P.Q.-Animal science, crops, administration, support services

Exp. Farm, Caplan, P.Q.-Animal science, crops, administration, support services

1(6) Research Station-Lennoxville, P.Q.

Population 74

Animals-dairy cattle, beef cattle, sheep, swine, general operations

Crop Research-forage grasses and pastures, forage pastures and legumes, cereal research

Soils Research-soil fertility, soil physics Laboratories Administration

Farm Operations

1(7) Experimental Farm-L'Assomption, P.Q.

Population 35

Tobacco Breeding-Tobacco Crop Management, Tobacco Crop Protection, Forage, Cereal and Vegetable Crops Evaluation, Plant and Soil Chemistry, Poultry Breeding and Management, Administration, Farm Operations

1(8) Research Station-St. Jean, P.Q.

Population 57

Vegetable Research–Entomology (onions, potatoes, corn, canning peas), plant pathology (crucifers, beets), plant physiology, genetics, pesticide residues, management *Fruit Research*–entomology (apples), genetics (apple trees), management (apple orchards)

Soils Research-soil chemistry, soil-plant

relations *Administration*-office services, maintenance *Exp. Farm, L'Acadie, P.Q.*-Seasonal

Exp. Farm, St. Clothilde, P.Q.-Seasonal

1(9) Research Station–Ottawa, Ontario Population 188

Cereal Crops-oats & barley, wheat & peas, wheat quality, plant pathology, plant physiology, field operations *Forage Crops*-grasses & legumes, corn and soybeans, plant pathology, field operations

Horticultural Crops-vegetables, fruits, ornamentals, plant pathology, field operations

Agronomy-crop management, field operations

Cytology-cereal crops, forage crops, mutation genetics

Administration-office services, agricultural services, library

Exp. Farm, Smithfield, Ontario-nutrition and irrigation, fruit crop management, tomato breeding, food processing and storage, physiology and biochemistry, administration, farm operations. Exp. Farm, Kapuskasing, Ontario-animal science, field crops, soil science, administration, farm operations Exp. Farm, Fort William, Ontario-crop management, administration

1(10) Research Station–Harrow, Ontario Population 94

*Chemistry–Physiology–*greehouse crops, pesticide residues, greenhouse operations *Entomology–*field crops, greenhouse crops, tree fruits, vegetables, chemicalbiological control, aphids, vegetables, nematology, insect pathology

Field Crops-corn, soybeans, tobacco, crop adaptation

Horticultural Crops-tree fruits, vegetables, white beans, food science, food technology, greenhouse operations, cereal crops

Plant Pathology-vegetables, tree fruits, soybeans, white beans, corn, soil microbiology, peach canker, greenhouse operations, soil toxins, fungicides

Soil Science-soil physics, soil fertility, statistical services

Administration-office services, engineering and maintenance, agricultural services, landscaping and grounds, library services, photography.

Extension Services-tree fruits, greenhouse crops

Soils Sub-Station, Woodslee, Ontario agronomy, soil physics, white beans, administration, agricultural service Entomology Field Office, Chatham, Ontario

1(11) Research Station–Vineland, Ontario Population 51

Entomology-peach insects, apple insects, orchard mites, vegetable insects, insect reproduction

Nematology-zoology research

Plant Pathology-fruit viruses, grape viruses, vegetable viruses, vegetable diseases

Pesticides-tree fruits, zoological research *Administration*-office services, maintenance service, greenhouse service, farm service

1(12) Research Station-Delhi, Ontario

Population 39 Nutrition and Soils Plant Science Plant Physiology Genetics and Breeding Plant Pathology Entomology Technical/Group and Farm Operations Administration

2(1) Animal Research Institute-Ottawa, Ontario

Population 223

Biochemistry Section-ruminant ketosis and lipid metabolism, membrane structure and steroid analysis, mucopolysaccharides, white muscle disease, energy metabolism, nucleic acid and protein metabolism, hormones, cholesterol, experimental animals, general services. *Genetics*-protein genetics, enzyme genetics, dairy cattle genetics, dairy cattle field records, sheep genetics, poultry genetics-egg production, poultry genetics -meat production, population geneticsmice, population genetics-insects. *Nutrition*-forage utilization, beef cattle nutrition, dairy cattle nutrition, white muscle disease, poultry-protein, poultryamino acids, poultry-egg quality. *Physiology*-reproductive, poultry, physiological genetics of poultry.

Institute Data Processing Committeecomputer systems, programmers, unit records

Resources Management-special projects, animal plant, poultry plant, crops and services, large animal laboratory, small animal laboratory, labour pool *Administration*-personal services, purchase, stores, inventory, accounts, revenue, typing and transcribing, general services.

2(2) Entomology Research Institute– Ottawa, Ontario

Population 116

Administration-office services Agriculture-ecology, pathology, pollina-

tion and nectar chemistry *Experimental Biology*-insect ecology, insect genetics and cytology, insect physiology

Insect Taxonomy-acarology, aquatic insects, coleoptera, distera, hemiptera, hymenoptera, lepidoptera, morphology, technical services, siphonaptera Nematology-ecology, taxonomy

2(3) Food Research Institute-Ottawa, Ontario

Population 60 *Carbohydrates*-rapeseed, potatoes *Dairy*-cottage cheese, cheddar cheese, aroma, cheddar cheese flavour, milk enzymes.

Lipids-plant lipids, animal lipids *Microbiology*-bacteriophage, lactic streptococci, fungal rots.

Food Prodessing-new foods, freezing, sensory evaluation, chemical evaluation *Proteins*-muscle protein

Storage-chemical analysis, senescence Food Research Liaison

Administration-office services, farm la-

bour services, scientific support services

2(4) Cell Biology Research Institute-Ottawa, Ontario

Population 54

Biochemistry-bacterial metabolism, biosynthesis, fungal metabolism, macromolecules, tissue culture, biochemical taxonomy, viral biochemistry, enzyme regulation

Cyrobiology-frost hardness mechanisms, frost resistance

Cytology and Electron Microscope-cytology, micro-organisms, electron microscopy

Microbial Ecology-rhizosphere bacteria, rhizosphere fungi, microbial selection, numerical taxonomy

Physiology-fungal toxins, physiology of growth, frowth regulators

Phytopathology-of seed, soil borne diseases, bacterial diseases, seed borne diseases, bacteriophage, crop disease loss assessment

Virology-cereal viruses, leafhopper transmitted viruses, aphid and trypstransmitted viruses, virus-vector relationships *Administration*-maintenance and stores, purchasing and payment, area stenographers

2(5) Plant Research Institute– Ottawa, Ontario

Population 144

Agrometeorology-ecoclimatology, micrometeorology, agroclimatology. A.R.D.A. Met. coordination, mete

Environmental Physiology-plant dormancy, plant physiology, plant growth and development, growth analysis, growth efficiency,

Mycology-pyrenomycetes, mycology herbarium, parasitic fungi, phycomycetes, hysteriaceae and hypodermataceae, discomycetes, agaricales and discomycetes, fungi imperfecti, hyphomycetes, polyporaceae, tremellales, hydnaceae, woodinhabiting hymenomycetes, uredinales, thelephoracease and hydnaceae *Ornamental Plants*-turfgrass, ornamental hort., physiology, biochemistry, native plants, frost hardiness Vascular Plant Taxonomy-saxifragaceae and experimental morphology, phanerogamic herbarium, pteridophyta, plantaginaceae, palynology, aveneae, floristics, gramineae, cynareae, cytogenetics, leguminosae, experimental taxonomy, cruficerae, cytotaxonomomy *Operations*-greenhouses, botanic gardens, ornamental gardens, arboretum, campus, nurseries, research plots. *Administration*-office services, stenographic services, stores services, library service, landscape architecture.

2(6) Soil Research Institute-Ottawa, Ont.

Population 135

Soil Fertility-potassium, phosphorus, soil environment, nuclear isotopes, management Soil Mineralogy-mineral transformation and weathering Physical Chemistry-ionic interactions and equilibria in soils Soil Biochemistry-organic nitrogen, microbial decomposition, phenolic chemistry of humus and plants Humic Acid Chemistry-properties and structure, biodegradation Soil Physics-soil moisture distribution Pedology-classification and correlation, genesis Alberta Pedology Unit **Ontario** Pedology Unit Nova Scotia Pedology Unit **Administration** Cartography

2(7) Research Institute–Belleville, Ontario

Population 86

Biting Fly Biology-fecundity, chemical sterilants, experimental populations, predators, physical sterilants, reproductive behaviour

Nutritional Physiology-nutrition, histology, antimetabolites, growth, host preferences, reproductive physiology Population Analyses-experimental populations, ants, spiders, aphids, mirids, apple maggot, host-parasite interactions Insect Plant Relations-biological control of weeds, control of Canada Thistle, feeding behaviour, bioenergetics *Microbial Controls*-insect pathogens, European skipper, viruses, bacteria *Insect Imports and Exports Administration*-library, office services, building maintenance

2(8) Research Institute–London, Ontario

Population 81

Bacteriology-electron microscopy and cell cytology, microbiology and virology *Chemistry*-biophysical, organic chemistry and fungicides, radioactive tracers, photochemistry and fungicides, natural products, enzyme kinetics, comparative biochemistry and toxicology, chemistrytoxicology

Entomology-comparative biochemistry and toxicology, biochemistry, physiology and biochemistry, physiology Fumigation-fumigation, fumigation and

toxicology, analytical chemistry *Plant Pathology*-histology and physiology, fungicides, plant biochemistry and fungicides

Plant Physiology-herbicides, physiology, biochemistry

Soil Pesticide Behaviour-toxicology, analytical chemistry, microbiology, ecology Administration-office services, engineering services, stores, library, greenhouse, photography

2(9) Analytical Chemistry Research Service-Ottawa, Ontario

Population 34

Method Research-inorganic chemistry, physical chemistry, organic chemistry, pesticide residues

Analytical Cooperation–special analyses, proximate constituents, instrumental, technicians pool Administration

2(10) Engineering Research Service-

Ottawa, Ontario Population 39 Research Service Development and Advisory Scientific and Technical Information

2(11) Statistical Research Service-Ottawa, Ontario Population 21 Biometrics Quantitative Genetics Computing-data analysis, programming Office Services

3(1) Property and Finance-Ottawa, Ottawa

Population 38 Finance Unit-operations, purchasing General Administration-central registry, office services, typing and transcribing

3(2) Architectural and Engineering-Ottawa, Ontario

Population 14 Structural Engineering Plumbing and Sewage Environmental Control Heating and Ventilation Electrical Engineering Laboratories Coordinator Mechanical Systems Animal Structures Service Buildings Design (drafting)

3(3) Scientific Information-Ottawa, Ontario

Population 52

Technical Information-insecticides, herbicides, fungicides, insect pest surveys, plant disease surveys

Public Information-general information, herbicides, farm management, press, radio, T.V.

Information Processing-systems, projects Illustrative-photography, micrography, photo engineering, arts, modelling, biological art, special projects, photo library Scientific Editing-research reports, soil surveys, departmental publications Administration-fellowship grants, office services

3(4) Ottawa Services–Ottawa, Ontario Population 108

Administrative Unit-general administration, receiving, shipping, taxi, building maintenance *Technical Unit*-modification of special equipment, operation and maintenance, instruments

General Unit-farm machinery and vehicle shop, carpenter-shop, farm operations

4(1) Research Station-Brandon, Man. Population 76

Plant Science-cereal crops, barley breeding, forage breeding, forage management, horticulture crops Animal Science-poultry breeding, apiculture, animal breeding, animal physiologyreproduction (male), reproduction (female), meats Soils and Agronomy-soil fertility, plant phys., agronomy-rotation and off-stations cultural practice, weeds

Administration-office services, operations and maintenance

4(2) Research Station-Morden, Man.

Population 83 Information Services Administration Corn and Soybeans Weed Control Vegetable Crops-tomatoes and potatoes, vegetable quality, plant physiology, crop management, sweet corn and cucumbers, plant pathology Special Crops-flax and cereals, buckwheat and peas, oilseed quality, sunflowers, plant pathology Ornamentals and Fruit

Operations and Maintenance Sub-Station, Portage La Prairie, Man.

4(3) Research Station–Winnipeg, Man. Population 111

Cereal Rusts-common wheat breeding, Durum wheat breeding, wheat rust pathology, wheat leaf rust, oat crown rust, physiology

Cereal Diseases-barley breeding and genetics, cereal pathology, antibiotics, cereal smuts, cereal viruses, virology Crop Protection-insect biology and control, insect toxicology, insect and mite ecology, population dynamics, insect biochemistry, pesticide residues, plant pa-

thology, fumigant biochemistry

Pedology-classification, chemistry, classification and genesis, classification and cartography Cereal Chemistry-scientific liaison Administration-mechanical maintenance, photography, support services, building and ground maintenance

4(4) Experimental Farm–Indian Head, Sask.

Population 43 Agronomy Forage Crops Experimental Project Farms Soil-Horticulture Poultry Administration-office services, maintenance services, farm service

4(5) Research Station-Melfort, Sask.

Population 50 Ruminant Nutrition and Pasture Research Swine Nutrition Forage Production and Pasture Research Forage Ecology and Weed Control Soil Fertility and Pasture Research Grey-wooded soils Tillage and Cropping Cereal Crops Horticulture Administration Farm Operation and Upkeep

4(6) Research Station-Regina, Sask.

Population 34 Weed Science-weed physiology, range weeds, weed morphogenesis, herbicide chemistry, weed ecology, weeds of field crops

Cereals and Seeds-cereal testing, seed distributions, var. verif. and genetic stock

4(7) Research Station–Saskatoon, Sask. Population 139

Administration-office services, library computer systems, program services, photographic services, greenhouse services, maintenance services, glassware washing service, farm operations Scientific Information

Crops-grass breeding, legume breeding, oilseed crops-rapeseed, sunflower, mus-

tard, crop management, irrigation, cytology, field operations

Insect Bionomics and Control-forage crop insects, forage crop insect pollinators, biting flies, mosquitoes, oilseed insects, pesticides, insect toxicology, garden insects, field operations

Insect Ecology-grasshoppers, wireworms, insect nutrition, mosquito physiology, insect reproductive physiology, insect endocrinology, field operations *Plant Pathology*-cereal root rots, soil microbiology, physiology of drought resistance, legume diseases, oilseed crop diseases, grass diseases, field operations *Pedology*-pedological characterization, soil analysis

Experimental Farm, Scott, Sask.–Crop management and weed control, soils research, potato investigations, crop research, administration, farm operations

4(8) Research Station-Swift Current, Sask.

Population 144

Agricultural Engineering-irrigation, hydrology, equipment testing, power and machine design, drainage and salinity, field operations

Animal and Pasture Science-turkey nutrition, botany, ecology, pasture management, forage evaluation, field operations *Plant Science*-alfalfa breeding, cereal breeding, forage physiology, forage agronomy, grass breeding, plant physiology, field operations

Soil Science-soil fertility, chemistry, physical chemistry, agronomy, agrometeorology, soil structure, soil moisture, plant physiology, microbiology Administration-office services, drafting,

plant operation, photography, stores, station operations

4(9) Research Station-Beaverlodge, Alta.

Population 112 Agrometeorology and Weeds Cereals and Horticulture-horticulture breeding, horticulture management, cereal crops, oilseed crops Soils-organic matter studies, nutrient availability, cultural studies

Forage Crop Breeding and Seed Production-legume seed production, apiculture, grass breeding, legume breeding, grass seed production Forage Production and Management-pasture management, ecology Administration-office operations, farm operations, greenhouse operations, special services Experimental Farm, Fort Vermillion, Sask.-Administration, crop research, farm operations Experimental Farm, Fort Simpson, N.W.T. Crop Management Experimental Farm, Prince George, B.C.-Office and farm operations, horticulture, soils, forage, dairy cattle Experimental Farm, Mile 1019, Yukon-Crop management, farm operations

4(10) Research Station–Lacombe, Alta. Population 99

Animal Science-animal breeding, animal physiology, breeding and genetics, poultry, beef cattle and lab animals, swine breeding and meats

Plant Breeding-cereal crops-oats and barley breeding, forage crops-breeding and management, horticulture, plant pathology-cereals, forage

Crop Management and Soils-weed research, soil chemistry, plant nutrition, tillage and soil physics, operations Administration-office services, operations and property management

Soil Research Sub-Station, Vegreville, Alta. Administration-office services, operations and property management

4(11) Research Station-Lethbridge, Alta.

Population 311

Soil Science-agricultural engineering, dryland agronomy, irrigation agronomy, plant nutrition and chemistry, irrigation efficiency, organic and genesis chemistry, pesticide-residue chemistry, microbiology, physics and physical chemistry, drainage engineering, land classification, technician operations, field operations *Plant Science*-cytogenetics, cereal breed-

ing, alfalfa breeding, vegetable breeding,

vegetable culture, crop management, pasture ecology, range ecology, weeds, food technology, field operations *Plant Pathology*-winter survival, cereal diseases, forage diseases, vegetable diseases, vegetable diseases, crop residues *Crop Entomology*-wheat stem sawfly, aphids, cutworms, grasshoppers, pollinators, forage pests, sugar beet insects, special crop insects, insect attractants, toxicology, insecticide chemistry, cold hardiness biochemistry

Animal Science-wool, animal physiology, animal nutrition, animal breeding, poultry nutrition, technical unit, livestock unit, poultry unit

One-four Sub-Station

Veterinary-Medical Entomology-bioclimatology, toxicology, serology, reproduction, physiology, histo-chemistry, biting flies, operations unit

Scientific Support

Administration-office services, construction and maintenance, photography, miscellaneous services, farm operations, grounds, greenhouse Field Operations-Vauxhall

4(12) Research Station-Agassiz, B.C.

Population 71 Forage Crops-forage breeding, forage management Horticulture-small fruit breeding, small fruit management, vegetables Soils-soils fertility Animal Science-dairy cattle research, poultry research Administration-office services, farm operations

4(13) Research Station-Kamloops, B.C.

Population 42 Animal Entomology-ticks, biting flies, chemical control Forage Crop Insects Range Management-ecology and management, plant physiology Soil Science Forage Crops-crop testing Support Services-field directorate and support services, building, vehicle and equipment maintenance, farm operations

4(14) Research Station-Saanichton, B.C. Population 39

Horticulture Crops-vegetables, weed control, entomology, ornamentals, turf grasses, small fruits, nematology, pathology, virus indexing Soils and Plant Nutrition Building, Vehicle and Equipment Maintenance Farm Operations-greenhouse operations Administrative Support Services-office

services, library

4(15) Research Station–Summerland, B.C.

Population 121

Animal Science-bloat in cattle and forage, bloat chemistry Soil Science-plant nutrition, micro elements, soil moisture

Entomology-integrated control of tree fruit insects, control of coddling moth, bionomics of pear psylla, control of orchard mites, taxonomy, biology of mites, biology and control of vegetable insects, pesticide chemistry

Vegetables and Ornamentals-vegetable breeding culture, physiology Pomology-variety evaluation- thinning, fruit breeding-hardiness, agromet.growth regulators, fruit storage Agricultural Engineering-agricultural equipment development

Fruit and Vegetable Processing-candied fruit chemical compounds, eng.-new products, juice, jam, pie filling, microbiology, analytical chemistry, home economics.

Plant Pathology-tree fruit virus diseases, vegetable parasite diseases, tree fruit parasite diseases, pome and veg. virus diseases, stone fruit and grape virus diseases Administration-office services, photo services, farm and maintenance

Library Services

Creston Sub-Station-cereals and forage crops

4(16) Research Station–Vancouver, B.C. Population 54

Plant Pathology-potato viruses-serology, rootrot-horticultural crops, viruses-

horticultural crops, nematodes, legume viruses, plant disease survey, field operations

Virus Chemistry and Physiology-physiology and electron microscopy, chemistry and virus hosts, biophysics and chemistry, biochemistry and virus hosts Entomology-virus vectors, fine structures of virus vectors, leafhopper virus vectors, ecology of vectors, chemical control of insects, biological control of insects, insecticide residues, small fruit insects, stored

product insects

Soil Science Section-soil classification and capability, soil mapping-classification, soil capability-photo interpretation, soil mapping capability, soil minerologygenesis, forest capability

Administration Section-administrative services, office services, greenhouse services, photography, electron microscopy, maintenance services

Regional Library-library services

Appendix B

The Agricultural Research Coordinating Council: Membership and Terms of Reference

When the Agricultural Research Coordinating Council is established, it will be important to ensure that those appointed provide, as a group, for effectively balanced participation by the many interests which make up the agricultural community in Canada. There will be a need to balance this discipline representation and the geographical distribution of the membership, and there will be a need to ensure representation from a wide variety of organizations and agencies, including:

-the Canada Department of Agriculture

-the provincial Departments of Agriculture (though not all simultaneously)

-the universities, including those which undertake agricultural research without having either a faculty of Agriculture or of Veterinary Science

-the producer organizations -agricultural industry (e.g. processors, distributors, agricultural engineers, etc.)

-the Agricultural Institute of Canada.

In addition, it may be desirable to make available an ex-officio appointment for a representative of the National Research Council, to provide a means for effective co-ordination of the research support policies of the ARCC and the NRC.

As a basis for action, the Science Council would propose the following five terms of reference for the ARCC.

1. To take a forward view of the problems facing the Canadian agricultural industry, and, by developing a consensus among its members, to ensure that the program of Canadian agricultural research and development continuously adapts itself to serve the interests of the industry and the country at large. 2. To be responsible for the distribution of the major portion of all federal funds in aid of mission-oriented agricultural research (whether basic, applied or developmental); to establish such committees as may be appropriate for this purpose; and to collaborate with other granting agencies supporting agricultural research relating to agriculture, whether in universities, industry or elsewhere.

3. To organize continuing reviews of research in progress in the principal establishments undertaking agricultural R & D; to make summary reports on these reviews available to all members of the Board and to the establishment reviewed; and to initiate appropriate action arising therefrom.

4. To have a continuing concern for the extension and application of information generated by research.

5. To be concerned with ensuring the continuing health and vitality of Canadian agricultural research as it is performed in the university faculties of agriculture and colleges of veterinary medicine.

Appendix C

Recommendations from the Report of the Federal Task Force on Agriculture–Canadian Agriculture in the Seventies, Part 2, Chapter 4

5. Canada must experiment with pricing strategies aimed at meeting dumping of products by its competitors, e.g. 1968 and 1969 barley exports by France to Japan. This might be the best possible means to restore international competition to a commercial basis.

6. Increased trade promotion and trade development activities are required. Support and encouragement must be given for joint endeavours by farm groups, by the Federal and provincial governments, by trade associations and private business.

7. Export credit and export insurance. The Export Development Corporation must be fully competitive, in its time horizons and interest rates, with similar bodies in other countries. Credit terms are often as crucial to sales as are prices.

8. Canadian grades and grading must be improved on many agricultural commodities. Failure to move to protein grading has resulted in loss of wheat sales.

9. Emphasis must be placed on continuity of supply for export markets. Because export markets are residual markets for many products and often yield a lower net price than the home market, there has been a tendency to turn to them only in emergencies, a poor way to create a market for exports. British Columbia apples, controlled by a provincial marketing board present a sharp contrast to tobacco, winter wheat and white beans also marketed by provincial marketing boards.

Appendix D

Science Council Committee on Agriculture

Chairman

Dean L.H. Shebeski, Faculty of Agriculture and Home Economics, University of Manitoba, Winnipeg, Manitoba.

Members

Dean J.W. Ker, Faculty of Forestry, University of New Brunswick, Fredericton, N.B. Mr. A.D. Turnbull, 3614 Cadboro Bay Road, Victoria, B.C. Dr. G.F. Clarke, Vice-President, Canada Packers Limited, 2200 St. Clair Avenue West, Toronto 9, Ontario. Mr. David Kirk, Secretary, Canadian Federation of Agriculture, 111 Sparks Street, Ottawa, Ontario. Dr. Bertrand Forest, Director, Research and Education, Quebec Department of Agriculture and Colonization, Parliament Buildings, Quebec City, Quebec. Dr. B.B. Migicovsky, Director General, Research Branch, Canada Department of Agriculture, Ottawa, Ontario.

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The Committee is grateful to its Secretary, Mr. J. Mullin, and to its Project Officers, Dr. A.H. Macpherson (up to April 1969) and Dr. W.J.D. Stephen (from April 1969), and to the Study Group led by Dr. B.N. Smallman.

*Member of Science Council of Canada.

Publications of the Science Council of Canada

Annual Reports

First Annual Report, 1966-1967 (SS1-1967) Second Annual Report, 1967-1968 (SS1-1968) Third Annual Report, 1968-1969 (SS1-1969) Fourth Annual Report, 1969-1970 (SS1-1970)

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