FOOD RESEARCH - FOR WHOSE BENEFIT?

Joseph H. Hulse*

C'est un honneur et un grand plaisir pour moi de présenter le discours à l'ouverture de cette vingt-et-unième conférence du CIFST. Il y a vingt ans, le Conseil me donnait une tâche formidable: être Président du programme de la première conférence de l'Institut qui a eu lieu à Montréal en 1958. Je dis "formidable" parce qu'il fallait alors assurer l'assistance d'un minimum de 150 délégués afin d'empêcher l'Institut de "crouler".

Heureusement, la participation d'orateurs superbes ainsi que l'hospitalité incomparable de la belle province de Québec ont attiré plus de 180 délégués. L'Institut a donc survécu pour en arriver à sa position d'importance et de prospérité actuelle. Il faut remercier et féliciter tous les présidents et officiers qui se sont succédés à l'Institut et qui ont contribué à son succès.

This being Sunday evening a homily may seem more appropriate than a lecture. If this is so I would choose for my text:

> "So let your light shine before men (and women)
> that they may see your good works."

The question that we as an institute and as individual food technologists and scientists must ask ourselves is: what good works have we to offer that will withstand the penetrating light of public scrutiny?

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Winston Churchill's recommendation was that before embarking on any new venture one should first examine the history of what has gone before. Therefore before suggesting what good works we might seek to perform in the future, first it may be useful to reflect upon some of the events of the past.

It is twenty years and ten days since I was honored by being installed as President of CIFT at its first national conference in Montreal.

Without wishing to display undue chauvinism or zenophobia it was the belief of the CIFT Council that the first and subsequent conferences should be uniquely Canadian and that part of each conference program should be given over to a critical examination of how well we, first as Canadians, second as food technologists, were serving Canadian consumers, and the Canadian food and agricultural economy.

The program in Montreal was designed to take stock of Canada's food technologies, of the industries that practice them and the consumers they seek to serve. The program was based on the premise that scientific principles are universally valid and transferable, many technologies including vertically integrated systems of production, processing and distribution are not readily translocated from one environment to another. What is good for General Motors (or British Leyland) is not necessarily good for Canada.

Consequently several outstanding Canadian scientists were invited to take part in the first conference, each speaker being representative of a major food processing industry or consumer interest.

Many of us will remember with deep gratitude those who contributed so greatly both to the first conference and to the subsequent growth of CIFT and who are no longer with us including such great Canadians as Gordon Maybee, Ralph Larmour and Felix Lehberg. Fortunately, several of the remainder including Leon Rubin, Ross Chapman and Bob Marshall continue to inspire us with their wisdom and unique standards of professional competence.

When preparing this talk I read again the papers presented at the first 1958 conference. Bill Carrol, Senior Vice-President of Canada Packers, set the tone twenty years ago when he said, "Among food executives there is more reliance on scientists than the scientists realize... In many cases the scientists are not ready to accept the responsibility executives are prepared to give them." Bearing in mind how very few food scientists are to be found among the presidents of Canada's major food companies and that not a single Federal Deputy Minister possesses a degree in food science, Bill Carrol were he here today could confidently repeat his statement of twenty years ago.

If we the members of CIFST have not been active as senior executives what have we been doing over the past twenty years that is worth reporting?

One objective common to almost all food industry research and development over the past two decades is clearly evident - to lower the labour intensity in all components of the food system by reducing the human physical effort in production, in quality control and, most important for the consumer in the home. In 1958 Leon Rubin described the trend in most meat packing plants as being "to replace batch methods with continuous

rapid processes with consequent savings in labour and space, and more uniform and sanitary products." It is probably fair to say that the increased production efficiency that subsequently justified the Rubin prophecy owes much more to adaptive engineering than to fundamental food science. With a few notable exceptions, modern food processing appears largely as an extension of the industrial revolution of the 18th and 19th centuries in which machine power replaced person power. The most noteworthy fact is that the food industry was slower to adopt mechanization than the textile and transportation industries.

Similarly the dehumanizing of process and quality control is in large part attributable to the ingenuity of the physicists and electronic engineers who provide the spectrophotometers, autoanalyzers and feedback mechanisms with which to replace the professional chemist and his old fashioned methods of gravimetric and volumetric analysis.

Dr. Rubin also said in 1958 "The modern housewife demands convenience and she is going to get it." No one ever spoke truer words. One does not require a degree in food science to recognize how the Rubin prophecy has been fulfilled. The food technologist probably more than anyone has helped to liberate Canadian consumers from kitchen chores. It would be interesting to speculate to what extent the convenience products of Canadian food technology have contributed to the increase in married women in the Canadian labour force.

Winston Churchill is also supposed to have commented that most people use statistics as a drunken man uses a lamp post - to lean upon rather than

for illumination. Statistics may seem dry and dusty for a summer Sunday evening; nevertheless a few may serve both to support the subsequent arguments and also illuminate some of the patterns of change that Canadian food and agriculture has experienced over the past twenty years and what may be in store during the next two decades.

In 1958, agriculture stood first in the Canadian economy representing seven per cent of the GNP. Now it has dropped to become the second largest primary industry representing four percent of GNP. Over the past twenty years the number of census farms has declined by 40 percent and there has been a 50 percent reduction in the number of Canadians reporting farming as their principal occupation. Though fewer farms are contributing a larger share of total production there is a trend towards increased specialization; the average number of commodities per farm having declined from 4.9 in 1951 to 3.7 in 1971. Agriculture is still however one of the most productive industries in terms of increased output per capita.

In total sales, the food and beverage industry is Canada's largest secondary industry, its real growth at three percent per annum falls far short of many other major secondary industries. Among the fastest growing are the producers of alcoholic beverages, animal feeds and vegetable oils. Meat packers, fruit and vegetable processors are growing at barely two percent per annum, cereal industries are at zero real growth and the dairy industry is in significant decline. At the 1958 conference Ralph Larmour's vision of the bakery of the future was a few men replenishing ingredient bins and tanks with one technician pressing buttons and watching colored

lights on a multiple control panel. If the baking industry doesn't see fit to invest more heavily in imaginative research even the colored lights may soon go dim.

CONSUMER PATTERNS OVER THE PAST TWENTY YEARS

Per capita calorie consumption has remained comparatively stable (Figure 1). The composition of the food basket has changed - meat, poultry and fish consumption have risen sharply. Plant products, mainly fruits and vegetables, are rising steadily, dairy and eggs have declined sharply and there has been a dramatic decline in sugar syrups and beverages since 1972 (Figures 2,3). Expenditures on food have risen faster than the consumer price index. Using 1971 as a base year the food retail price index increased by 128 percent between 1961 and 1975; all other consumer items increased by only 85 percent during the same period (Figure 4).

Nevertheless food expenditures as percent of Canadian disposable income declined from more than 22 percent to 18.3 percent during the past twenty years. The fact is that disposable income has risen faster than expenditures on food (Figure 5).

For the future, per capita food consumption (i.e. calories per capita consumed) is likely to remain fairly stable but meat, poultry, fruits, vegetables, vegetable fats and oils, are likely to increase while dairy products and carbohydrates are expected to decline.

Perhaps the most important forecast by students of the Canadian food

scene is that by the late 1980's at least 50 percent of all meals will be eaten or prepared outside the home. Furthermore a recent study stated that about 50 companies control 45 percent of the entire hotel, restaurant and institutional trade, a situation not dissimilar from the grocery products retailing business in which comparatively few giants control most of the business. Consequently over the next two decades we may well see the food industry distributing most of its manufactures roughly equally between (a) large restaurants and fast food take-out chains, and (b) an even smaller number of companies that control the grocery chain outlets. It will be interesting to observe how this heavy concentration of power affects consumers' interests.

RESEARCH IN THE AGRICULTURE AND FOOD SYSTEM

Investment in agricultural research in Canada represents roughly two percent of farm income, 50 percent of which is financed by the federal government and 30 percent by provincial governments. The government's investment in agricultural research has increased significantly over the period we are studying and during the past ten years the government's agricultural research investment has almost tripled. However Canadian investment in agricultural research is not exceptionally high by developed country standards.

In sharp contrast to agricultural research, investment in food research in Canada is pitifully low - over the past ten years it has increased by only 11 percent in terms of constant dollars and as a percentage of food factory shipments research expenditures have declined from 0.14 to 0.12 during the

past ten years (Figure 6). The zenophobics in our midst may claim that research in Canadian subsidiaries is impeded by foreign ownership. This argument cannot be readily substained by the facts. Foreign ownership of the food and beverage industries is 25 and 33 percent respectively. The expenditure on R & D represents about 0.12 percent of sales. Forty-three percent of the paper industry is foreign owned yet their investment in R & D represents 0.4 percent of sales. The Canadian chemical industry is 81 percent foreign owned yet it invests 3.1 percent of sales in R & D (Figure 7).

IMPORTS AND EXPORTS OF PROCESSED FOODS

Processed foods valued at 580 million dollars represent about 27 percent of our total food imports. In spite of the decline in consumption of Canadian dairy products, 11 percent of the processed imports are dairy products and 10 percent processed vegetable oils.

CEREALS

Wheat flour represents a significant portion of our processed food exports yet it is probable that as much as 15 percent of what we export goes to developing countries as food aid under concessional terms. In Canada we possess as comprehensive a knowledge of the nature, structure and composition of wheat as any nation on earth yet our cereal industry is static and per capita consumption of cereals is declining.

In spite of our outstanding knowledge of cereal chemistry and technology, we import almost all our milling, baking and other cereal processing machinery.

Wheat flour milling has not changed in principle in 6,000 years during which time the industry has done little more than to replace slave and donkey labour with, first, water wheels and later electric motors. Why has Canada not become a vertically integrated merchandizer of not only wheat, but of all of the machines, equipment, technological and management know-how needed to process wheat? Flour mills and bakeries are being constructed all over the world and the only piece of the action to which Canada has access is the provision of a comparatively small proportion of the wheat consumed. In this context, twenty years ago our best customer, the United Kingdom, used 65 percent of Canadian wheat in its bread grist. Then a couple of bright physical chemists and an engineer invented and developed the Chorley-Wood process. Now Britain uses only 35 percent Canadian Western wheat in its bread flour. When it was proposed some years ago that Canada should move to invent, develop and market a simpler system of flour milling, the idea was opposed on the grounds that we could not sustain a major food machinery exporting industry with a population of only 20 million people. It may be interesting to note that one of the world's most successful manufacturers of flour milling and other food machinery resides in Uzwill, Switzerland. Switzerland's total population is about equal to that of the province of Quebec; what is more, the Swiss don't combine-harvest much wheat from the gentle slopes of Montblanc.

As already mentioned, foreign dairy products represent 11 percent of the total processed food we import. Tom Cooper, in 1958, stated "What the future holds for the dairy industry will be decided by many factors, not least of which is the part played by the food technologists." I would

not presume to suggest that the food technologist has not played a useful role in the Canadian dairy industry. But clearly if the declining consumption of processed dairy products is to be reversed and the large volume of imported dairy products replaced by home manufactures, dairy technologists should not be swelling the ranks of the unemployed during the next twenty years.

EDIBLE OILS

At the 1958 conference Felix Lehberg proposed three ways by which science could benefit Canada's edible oils industry:

(1) chemical synthesis of edible fatty oils;

(2) improvement of Canadian oilseed production; and,

(3) improved processing technologies in the vegetable oils industry.

As Canadians we can be justly proud of the joint achievement of the plant breeders of the Canada Department of Agriculture and the scientists of the Prairie Regional Laboratory who developed rapeseed varieties low in both erucic acid and glucosinolins. Dr. Burt Craig's ingenious method of analyzing the fatty acids present in half a rapeseed cotyledon by GLC provides a fine example of how analysis can be used for technological progress rather than as a means of filling laboratory notebooks and scientific journals.

I feel sure were he here, Felix Lehberg would concede that current economic facts militate against the commercial synthesis of fatty acids from either petroleum or coal tar by-products. But what about microbial synthesis? Glycerol was for years produced by fermentation of simple sugars with the common yeast S. Cereviseae. As every microbiologist knows, by adding bisulfite, the pyruvic acid in the Robinson-Harden and Young cycle is blocked and the main

product of the yeast fermentation is glycerol rather than ethanol and carbon dioxide. Several mold fungi that will convert carbohydrate to lipids are known and there are probably many thousands of others yet undiscovered. Given a fraction of the effort spent on microbial protein synthesis one might cheerfully anticipate an economically and practically sound use of lipogenic organisms to convert surplus carbohydrate to edible fats.

CIFST IN INTERNATIONAL AFFAIRS

At its meeting in late 1959 the CIFT Council appointed a Committee on International Relations to explore what role the CIFT might play in international food science in general and how it could help the then embryonic Freedom From Hunger campaign in particular. The outcome was the Canada/Mysore project, a project to which many members of CIFST and the Canadian food industry made an immense contribution. It can be stated with some confidence that no other professional scientific organization in the world has successfully undertaken any comparable venture in assistance to developing countries. During the ten years the International Food Technology Training Centre of Mysore was financed from Canada, more than 800 Asian food technologists were trained there. Former graduates and trainees are to be found in almost every country and food research organization throughout Asia.

The centre at Mysore was recently designated as an associated unit of the United Nations University with special responsibility for training food scientists and technologists from all parts of the developing world.

Consequently the good work at Mysore that so many members of CIFST helped to make possible will continue long into the future.

THE FUTURE OF THE CIFST

What is to be the future for Canadian food scientists and technologists? What should be our priorities for research and technological development? Consequently what skills, attributes and attitudes will future Canadian food scientists and technologists need to possess and what formal training will they need?

It has already been mentioned that Canadian per capita calorie intake is unlikely to increase significantly in the next ten years. Our population increase will continue to be relatively small given our low birth rate (.4 percent per year) and restricted immigration. Consequently any growth in one branch of the food industry will probably take place at the expense of another.

If we are to believe that within ten years 50 percent of all Canadian meals will be cooked outside the home, the industries that supply the restaurant, institutional and take-out food services are likely to have an edge on those that serve the consumer only through the grocery store. It is difficult to believe that fast take-out service will be dominated perpetually by hamburgers and fried chicken. Consequently there is considerable scope for technological ingenuity in developing an imaginative wide range of portion-controlled easy-to-serve foods for the fast food service outlets.

We may bewail the fact that the Canadian dollar finds difficulty floating

in the Dead Sea, but let us recall Francis Bacon's Obiter Dictum that "A wise man makes more opportunities than he finds". A devalued dollar may cause distress to importers but it offers an immense advantage to exporters and to those who can provide a cheaper substitute for an imported product. So why aren't we promoting new and nutritious fruit drinks from the Canadian sunshine tree? What are we doing to replace expensive imports of fresh fruits and vegetables during the winter months with cheaper packs of stored, frozen, dehydrated or pre-cooked alternatives? Most important why are we not exploring more aggressively what the oil-exporting countries of the Middle East may wish to buy and which we can supply in the form of processed or partially processed foods and managed technologies? Contrary to some people's belief, the majority of the Middle Eastern people are extremely kind and friendly, and willing to pay a reasonable price for a reliable product or service. It's high time we, as supposedly creative professional people, cast our vision beyond the eye-level or end-aisle display in the Dominion and Loblaws and realized that while there are only 22 million of us spread around Canada, there are approximately 4,000 million people outside our country all of whom need to be fed and among many of whom disposable income is significantly rising.

ENERGY AND THE FOOD SYSTEM

It is hardly necessary to emphasize that a major constraint to future food industrial economics will be energy consumption and cost.

The Canadian food and agricultural system absorbs about 16 percent of our total national energy consumption (Figure 8). At present about 80 percent

of all food consumed by Canadians requires some post-harvest energy input.

Clearly the big users in the food chain are the food processing industries, 32 percent being used in processing, 20 percent in transportation and distribution (Figure 9). Though much ingenuity has been invested in the development of Canada's food processing systems it is doubtful if until recently fuel efficiency was one of the industry's first priorities.

The ratio of energy cost to value-added varies widely among industries. One study suggests a ratio of 10 percent for meat packing and only 0.5 percent for vegetable oil extraction. Nevertheless one has only to observe the ambient temperature in their processing plants to realize how much more efficient could be the insulation and heat-transfer systems in many baking, cooking and retorting processes. And how many food processors recover any of the latent heat of evaporation from the steam they blow out in huge clouds into the atmosphere?

In general it is more efficient in fuel consumption to cook in bulk than in small quantities, which may explain the marked trend among Canadians towards eating out. It is nevertheless difficult to imagine a cooking method less efficient in energy use than the large black surface radiators on which most restaurants fry hamburgers.

A recent study among restaurants and fast food services in the U.S.A. reveal that more than 60 percent of the energy used for cooking is lost as unused heat. Clearly there is scope for redesign of almost all manner of cooking and heating devices in processing industries, restaurants and in the home. Furthermore, food products that require little cooking by the consumer

not only are more convenient but use less household electricity and gas. A recent study in Britain indicates that the least efficient domestic cooking appliances use four times the amount of energy as the most efficient to perform the same cooking operation. It would appear there is an urgent need for a Consumers Association study on the fuel efficiency of different domestic cooking appliances.

Bearing in mind that transportation absorbs 20 percent of the energy that goes into the Canadian food chain, the automotive manufacturers would do well to streamline food transport vehicles most of whose large rectangular surfaces must present a massive resistance to head winds.

It seems probable that those industries that rely mainly on electricity will be better off ten to twnty years from now than those that depend upon oil and natural gas, since from extrapolation of current demand and supply trends of these three sources of energy, only in electricity will supply exceed demand over the next twenty years.

If we believe the MIT model of energy alternatives, 1983 (not Orwell's 1984) will be the critical year. By that date the oil-producing countries will receive as much in revenue as they can possibly spend and therefore, though world demand will continue to increase, oil production from present sources will tend to level off. Since it seems improbable that new energy technologies will be on stream before 1983, I would suggest we all develop a taste for steak tartare and raw onions to replace our present addiction for well-cooked macro-macs and deep fried rings.

For those interested I would recommend a set of excellent publications

from the British Department of Energy on energy audits in industry*. Briefly these describe how to analyze the energy demand among different components of each processing system. In Australia an energy audit was made to determine to what extent solar energy could be applied to food processing. It was concluded that solar plate collectors are efficient only where the processing temperature is below 80°C. An energy audit of several Australian food factories showed that a high proportion of processing operations operate below 80°C indicating that when the technology is available solar energy could be used in significant degree to power future food processing operations. The British publications describe several means by which fuel efficiency may be increased in food processing.

CONSUMER INTEREST

It is unnecessary to dwell at length with the growth of consumer interest in an influence upon the food production and distribution system. Of a large number of American canvassed by the 1977 Harris survey, 45 percent named the food industry as the one that should receive most attention from consumer interests. This may not be surprising. We can all manage nicely without either electric toothbrushes or anti-perspirants (I say "either/or" since if you forego the first you may well need the second). But the need for food is universal. Consequently it is a subject that concerns everyone and upon which everyone tends to be an expert.

Many of the statements that catch the attention of the press concerning Canadian food quality and food processors can be classified somewhere

* Department of Energy, Thames House South, Millbank, London SW1P 4QJ, ENGLAND.

between "ill-informed" and "not proven". On the other hand we would be wise to pay heed to the many thoughtful and constructive observations of the Consumers Association of Canada, and seek to cooperate with that splendid organization.

At the 1958 conference Ruth Harding then the CBC's principal broadcaster on consumer affairs stated "Food technologists can translate scientific terms into practical ones for the consumer... More consumers are intelligently interested in this information than you realize and more are becoming increasingly so... Consumers are becoming dubious (of food technology)...Many feel more emphasis is placed on the reduction of labour than on the improvement of nutritive value."

Miss Harding's words were but a foretaste of the dramatic change in public attitude to science in general and to food science and nutrition in particular that has been evident over the past ten years. At the time of the first CIFT conference science enjoyed universal glamour; government departments and the major food industries regularly visited universities and competed to recruit the best science students. The Director of the Oakridge Laboratory was stating that the monuments of big science such as rockets and high energy accelerators were symbols of our time equivalent to the Cathedral of Notre Dame as a symbol of the Middle Ages.

In sharp contrast to the glorious and limitless future for scientific men predicted in the 1950's stand the science writings of the 1960's with titles such as "Can we survive our future", "The technological threat" and "Science, servant or master". Shirley Williams, a former Minister of

Education and Science in Britain in 1971, made the statement that "for scientists the party is over".

A significant drop in the growth rate of government investment in science has accompanied the mounting public skepticism towards science and scientists over the past decade. The skeptics built much of their initial case against science upon the grotesque techniques of modern warfare used in Vietnam. Subsequently the scope of adverse criticism has broadened to express concern for the potential influence of science, technology and industry upon the environment and of the food we eat upon human health and welfare.

The food and pharmaceutical industries have suffered a good deal of the adverse criticism, some of which is justified, much of which is difficult to rationalize if viewed in a larger perspective. Criticism is well deserved where for example, food manufacturers deliberately use deceptive packaging. One can only regard as mindless nonsense a statement attributed to a Canadian professor that Canadian housewives should throw away all their canned and processed foods, because their nutritional value is debased in processing.

We should welcome the growing interest in nutritional quality. But as a responsible professional body we must be prepared to speak out against self-proclaimed experts and food companies who make extravagant or unwarranted nutritional claims for extraordinary new diets or unusual new health foods. The result of the publicity given to high fibre diets is evident in the market place, though any direct cause and effect relation

between fibre intake and colonic cancer is far from proven.

While it is evident that the public at large no longer regard scientists as knights in shining armour or food scientists as noble guardians of the national cornucopia, a more important question for CIFST to address is what do food scientists think of themselves, of their motivations, of the quality and usefulness of their work, of their social responsibility to other Canadians and to the world at large?

We must ask the questions: for whom are the products of science and technology intended and whom do we propose should be the principal beneficiaries of what we do? What is our basic research philosophy? The contemporary conventional scientific wisdom appears to follow Karl Popper's "Logik Der Forschung" which proclaims the hypothetico-deductive process in which an imaginative hypothesis is subjected to experiment and deductive reasoning by which it is either proved true or false. One of the few outstanding and productive examples of such an imaginative hypothesis in recent times is that of Norman Borlaug and the short-straw wheats. It is however difficult to think of a comparable example from food science over the past twenty years.

I have the impression that many food scientists wish first and foremost to prove that they are truly scientists and not butchers, bakers or candle-stick makers. They conceive food research as a linear model similar to that from which the hydrogen bomb and nuclear power plants were derived. First came the fundamental research by geniuses such as Rutherford, Soddy and Bragg, followed much later by applied research, then development and finally

a finished commercial technology.

The essential difference between food technology and technologies based on electronics and nuclear energy, is that food technology and food processing preceded any concept of food science by thousands of years. Consequently, food research scientists need first to comprehend existing food technologies, technologies that science and research will one day help us better to understand and control. As Ralph Larmour said in 1958, "Baking is in essence a kitchen craft which depends upon the skill of an experienced cook. This induces a psychological attitude that leads the craftsman to scorn the scientist who has not taken the trouble to become a skilled operator through actual technological practice".

I would therefore propose that the starting point for food science is not the laboratory or the pilot plant but the dairy, the bakery or the packing house. The search for truth starts not with fundamental research but with the technology and the consumers the technology seeks to serve. Until food scientists, particularly those who teach the subject, accept this fundamental fact, we shall continue to witness research institutes devoted to collecting large volumes of analytical data they can't use and formulating solutions for problems that do not exist. For example, in the Agriculture, Food and Nutrition Sciences Division of the International Development Research Centre, we have over the past eight years supported close to 300 different projects in developing countries in crops, animals, fisheries, forestry and post-production systems research. We try not to impose our will upon the scientists we support but endeavour to encourage them to make their own decisions both in terms of what research is to be

undertaken and how it will be carried out. It is mandatory however that every research proposal state clearly whom the research is intended to benefit and how the benefit will be delivered.

Food research is applied research. Applied research is essentially research for human benefit. Consequently it is important that food scientists and technologists be persuaded that the criterion of research success is not technical ingenuity or a paper in a journal but the satisfaction of a human need. It is inadequate in today's complex world to teach food science in terms only of scientific theory and research techniques. Food science is a human and a social science. Consequently every food scientist must possess a high degree of professional integrity and competence, together with a highly refined social conscience and a sensitivity to human need.

We can argue with considerable justification that Canadians are well served by food technology. Few of us cannot afford an adequate and varied diet all the year round. But most of our technologies have been bought or borrowed. Surely it is time to be more innovative: to be creators not imitators: to be sellers not buyers of food technology and its products. We possess the competence - all we require is the will.

Since this homily began with a text it would seem appropriate to close with the words of a famous hymn. I hope the ghost of Dr. Whitter will forgive the misquotation:

> These things shall be: a loftier race
> than ere the world hath known shall rise,
> with social conscience in their souls,
> and light of food science in their eyes.

As Bob Marshall eloquently pointed out in 1958, "The young technologist today has an enviable future. The best products have not yet been made. The best method of processing has not yet been discovered. This is our future."

It is indeed a future we can look to with excitement and optimism. Ours is among the most important of all scientific professions in that it serves the most basic of all human needs, the need to survive, to live and work happily, healthily sustained by an adequate diet.

It is our responsibility to provide such a diet for all Canadians and for all mankind.

IDRC/OTTAWA
JUNE 1978

Figures 1-5 have been taken from "Orientation of Canadian Agriculture - A Task Force Report", Agriculture Canada, 1977.

Figures 8,9 have been taken from "Energy and the Food System", Agriculture Canada, December 1977.

Figure 1

POPULATION & PER-CAPITA FOOD CONSUMPTION,
CANADA, 1961 to 1975
(kilograms)

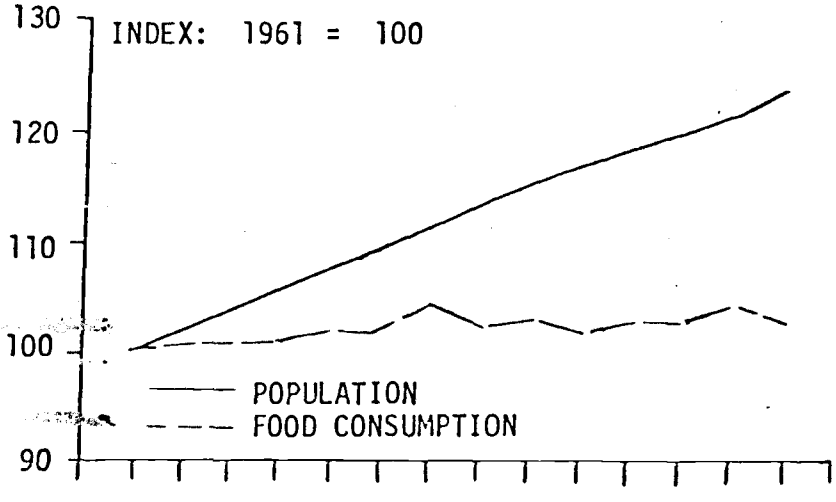

Figure 2

PER-CAPITA CONSUMPTION OF SELECTED ITEMS
CANADA, 1961 to 1975
(kilograms)

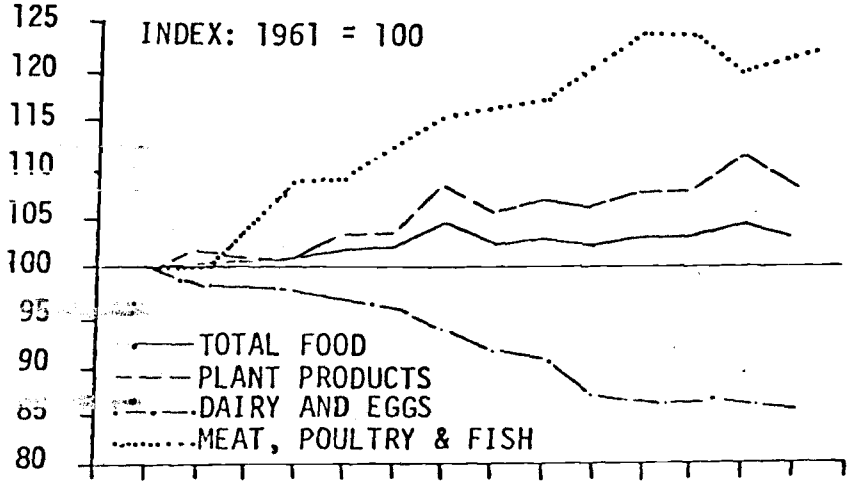

Figure 3

PER-CAPITA CONSUMPTION OF
SUGAR, SYRUPS & BEVERAGES,
CANADA, 1961 to 1975
(kilograms)

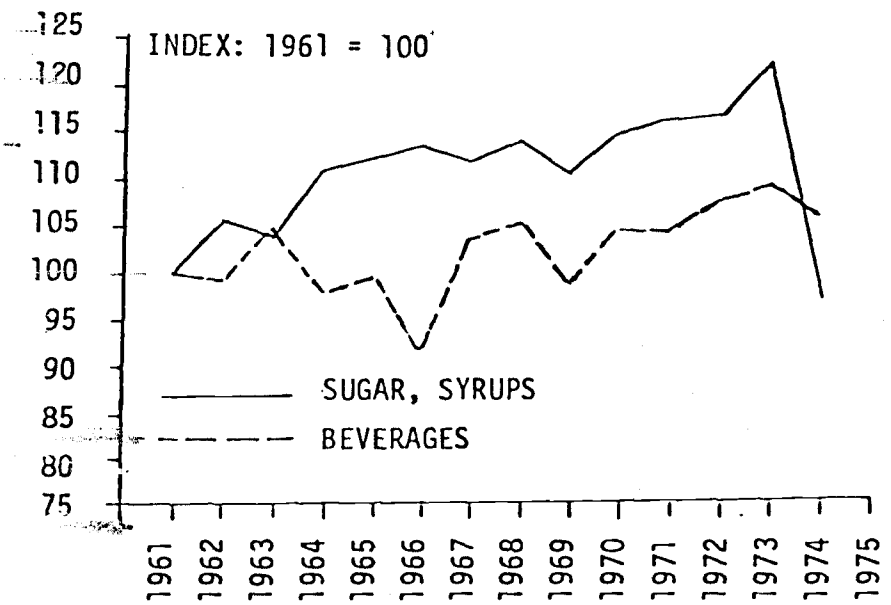

Figure 4

CONSUMER PRICE INDEXES: FOOD & ALL ITEMS LESS FOOD,
CANADA, 1961 to 1975

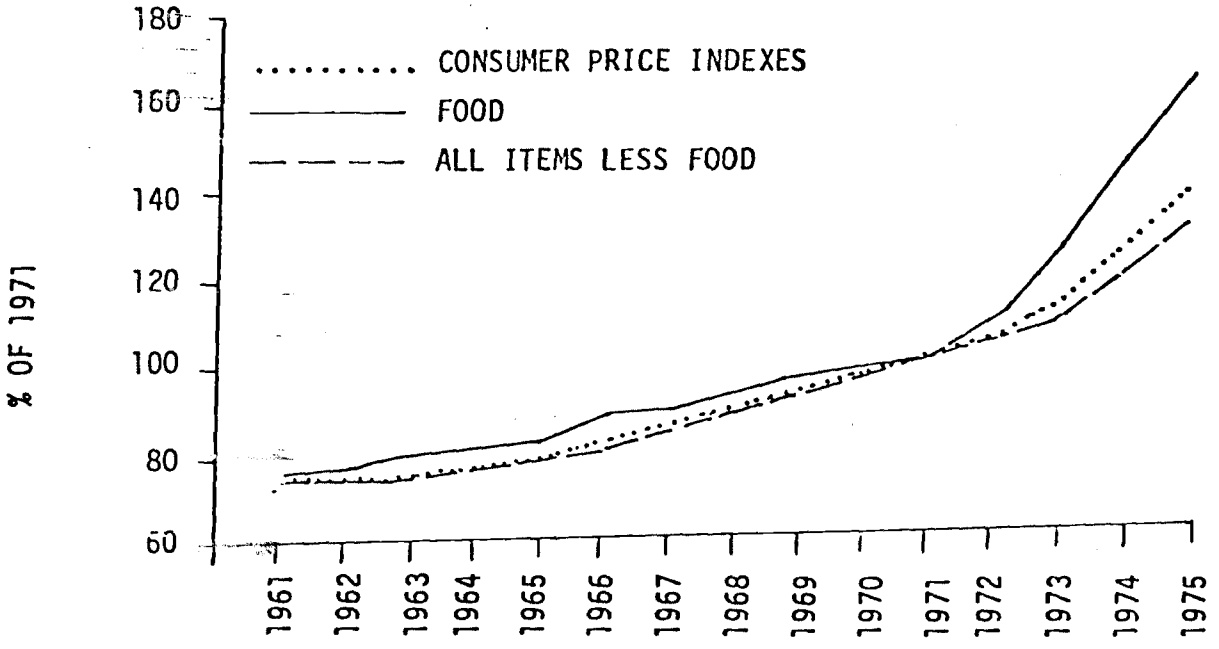

Figure 5

FOOD EXPENDITURES & PERSONAL DISPOSABLE INCOME,
CANADA, 1961 to 1975

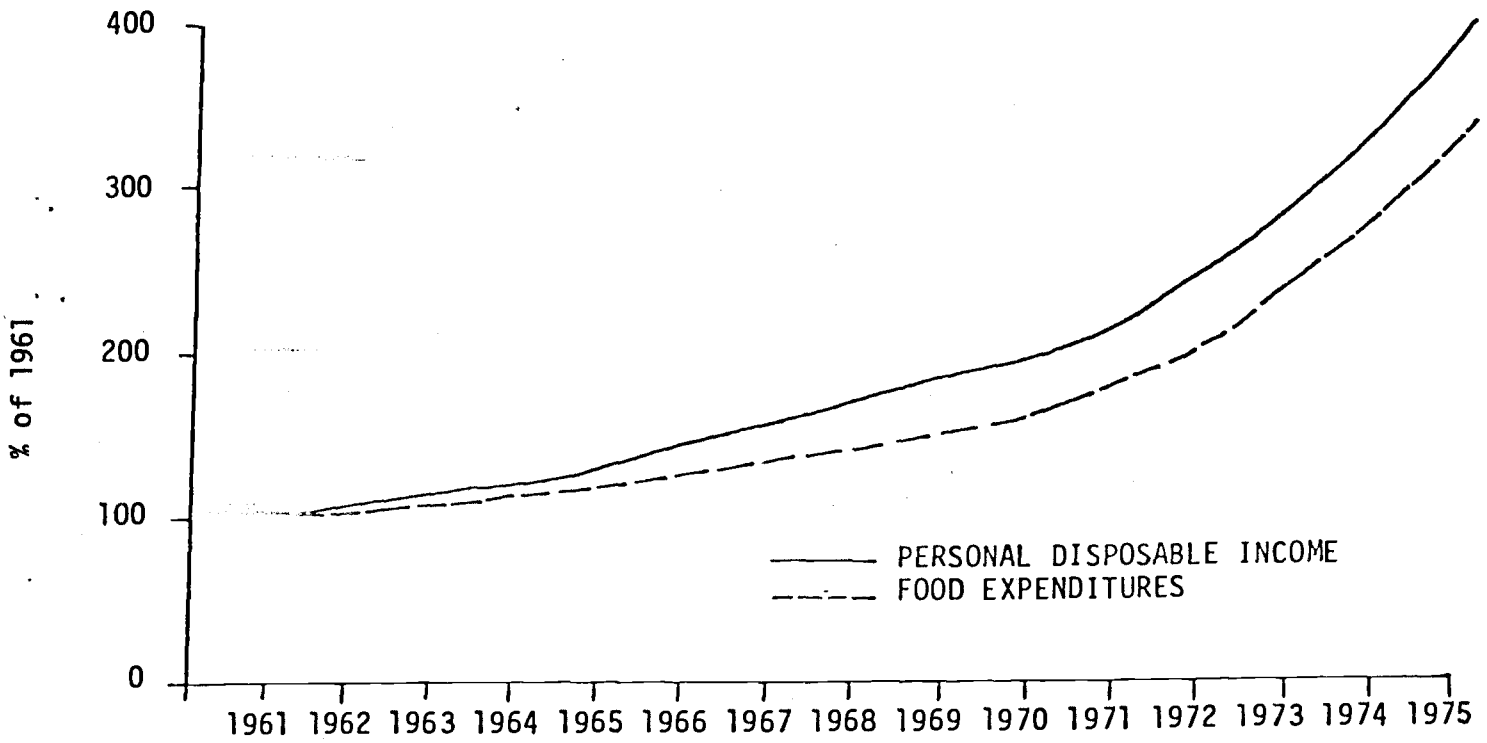

Figure 6

TOTAL R & D, 1967-76
BY THE CANADIAN FOOD, BEVERAGE AND TOBACCO INDUSTRIES

(Millions of Dollars)

1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
10.8	11.8	12.3	12.8	14.8	16.1	15.5	17.2	18.6	19.8

INDUSTRY	% FOREIGN OWNERSHIP	R&D % OF SALES
FOOD	33	
		0.12
BEVERAGE	25	
PAPER	43	0.4
CHEMICALS	81	3.1

Figure 7

Figure 8

END USE ENERGY AND FOOD SYSTEM DEMAND
CANADA, 1975

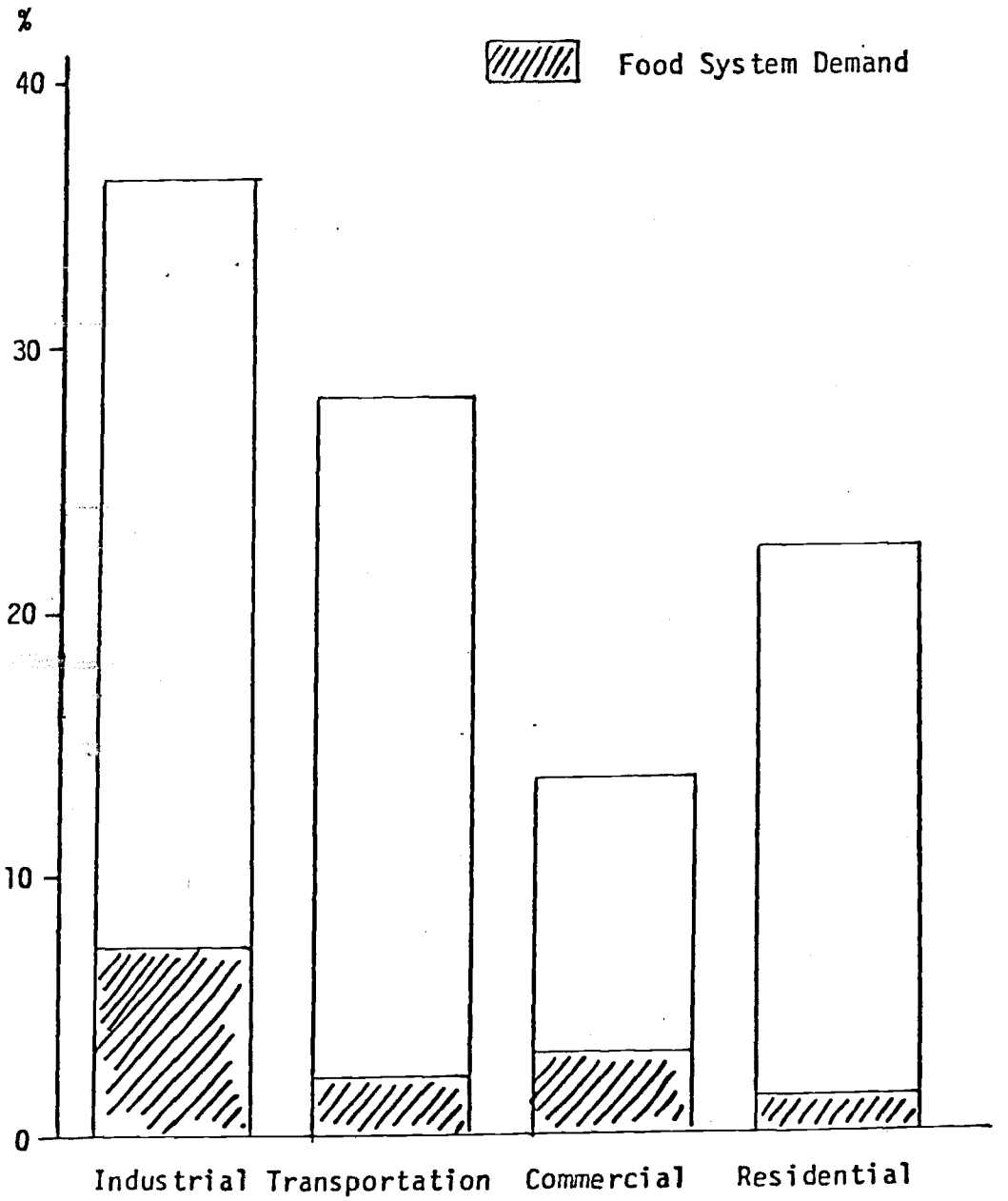

Figure 9

ENERGY USE IN THE FOOD SYSTEM

CANADA, 1975

Component	Percentage of total energy in the Food System
Production	18
Processing, Packaging	32
Transportation, Distribution	20
Preparation	30
Total	100