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AGRICULTURAL RESEARCH AND DEVELOPMENT IN ATLANTIC CANADA

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The status of the agricultural industry in Canada is summarised and the segment of the industry in the Maritime Provinces reviewed in its relationship to the whole. The level of research and development in the industry in the Maritime Provinces is examined in detail, and it is concluded that an increase in such activity is desirable. Areas that require greater investment in research and development are presented.

Introduction

Agriculture in Atlantic Canada generates farm-cash receipts of approximately $400 million annually and with value added, the sector grosses in excess of $600 million in total revenues. Farmers in the region, aided by government, are oriented toward growth. Under the aegis of the Maritime Farmers Council, a product of the 3 Maritime Federations of Agriculture, producers have set for themselves the target of tripling the size of the agricultural industry in the region by the early 1990's. This initiative, which was effectively launched in late summer of 1979 within the framework of "The Billion Dollar Challenge", has given a sense of purpose and direction to this industry at the very level where the action is centered and where the development must ultimately begin, i.e. on farm and among producers. But let us examine more carefully some of the trends and indicators within the agricultural sector as a basis for reflection on future research and development initiatives.

Canadian agriculture generates in excess of $10 billion annually in farm cash receipts (Table I), 52% of which is derived from the sale of livestock and their related products and the balance (48%) accrues from the production of a diverse array of crop plants.

The 3 Maritime Provinces contribute about 3% of this total from 4% of Canada's census farms. Livestock in this region commands a proportionately greater share of attention than the national whole, accounting for approximately two-thirds of the total farm receipts.

Some measure of the extent to which Atlantic agricultural potentials are currently developed can be obtained by relating the extent of present farming to the total land area which is considered suitable for agriculture, as classified according to the Canada Land Inventory, classes 1 to 6 inclusive. Canada's food-land resource totals about 122 million hectares (Table II). If we assume that the bulk of the present farms are already located on land that falls within this same class range, then a surprising 56% of the adapted whole is currently utilized, ranging from a high of 84% in Saskatchewan to less than 1% in Newfoundland. Looking specifically at the Maritime Provinces, one is not surprised to find that Prince Edward Island has the highest rate of suitable land already committed to agricultural purposes, followed by Nova Scotia where there is potential for a near tripling of actively farmed lands and finally, New Brunswick which, with its relatively low level of utilization for agricultural purposes, appears almost as a development frontier.

The great bulk of the potential agricultural land is class 3 or lower, i.e., the soils have distinct limitations such as in fertility, organic matter content, moisture, etc.; nonetheless there is sufficient adapted land to support significant growth within the sector (Table III).

Table I. Farm-cash receipts (1977) for Canadian agriculture

	Thousands of Dollars
Nova Scotia	127,000
New Brunswick	109,000
Prince Edward Island	88,500
Quebec	1,430,000
Ontario	2,860,000
Manitoba	899,000
Saskatchewan	2,140,000
Alberta	1,990,000
British Columbia	502,000
Canada	10,100,000

Table II. Utilization levels for agricultural land in Canada (hectares x 1000)

	Total Farmland	Potential Agricultural Land	Percentage Utilization
Newfoundland	25	3,306	1
Prince Edward Island	309	523	59
Nova Scotia	529	1,650	32
New Brunswick	538	5,000	11
Quebec	4,288	6,390	67
Ontario	6,441	12,815	50
Manitoba	7,591	11,710	65
Saskatchewan	26,016	31,153	84
Alberta	19,814	39,649	50
British Columbia	2,318	14,570	16
Canada	67,734	121,766	56

Agriculture in Canada has enjoyed relatively steady growth in spite of a continued consolidation in the resources (land and labor) used in food production. The development record over the period 1961-76 has in fact been a very creditable, 3.5% growth per year in indexed dollars (Table IV).

Comparable figures for the Maritime Provinces for the same period, however, show an average growth in real-farm cash receipts of 1.2%/annum for Nova Scotia; 2.9% for Prince Edward Island, and zero growth for New Brunswick. If the current growth rate only is sustained, we will experience only 15% growth overall by 1990 or about 60 million indexed dollars. On the other hand, Maritime ingenuity and drive in concert with a significant developmental impetus within the sector could result in a farm-gate value of $600 million or 50% growth over the next decade. If so, then the balance of the billion dollars sought in the "Challenge" will have to come from ad-

Table III. Potential agricultural land by soil capability, class and province, Canada, 1971 (hectares x 1000)

Soil Capability Class	B.C.	Alta.	Sask.	Man.	Ont.	Que.	Atlantic Provinces	Canada
1	70	831	1,072	184	2,249	14		4,402
2	398	4,041	6,446	2,556	2,360	976	611	17,388
3	1,000	6,477	10,082	2,190	3,279	1,381	2,561	26,940
4	2,132	9,940	4,252	2,573	2,902	2,830	2,544	27,173
5	6,138*	11,433	7,799	2,250	1,910	1,636	2,352	33,518
6	5,358*	3,794	4,065	2,162	1,192	9	2,903	19,483
Total	15,096	36,486	33,716	11,915	13,892	6,846	10,971	128,904

*Incomplete

Sources: (1) Canada Land Inventory, Soil Capability.
(2) British Columbia Environmental Land Use Commission Victoria, B.C.

Table IV. Historical performance of the Canadian food industry

	Real Domestic Product: By Sector		
	Agriculture	Fisheries	Food Processing
1961	100.0	100.0	100.0
1964	123.9	110.9	117.9
1967	118.6	115.6	136.8
1970	131.4	119.7	149.3
1973	142.3	104.1	166.9
1976	153.3	N/A	173.5

* Indexed measure of output in constant 1961 dollars.
Source: Statistics Canada publications, catalogue 61-005 (March 1974 supplement) and 61-510.

ding value to the sector through more complete processing and product manufacture from the base agricultural products of the region.

Some added insight to development potentials can be obtained if one compares present returns per hectare of land farmed from province to province across Canada (Table V).

Although a very coarse input/output measure, the average rate of return per hectare committed to both crop and livestock enterprises exceeds the national average but falls substantially short of Quebec and particularly Ontario which have a similar sort of agriculture to the Maritimes. Again Prince Edward Island appears to derive

Table V. Cash receipts per hectare of land farmed in Canada, 1977

	Total Farm Enterprise	Crop Receipts Only
Newfoundland	*	*
Prince Edward Island	286	132
Nova Scotia	240	51
New Brunswick	203	81
Quebec	333	31
Ontario	444	146
Manitoba	250	64
Saskatchewan	82	63
Alberta	100	50
British Columbia	217	72
Canada	149	65

*Not available

the highest level of return from its present foodland resource whereas, New Brunswick is on the low side among the 3 Maritime Provinces. These data do suggest: (1) the importance of stressing commodities which can be grown to comparative advantages with potential for maximum returns; and (2) there is a need and an opportunity to increase efficiency in relation to the output from the basic units of adapted agricultural land. I project that better utilization of existing resources alone would add nearly $300 million annually to the Maritime farm total.

Certainly the point I wish to make is simply that the "Billion Dollar Challenge" target is attainable even within the time frame set by its principals. If this goal is to be achieved, however, Maritime farmers as a whole must become more innovative and oriented toward sector growth. Most importantly, they should strive for even higher levels of returns from their base land, labor and material resources inputs through the employment of even more effective production and marketing approaches.

Agricultural Research

The challenge to the agricultural researchers flows quite naturally from the foregoing. As I see it, the role is primarily one of enhancing the comparative advantage for food production in Atlantic Canada by identifying those commodities which the region might produce to advantage and secondly, developing the appropriate technology to enable regional producers to fully exploit their apparent advantage. There is a responsibility also, which is jointly borne by industry and government, to ensure consumers in Atlantic Canada of a safe, well-balanced or nutritious diet of foodstuffs at reasonable prices and in reliable supply. This suggests continued production of certain commodities which may not be grown locally to any comparative advantage but which through problems of transport, supply, and perishability would be scarce and more costly were it not for the commitment of local producers. These same commodities, and the dairy sector is a good example, often require some level of public subsidy to ensure adequate returns to the producers and here also, there is significant responsibility on the scientist and the farmer to develop and employ a level of technology which minimizes the subsidization demands of the sector.

Let us look then at agricultural research as it is practiced both nationally and regionally. And because this sector is so integrally interwoven with the social and economic fabric of Canada, we should identify at least some of the major current issues and challenges.

Resources

It is difficult to provide a highly accurate description of the resources allocation to agricultural research. However, because of the sheer size of the sector we can tolerate a fair amount of error and still arrive at a fairly thorough overview.

Total expenditures on food and agricultural research (Table VI) in 1978-79 approximated $263 million. And the largest single research component, or 51%, is represented in the R & D activities of Agriculture Canada with its professional staff of about 937 scientists dispersed among 55 establishments from coast to coast. Universities, we estimate, commit an additional 520 full time person-years or about 30% of the national effort. Industry selectively employs another 140 scientists, largely in the food research and plant breeding fields; and the National Research Council through its network of laboratories devotes about 46 person-years of professional R & D support to the food and agriculture sector.

The adequacy of this level of commitment can be assessed in several ways. On the one hand, expenditures can be related to the gross returns, i.e., overall economic

Table VI. Resource allocation for agriculture and food research, 1978-79

Agriculture Canada	$134.7 million
Fisheries and Environment	38.0 million
N.R.C.	10.7 million
Universities	57.2 million
Provinces	9.6 million
Industry	12.5 million
	$262.7 million

impact of the sector. Excluding imports, the food and agriculture producers of Canada, consisting of farmers and processors, must gross something in the order of $25 billion annually. Conventional wisdom has dictated that a 2% R & D investment is of the right order of magnitude which, if applied, would dictate annual expenditures of about $500 million to food and agricultural research. Clearly the present $275-300 million is nearer the 1% level and about half-strength if judged by this yardstick.

Adequacy might better be judged however in terms of the principals in the food system serviced by this research community, i.e., the farmers at the one end of the chain and consumers at the other. In short, can we relate with the clientele and draw some appropriate conclusions?

Table IV shows that in spite of a massive 50% consolidation in farm numbers over the past 30 years and a 25% reduction in designated farmland, there has been steady growth in the real output of the farm sector as it has been in the order of 3-4% per annum over the past 2 decades. Most significantly the growth rate has exceeded the 2%/year cited for the United States agriculture, although the measure of reference is for a significantly longer period of time. Farming generally in this counry is, I believe, in a reasonably healthy state and I share the view of persons like Wortman (1979) that science as well as industry have effectively provided the building blocks for the relatively advanced agricultural systems which make up Canadian agriculture.

And the Canadian consumer appears fairly treated as well. The proportion of income spent on food has declined progressively over the past 20 years to less than 20% of disposable incomes although inflation has somewhat reversed this trend lately. Nonetheless Canadian food costs are either the lowest or certainly among the lowest in the world, and this too is a tribute to those who labor within the Canadian food system as well as to the level of technology which they employ.

These 2 indicators, at least, suggest that the sector is reasonably well-attended. I accept also that higher order R & D inputs are likely to further stimulate real agricultural growth as well as to give additional advantage to the consumer. But the basic question of adequacy can, it seems to me, be responded to affirmatively. What may be more to the point, however, is the adequacy of the distribution and the regional health of the food and agricultural research effort.

Again, recalling earlier-cited statistics, real growth of Maritime agriculture has been averaging only about 40% of the national growth rate. Does this relate in any way to the relative extent of R & D supports?

It is true that in the absence of any agricultural faculties at Atlantic universities, this significant source of expertise is relatively underdeveloped in the region. Most

recently we see signs of encouraging developments in this direction at the Nova Scotia Agricultural College in relation to the basic agricultural sciences and similarly, there are healthy indications of new initiatives in food research.

The provincial Departments of Agriculture in Atlantic Canada have not developed any extent of R & D programs. Instead, with their own constraints on resources, they have chosen to support and complement the federal Research Stations within the region by transferring and extending new technologies to the farm level.

Federal science managers would probably insist that budgets and related resource allocations to the region are equitable as the present $12 million allocation to the existent federal institutions represents about 4.5% of the total Canadian agricultural research budget and that equates very favorably with the approximate 4% gross output of the region.

Such an attitude ensures, however, only the status quo and surely militates against future growth in the regional sector. The facts are that the region includes 9% of Canada's foodland resource, 10% of its people, and moreover, its farmers have said that even in today's economic terms, a reasonable target for total farm gate returns would be $1 billion or again, 10% of Canada's gross farm output. Clearly, if the Atlantic Region is to break out of its historical performance bounds, the scale of research investment should be in the order of a doubling of present R & D commitments to the sector.

Such stimulus would not only enable the proper franchise of the Agriculture Canada Research Stations to service the commodity development interests but would in addition encourage a significant commitment of university and industrial researchers in the region to food and agricultural research.

The Program

Considering the great diversity in crop and livestock enterprises as well as the complexity of the food system itself, any initiatives to generalize on program would seem relatively futile. On the other hand, there is just enough commonality to allow one to identify several recurring elements.

Resources development or the concept of more efficient utilization of existing natural soil, water, and climate resources is a logical beginning point. In spite of the fact that our soil resource has been systematically mapped and classified, I find very little information which can be used to determine the suitability of our Atlantic soils for production of the various existent and potential crop species. Nor do development initiatives selectively differentiate and stimulate crop production according to any philosophy based on a "best use" concept. The consequence is under-utilization of the based soil resource and so we find some of our best class 2 land given over to pasture while at the other extreme, fruit growers are attempting to develop highly productive orchards on land which should be pastured.

Even given adequate inventory and suitability data, we need many more technological developments to enable a fuller exploitation of the soil resource. Agricultural soils in the Atlantic region are generally acid, low in fertility and organic matter content, imperfectly drained, and inundated with physical or structural problems, both natural and man-made.

Water, in a maritime environment would seem invariably to be a natural resource in excess supply yet on the lighter soils and particularly with the production of the relatively more intensively-cultured, high value crops, significant drought stresses and loss in productivity will usually occur one or more times throughout the growing season. We are generally lacking in appropriate irrigation technology.

Climate itself might seem at the outset to be beyond easy manipulation. Nonetheless, as we attempt to farm under relatively harsh conditions, it behooves us to develop ways and means which enable the manipulation or fuller exploitation of that which we have. To give examples of the sorts of technology which need stimulus let me cite; 1) the matter of windbreaks and hedgerows and their impact on plant and animal production and protection; and 2) protected culture and the use of plastics and other means to extend the growing season through the artificial creation of a suitable environment for plant growth.

Breeding and genetic manipulation is the next major component of agricultural R & D which warrants continued stimulus. Remarkable strides have already been achieved in quality and with output of everything from milk and eggs to gherkins and strawberries. Moreover, the base adaptation has been altered to the point where crops such as grain, corn, and soybeans, which simply could not be grown here 10 years ago are now part of the local agricultural scene.

Natural speciation and survival has contributed also to genetic variability for traits which govern tolerance to various economic diseases and insect pests. Often the lowest cost and most stable means for control has been delivered by the breeder and geneticist.

Much is said these days about plateaus and it may be that some of the early works will be the most dramatic. The following table (Table VII) illustrates something of the contrast between known potentials and average production based on 1974 statistics, and I have no doubt that many of these so-called records are being re-established at new, even higher levels.

The third major challenge is the *development of efficient production and protection technology* which would enable the full exploitation of the enlarged genetic potentials. The poultry industry with its factory-type operations most closely approaches the upper limits of performance of any of the commodities. Hog production follows next on the efficiency hierarchy and the key is most likely that a fairly well-defined and complete system of production has been put in place in both instances. Housing structures, optimum population size, diets, animal health programs, etc., have been well-elaborated in economic terms and recommendations consequently have become standardized. Even more important, producers have

Table VII. Average and record yields (Wittwer 1975)

Food	Average, 1974	Record
Corn (bu/acre)	72	307
Wheat (bu/acre)	28	216
Soybeans (bu/acre)	24	110
Sorghum (bu/acre)	45	320
Oats (bu/acre)	48	296
Barley (bu/acre)	38	212
Potatoes (bu/acre)	420	1400
Sugarbeets (ton/acre)	19	54
Milk prod'n/cow (10^3 lbs)	10	50
Eggs/hen	230	365

generally seen a better-than-average success ratio in these instances and are now looking for something similar with the other commodities.

Unfortunately, where climate, disease, or pest variables are relatively less stable, these base production systems are less-easily defined. Nonetheless some parameters can be stipulated to the advantage of producers and a reference point established to which one can begin to build with better understanding and manipulation of the components within the system.

Fourth and final among production-oriented programs is the need to develop *improved technology for the harvest, handling, and storage* of plant and animal products, not only to maximize output efficiency on farm, but also to assure improved quality and greater continuity of supply and hence, more efficient marketing technology overall.

The fifth major category of R & D effort to which I will refer is the so-called "P.D.R." or processing, distributing and retailing sector. It is the program area which selectively will experience significant growth over the decade of the 1980's as at present only about 8% of food and agricultural-research resources are committed to this sector. There is also an increasing awareness of the significant development impact which will acrue with more complete processing and preparation of foods from our raw products array.

Development of new products and improved processing and food manufacturing technologies constitute the 2 major research initiatives within the sector. I would look for leadership first from the industry itself, but there is also a continuing role for the governmental and university laboratories in support of the processors, both large and small.

The Issues

To conclude my remarks on agricultural research, I would propose to highlight just a few of the more significant issues which are very much a part of today's agriculture.

(1) *Credit costs and high capitalization.* The high cost of land, buildings, and machinery makes it increasingly difficult to attract new entrants into farming as a vocation. Moreover, the current high price of borrowed money required to provide operating capital, particularly for those commodities where there is a substantial lapse in time between planting and harvest is a major determent. Land assembly and extension of leasal arrangements to farm operators would ease the capital burden since about 75% of capitalization in farm enterprises is tied up in the land component. Similarly, programs already exist to enable advances in payment for certain crops and in this way assist the producer to bridge the interval from seeding time to the point where his crop can be marketed.

(2) *Mechanization* is an issue today with significant socio-economic ramifications. There is, as noted earlier, the high capital-cost burden associated with equipping many of today's modern farms. Appropriate machinery technology needs further research and stimulus to production, particularly as relates to Atlantic Canada since we have no local manufacturing base but rely instead primarily upon the United States technology which is geared to the west and the mid-west with their highly extensive type of farming.

An additional aspect of the mechanization issue is the growing opposition in the United States to the public funding of research aimed particularly at mechanization of the harvest operations. This has become a

highly emotional matter and the labor movement with its basic job concerns appears to be gaining ground since Agriculture Secretary, Bergland has openly declared his opposition to continued funding of mechanization research and stated that private firms should be paying for these developments.

In an area such as Atlantic Canada where unemployment rates are relatively high, it seems incongruous to commit significantly to mechanization R & D. The consequences of not moving in this direction are serious however. Farm labor situations are simply least-choice options and without machine substitutions for labor, the competitive position of farmers will erode to the point where certain commodities can no longer be produced locally.

(3) *Chemical technology and particularly pesticide usage* is a matter of continuing concern to Canadians. All of us prefer our foods "au naturel" without chemical additives. Even as recent as January 30th, Agriculture Canada's Deputy-Minister, Gaétan Lussier, issued a formal statement on this issue:

"The Department's position is that the use of chemical pesticides is essential to efficient agricultural production and an abundant food supply. Pest-resistant varieties, integrated management techniques, cultural practices and biological control methods are the first line of defence against insects and weeds, but judicious use of pesticides is essential to modern agriculture. In other words, their use at the present time is necessary for maintaining an acceptable level of agricultural production. If viable and economical alternatives become available, Agriculture Canada will be the first to support their general use."

Clearly the importance of stimulating research to develop resistant varieties and alternative approaches to disease, insect and weed control cannot be overemphasized. The high development costs associated with new pesticides and the increasing restrictions and withdrawals by regulatory authorities serve only to make the overall situation more acute.

(4) *Energy*. Apart from the significant input production cost increases associated with rising fuel costs, there is growing interest in Canada in the feasibility of displacing hydrocarbon fuels with energy sources derived from agricultural crops. Alcohol fuels may offer feasible options according to Hayes and Timbers (1980) and major pilot production studies are currently underway in North America and other countries.

Basically, any substantial agricultural contribution to the national fuel requirement would require an extensive land base, suited to large-scale production of industrial crops. That does not sound very much like Atlantic Canada but more nearly describes Prairie agriculture to my view. On the other hand, however, significant quantities of waste or cull potatoes are available in the region and offer excellent substrate for small-scale "moonshine" or turnkey operations which could potentially service the fuel needs of relatively small groups of cooperating farmers. Similarly crop residues and wastes are available from local processing operations which might offer usable substrate. Engine technology, licensing, and distribution concerns will require some resolution prior to any widespread developments. Nevertheless energy production in association with Atlantic agriculture is worthy of further exploration.

DeWit (1979), from the Netherlands, has written recently on the greater issue of limited availability and increasing costs of energy sources and his conclusions are

worth sharing. Not only is the issue one of fuel, for there is direct implication to the supply of chemical fertilizers and pesticides as well. He states:

> "If energy should become a very scarce resource, it would be possible to grow agricultural products without the use of yield-increasing inputs. This would lead to lower yields and would still result in an increase of the added energy use per unit product, unless the energy use for substitution of labour were minimized at the same time. It may be questioned whether the total production volume would then be large enough to cover the basic needs. It is, however, certain that under such circumstances all reclaimable soil would have to be taken into production and much labour would be needed on the farm; it would then be impossible to maintain the urban civilization we seem to like.
>
> However, although scarce, it seems likely that energy is available in at least reasonable quantities for a long time to come. In that case, agriculture may contribute to a sensible use of energy, by developing in a direction where as high yields per hectare as possible are obtained from as small an acreage as possible by a reasonable number of highly skilled farmers per hectare. The spin-off from increasing energy productivity by higher yields per hectare and some substitutions of energy by labour may be considerable:
>
> (i) less energy use per unit of product; (ii) greater need for skilled labour in a society where job opportunities are limited by automation; (iii) more land available for other purposes; (iv) reduction of the environmental impact of agriculture because less resources are used per unit product and then in a more confined area; (v) and last, but not least, a challenging task for the agricultural scientist."

This statement provides a good point at which to conclude my overview of Atlantic agricultural research. While I am of the opinion that the resources fall short of the developmental requirements for the sector in the region, I believe that the base orientation of the research has been in the right direction and that the achievements to date are already significant. Our future is surely vested in the degree to which we succeed in effectively utilizing our rather limited resources and in the extent to which we exploit the unique comparative advantages which the region does enjoy.

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