CITY OF TORONTO
PUBLIC HEALTH

Rod MacRae

September 5, 1997

To: Board of Health

Subject: Is Food the Next Public Health Challenge?

Origin: Department of Public Health, September 5, 1997 (p:\1997\ug\cms\hld\hl970065.hld)

Recommendations:

1. That the Ontario Minister of Health produce a Food and Nutrition Strategy and establish appropriate budget commitments. In developing such a strategy, the Ministry should give strong consideration to the food and nutrition strategy developed by the Ontario Public Health Association.

2. That the Minister of Health Canada increase funding for nutrition programs at the population-based level and implementation of the National Plan of Action on Nutrition.

3. That, as part of the increased funding and programming, the Ontario Minister of Health and the Minister of Health Canada develop highly visible social marketing strategies that help to discourage people from consuming highly processed and fatty foods and encourage consumption of fruits and vegetables.

4. That the Ministers of Health Canada, Industry Canada and Agriculture and Agrifood Canada examine the feasibility of developing a positive attributable message on food labels that relates consumption of foods to Canada's Healthy Eating Guidelines.

5. That the Ministers of Health, Agriculture and Agri-food, and Industry Canada examine the feasibility of requiring Healthy Eating Guideline promotion within broadcast and print advertisements for foods and beverages.

6. That senior levels of government convene meetings with government and non-governmental monitoring and research agencies, working in the food-health field, to discuss new structures and processes for early detection of emerging problems, and appropriate research directions in the fields of food production and distribution and nutrition intervention to further our understanding of the public health implications.

7. That this report be forwarded to the Toronto Transition Team, the new Board of Health for the City of Toronto, and the new Toronto City Council, and that these bodies be urged to establish a new Toronto Food Policy Council as a subcommittee of the new Board of Health.

8. That the Medical Officer of Health of the new City of Toronto and the Toronto Food Policy Council bring forward a series of reports for the new Board of Health and City Council on additional strategies to respond to the new public health challenges posed by food-related issues, including reports on the burden of illness associated with inadequate nutrition, the cost effectiveness of nutrition interventions, regulatory reform of current food information systems (labeling, grading, advertising), and innovative policy and program interventions to address emerging food-health matters.

Comments:

This report, AIs Food the Next Public Health Challenge?@, was inspired by our recognition over the past year that food-related health issues and programs are a growing part of public health work. The report was prepared by staff of the Public Health Department and Toronto Food Policy Council.

In addition to some analysis of the relationship between diet and disease, the report summarizes five areas of emerging food - health problems. Some of these areas will be familiar to Board of Health members as they have been the subject of previous Board of Health reports.

I believe that public health problems associated with food and nutrition will constitute a significant part of the agenda of the new Board of Health of the City of Toronto.

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Medical Officer of Health

# Is Food the Next Public Health Challenge?

City of Toronto Public Health

August, 1997

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Acknowledgements

The writing of this report was coordinated by Rod MacRae. Many thanks to the following for their contributions:

Section 2 - Brenda Suggett and Ellen Desjardins
Section 3 - Franca Ursitti and Siu Fong
Section 4 - Charles Gardner
Section 5 - Pamela Scarfe and Deborah Wharton
Section 6 - Deborah Wharton

Comments were provided by Fred Goettler, Joyce Bernstein, Carolyn Barber, Maria Herrera, Lorraine Bodnaryk, Hazel Stewart, Steve McKenna, Jack Lee, and Liz Janzen.

Report Summary

Although food has always been a part of the public health agenda, a growing body of evidence suggests that health authorities have not devoted sufficient resources to this area, relative to the health risks associated with poor nutrition, hunger, and food contaminants.

Today=s major public health challenges and health care costs are related to such chronic diseases and conditions as cardiovascular disease, hypertension, stress, cancer, diabetes, low birthweight infants, obesity and anaemia, all of which are associated with inadequate nutrition. In particular, excess fat intake and / or insufficient consumption of fibre, fruits and vegetables are linked with such diseases. It estimated that 71% of deaths, including more than one-third of cancer deaths, fall into disease categories which have strong associations with diet. Given this, diet and nutrition interventions are inadequately developed and significantly underfunded.

New problems related to the structure of the food and agriculture system are emerging that will require additional attention from public health authorities. Some examples discussed in this report are:

- chemical contaminants in food, caused by industrial pollution and agricultural practices, that may be contributing to immune system suppression and hormone disruption;
- antibiotic-resistant bacteria, associated with agricultural production practices, that are difficult to treat with standard medical therapies;
- new food-borne pathogen strains, resulting from a complex interaction of biological and sociological forces, that pose new health risk, especially for immuno-compromised individuals;
- mad cow disease, also a product of agricultural production practices, that may be transmissible to human populations;
- food biotechnologies, that may produce allergenic reactions in some at risk populations.

To respond to these challenges, public health authorities must develop a range of strategies. We recommend:

1. That the Ontario Minister of Health produce a Food and Nutrition Strategy and establish appropriate budget commitments. In developing such a strategy, the Ministry should give strong consideration to the food and nutrition strategy developed by the Ontario Public Health Association.
2. That the Minister of Health Canada increase funding for nutrition programs at the population-based level and implementation of the National Plan of Action on Nutrition.
3. That, as part of the increased funding and programming, the Ontario Minister of Health and the Minister of Health Canada develop highly visible social marketing strategies that help to discourage people from consuming highly processed and fatty foods and encourage consumption of fruits and vegetables.
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nutrition intervention to further our understanding of the public health implications.

## 1. Introduction

For decades, the public health movement has ably foreseen emerging health problems and intervened to minimize disease development in the population. From 19th century sanitation problems, to tobacco and AIDS in the ›80s and ›90s, public health has demonstrated that early intervention saves lives, improves quality of life and reduces long-term health care costs. In this discussion paper, we continue this tradition and pose the question: is food the next significant public health challenge?

Food has always been part of the public health agenda. Public health authorities have long been concerned with what and how people eat, and the presence of undesirable agents and chemicals in foods that might constitute a health hazard. Food safety was a priority of public health pioneers. Awareness of the nutrient-disease connection began with the identification of diseases caused by nutrient deficiencies, and the cure of these diseases by eating foods containing those nutrients. With improvements in the standard of living, a sufficient food supply for most of the population, fortification of foods, better health care and public education, deficiency diseases are no longer as widespread, although poor health and poor nutrition are still common among those with low income (Health and Welfare Canada, 1990; McKeown-Eyssen, 1993).

Starting in the 1970s and gaining momentum in the 1980s, increasing attention was paid to the relationships between nutrition and chronic diseases and conditions, now some of the major public health challenges. These include cardiovascular disease, hypertension, stress, cancer, diabetes, low birthweight infants, obesity and anaemia, all associated with inadequate nutrition (Surgeon General (US), 1988; Health and Welfare Canada, 1988). As food bank use grew in the 80s, so did concern about the health consequences of food insecurity and restricted access to an affordable nourishing diet.

In the 90s, there is growing concern about biological agents and chemical contaminants that might contribute to health problems. These potential problem areas are the product of societal/environmental factors beyond the reach of individuals to resolve. In many cases, they are the consequences of technologies generally seen as beneficial, but having potentially negative impacts on the quality of the food supply.

Although many health care professionals are now aware of this diet - disease relationship and of the numbers of people at risk, most nutrition work has remained focussed on encouraging individuals to make appropriate lifestyle choices, without adequate recognition of the systemic forces in our society that prevent people from accessing affordable, nourishing food and being healthy. Examining systemic issues is sensible given the factors that determine how people eat (Table 1). Culture and ethnicity are very strong determinants of food choices. Socio-economic factors, such as income, employment, food costs, and the structure of the food industry all play a role in determining what people eat. Only recently have some health professionals turned their attention to all these factors and begun to design interventions that take them into account.

Table 1. Factors affecting food choices and eating patterns

| **Psycho-social factors** | | **Economic factors** |
|---|---|---|
| - education, formal and informal | | - income/employment |
| - beliefs, attitudes | | - food costs |
| - knowledge, food and nutrition skills | | - food advertising and food information systems, cosmetic appearance |
| - gender | | - access to quality retail outlets |
| - language, culture, ethnicity | | - housing, child care and costs of other basic needs |
| - social norms re: appearance, body image, self-esteem | | - structure of the food economy |
| - social and community supports, including access to community food programs | | - type of food available, and food quality |
| - personal tastes | | - food production and processing |

As well, food-related initiatives have tended to focus on factors of food intake. With the exception of microbial hazards, significantly less attention has been paid to the systemic factors contributing to nutritional quality and food contamination (Table 2), and the public health problems that might be associated with them.

Table 2. Major food intake factors that may affect health

| |
|---|
| Significant attention:<br><br>Factors relating to food selection and the inherent qualities of the foods selected<br>Servings per food group<br>Caloric and protein intake<br>% of calories as fat<br>Types of fat<br>Fibre<br>Major and micro nutrients |
| Less attention:<br><br>Factors relating to the growing, storing, processing, distribution and preparation of food<br>Production practices (soil management, agrichemical use)<br>Storage practices (nutrient retention, pest prevention)<br>Processing techniques and additives<br>Length of the distribution chain<br>Cooking techniques<br>Biological and chemical contamination<br>Freshness, absence of injury |

We believe the current level of interventions is inadequate given the scale of the problem and the factors involved in creating nutritional health. Unfortunately, regardless of type of intervention, investment in nutrition remains very low. Ontario's Ministry of Health devotes less than 0.1% of its annual budget to nutrition programs[1]. An even smaller percentage is spent on addressing hunger and food insecurity. Almost no health professionals receive training in food security issues. Nutrition training for doctors, the major deliverers of health services, remains inadequate. The kinds of public health campaigns that have made tobacco and communicable disease prevention so visible have not been applied to food and nutrition programs. The monitoring devoted to other health issues is not mirrored in food matters.

Several factors account for the health care system's reluctance to invest in food and nutrition as a health promotion strategy.

1. The individual behaviour change model is popular because it does not significantly challenge the status quo, does not require sophisticated community and government programs that address the underlying structural forces contributing to poor health, and does not require the same degree of program planning and evaluation. It is also supported by the food industry because it minimizes the attention paid to the structure of the food system.

2. Food, as opposed to other substances such as tobacco and alcohol, is essential for life. Consequently, the relationship between benefits and disbenefits of food consumption are more complex than other substances. Healthy lifestyle messages appropriate for tobacco and alcohol are

not sufficiently refined for food, and cannot be readily transferred. In particular, the variety of food choices makes recommendations on eating more complex.

3. Food is composed of thousands of constituents. They perform different functions in the body and not all are well understood. The interactions between constituents are generally even less well known.

4. In part because of these above factors, the scientific evidence supporting the links between diet and disease has been more difficult to establish than for many other substances. We do know that certain dietary risk factors lead to certain diseases. But a strict epidemiological approach does not yet permit incontrovertible conclusions to be drawn regarding appropriate food and nutrition interventions to counter the negative effects of poor diet. In the absence of such conclusions, many policy makers are reluctant to take significant action.

In this discussion paper, we explore these food issues in more detail. We examine the diet- disease link, and use coronary heart disease, colorectal cancer and low birthweight births as examples of the nature of the relationship. The examples suggest the extent to which diet is responsible for disease and how the number of lives lost and costs might be reduced by placing a greater emphasis on food and nutrition interventions.

We also comment on some other areas of the food-health relationship that, although not as well supported in the scientific literature, require monitoring by public health professionals: chemical contaminants in food; antibiotic resistant bacteria; new food borne pathogens; bovine spongiform encephalopathy; and food biotechnology. For these emerging concerns, we believe sufficient evidence exists to warrant interventions by health care and food system professionals. Given their emerging nature, it remains unclear which interventions might be most effective, but we do speculate on what they might be.

## 2. Nutrition and health

It is widely accepted that adequate nourishment is essential for normal growth and development, reproductive health, maximum work output, optimal mental functioning, the ability to concentrate and learn, physical stamina, and for a feeling of well-being (Spasoff, 1987; Surgeon General (US), 1988).

Appropriate nutrition is also essential for the prevention of disease. The link between nutrients and disease began with the identification of diseases caused by nutrient deficiencies, and the cure of these diseases by eating foods containing those nutrients. Nutrient deficiencies are no longer widespread health problems. Now the major public health challenges are posed by such chronic diseases and conditions as cardiovascular disease, hypertension, stress, cancer, diabetes, low birthweight infants, obesity and anaemia, all of which are associated with inadequate nutrition (Surgeon General (US), 1988; Health and Welfare Canada, 1988).

In particular, excess fat intake and / or insufficient consumption of fibre, fruits and vegetables are linked with such diseases. In fact, the 1988 US Surgeon General's Report on Nutrition and Health stated that: "the evidence suggests strongly that a dietary pattern that contains excessive intake of foods high in calories, fat (especially saturated fat), cholesterol, and sodium, but that is low in complex carbohydrates and fiber, is one that contributes significantly to the high rates of major chronic diseases among Americans@. Moreover, it estimated that 71% of deaths, including more than one-third of cancer deaths, fall into disease categories which have strong associations with diet**.**

The numbers of people at risk of poor diet leading to such chronic diseases and food insecurity is high.

According to the 1992 Ontario Health Survey, 75% of the population exceeds recommended dietary intake of fat. Over half the population does not consume recommended levels of vegetables, and over two thirds fail to consume recommended levels of grains. Up to 30% of Metro Toronto residents may not have sufficient income to afford a nourishing diet (Toronto Department of Public Health, 1997). Lower income people are less likely than higher income people to consume a nutritionally-optimal diet (James et al. 1997).

These chronic diseases also account for the majority of our health care costs. It is estimated that the total economic cost of illness, disability and premature death in Canada was $97.2 billion in 1986 (Laboratory Centre for Disease Control, 1991). The Ontario health care budget consumed over $17 billion in 1993, approximately 20% of this total devoted to treating chronic diseases and conditions[2].

Not all of these expenditures are preventable but that proportion of the disease risk associated with diet may be, whether that risk be associated with food-rich or food-poor circumstances. Precise dietary attributable risks are difficult to pin down, but as an example of the significance of diet, estimates attribute from 20% (Ontario Ministry of Health, 1994) to 33% (Surgeon General (US), 1988) of fatal cancers to unhealthy diets. It is likely that effective interventions in nutrition-related health matters could save our health care system millions of dollars annually.

As examples of the importance of diet in disease development, we review that evidence for three diseases/conditions: coronary heart disease, colorectal cancer and low birthweight births in the following sections. Many other diseases and conditions, such as dental caries, obesity, and hypertension also have significant diet related risk factors.

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The link between fat intake, serum cholesterol and coronary heart disease:

In the City of Toronto in 1992[3], coronary heart disease was the leading cause of death among both men and women, representing 860 deaths. In Ontario, the number was 39,905.

The link between high serum cholesterol levels and coronary heart disease (CHD) is well established (Canadian Consensus Conference, 1988). For example, it is well known that a reduction of 1% of the total blood cholesterol is associated with a decrease of at least 2% in the incidence of coronary heart disease (Lipid Research Clinics Program, 1984; Frick, 1987; Tyroler, 1987; National Research Council Committee on Diet and Health, 1989). Furthermore, evidence of the links between fat intake and serum cholesterol level is mounting (Browner et al., 1991; Ramsay et al., 1991; Hunninghake et al., 1993). A review of both epidemiologic studies and randomized controlled trials, which used either institutionalized or free-living subjects, found that in all 16 studies reviewed, the serum cholesterol level declined when fat intake was decreased (Disbrow, 1988).

The links between fat intake and CHD incidence, however, are not as conclusive. To date, evidence linking diet with lowered CHD incidence comes from ecological (Johnson, 1993) and epidemiologic studies (Ramsay et al., 1991). So far, there have been no population-based randomized trials studying this relationship. Despite this, however, the American Heart Association and the National Heart, Lung and Blood Institute consider the links between dietary fats, serum cholesterol and CHD, to be causally related (American Heart Association, 1990).

The Cholesterol Education Program in the US states that dietary change is preferred (and in particular lowering fat intake, especially saturated fat) to drug treatment and is considered the first line of defence against CHD and cancer and the first line of treatment for high blood cholesterol.

In addition, there is a consensus that while there are many determinants of blood cholesterol levels, no modifiable factor has been shown to influence cholesterol and LDL more profoundly than diet. In fact, the US Surgeon General's report on Nutrition and Health (1988) stated that "while many dietary factors have been studied, the strongest and most consistent evidence relates to dietary fat". Furthermore, "Even though the results of various individual studies may be inconclusive, the preponderance of the evidence presented in the Report's comprehensive scientific review substantiates an association between dietary factors and rates of chronic diseases".
The link between fat intake and colorectal cancer:

Colorectal cancer was the eleventh leading cause of death among City of Toronto residents in 1992, causing 133 deaths in that year. For Ontario, the number was 5,121.

Miller et al. (1994) have stated that "Of all dietary factors believed to affect cancer incidence, dietary fat has attracted the most interest. This is in part due to the strong correlations noted in international data between the incidence of, or deaths from, certain cancer sites and the estimated population intake of dietary fat, and in part because of observations from animal experimental models". With colorectal cancer, there have been numerous studies examining the relationship between dietary fat and cancer that have largely strengthened the dietary fat hypothesis. With other cancers, however, the evidence is not as consistent.

Evidence for the dietary fat-colorectal cancer link has come from migration studies. For example, Chinese who immigrated to Western North America, and adopted a high fat diet, experienced a significant rise in their risk of colon cancer, relative to that of Chinese living in the People=s Republic of China (Whittemore et al., 1990). A similar effect has been shown in Japanese migrants (Miller, 1992).

Several case-control studies have revealed a significant association between dietary fat and the incidence of colon cancer (Jain et al., 1980; Miller et al, 1983; Graham et al., 1988). Similarly, Freudenheim et al. (1990) found such a relationship between dietary fat and rectal cancer. On the international front, a case-control study in Greece found an increased risk for colorectal cancer among those with a high dietary fat intake (Miller et al., 1994). Furthermore, two studies conducted in Australia resulted in findings consistent with the above (Committee on Diet and Health, 1989; Miller, 1992). Some earlier studies, however, were not consistent, largely because of the simplistic dietary methods used (Committee on Diet and Health, 1989).

Results from cohort studies have provided further support for the dietary fat-colorectal cancer hypothesis. A 6-year follow-up study of American nurses showed a significant relationship between total fat and increased risk for colorectal cancer (Willett et al., 1990). This effect was also studied in male health professionals, where a positive association was found between saturated fat and an increased risk for colorectal adenomas (Giovannucci et al., 1992).

A four year randomized controlled trial in Australia (MacLennan et. al. 1995) involved 424 patients with small adenomas who were clear of synchronous polyps at the start of the study. The results demonstrated a 70% reduction in the development of large adenomas in the low-fat diet group and this risk was reduced 100% for the group which ate a diet low in fat and high in fibre. Preventing the development of large adenomas, from small ones may be blocking a critical step in the development of malignancy.

In summary, the evidence in support of a relationship between dietary fat and colorectal cancer is strong.

The link between inadequate prenatal nutrition and low birthweight births:

Incidence of low birthweight (<2500 grams) is an internationally recognized indicator of health, as it is strongly associated with childhood disability and infant deaths. In the City of Toronto, the incidence of low birthweight (including multiple births) was 6.9% in 1994. This compares to rates of 6.6% in Ontario, and 3-4% in some Scandinavian countries (Canadian Institute of Child Health, 1993). Among low socio-economic status groups, however, low birthweight is much more common. For example, in lower income neighbourhoods of Toronto such as Moss Park, Regent Park and St. Jamestown, the percentages are 8.6%, 8.6% and 7.7% respectively (City of Toronto Department of Public Health, 1995).

The aetiology of low birthweight is complex, including a number of risk factors which are often present in combination, such as poverty, poor nutrition, substance abuse and high stress (Canadian Institute of Child Health, 1993). One of the most influential factors, however, is maternal weight gain during pregnancy (Kliegman et al., 1990; Susser, 1991). Among high risk pregnant women in the Toronto Healthiest Babies Possible program, 20% of women who gained less than 20 pounds during pregnancy had a low birthweight baby (Desjardins, 1993).

The association between maternal weight gain and birthweight is the strongest for underweight women (Mitchell and Lerner, 1989; Mendelson et al., 1991). In order to have the best chance of a healthy baby, underweight women are encouraged to gain 30 to 35 pounds plus their own weight deficit (Special Panel, University of Minnesota School of Public Health, 1990). The nutritional state of women at conception influences their physiological response to pregnancy; thus, if adequate food is consumed, underweight women tend to gain weight easily (King et al., 1994). When pregnant women are inadequately nourished, however, they are at exceptionally high risk for low birthweight. When food supplements have been given to undernourished, poor pregnant women in developed countries, birthweight has increased (Rush et al., 1980; Rush, 1981; Higgins et al., 1989).

Further support for this relationship is generated through the results achieved in prenatal nutrition programs. A recent review in the international literature of 28 prenatal nutrition programs (Desrosiers-Choquette and Julien, 1995) drew the following conclusions:

- The mere supplementation of the mother's diet with a balanced energy and protein adjunct in accordance with her special needs favours healthy pregnancy outcomes. The improvement of the mother's dietary practices seems, at least partially, to overcome such risk factors as smoking, low pregravid weight and undernourishment.
- Nutrition counselling has been successfully integrated within comprehensive care programs and, as such, has been associated with improvement in pregnancy outcomes for high-risk populations.
- Intensive nutrition counselling has been associated with the improvement of pregnancy outcomes. Such supervision favours compliance, a necessary prerequisite for successful outcomes.
- Comprehensive care has consistently been shown to provide better pregnancy outcomes in high-risk women.
- Improved pregnancy outcomes have been associated with increased duration of program services and a low provider-to-client ratio.
- Without a thorough assessment, the risk of poor pregnancy outcomes for undernourished women can easily be overlooked.

Concluding remarks

Since 1964, over 3,000 scientific articles have been written on cardiovascular disease and nutrition and over

3,600 have been written on cancer and diet. Countless other articles have been written on diet and other diseases/conditions. Today, this vast body of evidence confirming associations between diet and disease is sufficient to allow nutritionists and health authorities to urge people to follow the suggested dietary recommendations. Although expert panels and committees emphasize the importance of improving nutrition to lower chronic disease risk, there continues to be a lack of commitment to creating policies and legislation to improve nutrition, especially when compared to the efforts aimed at smoking prevention and other health risks. Thus, while nutrition guidelines have been developed and public education campaigns have been delivered, few other government activities have been initiated.

The fact that people are heavier now than they were 20 years ago, are sedentary, and that the population structure is aging, coupled with the fact that 75% of the population eat more than the recommended fat intake of 30% of their total energy intake, places our society on a slippery slope to higher chronic disease rates. And the proportion of people who have the responsibility for supporting the health care costs and other expenses of persons 65+ (i.e. those aged 18-64) will have shrunk by more than half by 2031 compared to 1991 (Wigdor and Foot, 1988). This is especially sobering in the wake of a recent study by the Canadian Institute of Actuaries which stated that unless our current usage of health care services decreases by the year 2031, the total cost will surmount $1 trillion dollars (Anon., 1996).

## 3. Contaminants in food

Ingestion of contaminants in food is the most significant human exposure route for many substances. The body of evidence linking adverse health impacts with exposure to certain chemicals in food is increasing. There is general concern about the potential for short and long-term cumulative adverse health impacts for a broad spectrum of chemical contaminants in food. Yet, food as an exposure route has received significantly less attention from the policy and research communities than other environmental exposure routes such as air and water. There is much that remains unknown with respect to types and levels of chemical contamination in food and their resultant potential adverse impacts on human health.

### Overview of contaminants found in food

Chemicals found in food include inorganic and organic substances. A recent analysis of contaminants in the Canadian food supply identified a wide range of organic and inorganic substances in all major food groups including eggs, chicken and beef (Mausberg and Muldoon, 1997). Substances such as metals, pesticides, solvents and plasticizers, to name only but a few, were reported at parts per trillion to parts per million levels.

An Ontario-based study of dietary intake of selected organochlorines found a wide variety of organochlorine residues including chlorobenzenes, pesticides, polychlorinated biphenyls (PCBs), polychlorinated dibenzodioxins and dibenzofurans in fresh food composites grown in Ontario (Davies, 1988). Although the levels found were below Health Canada=s acceptable maximum residue levels (MRLs), many of the chemicals detected did not have MRLs. Under the residue testing program of the federal government, approximately half of the commodities tested have detectable pesticide residues. However, imported products, particularly fruits and vegetables, usually have higher percentages of samples with detectable residues[4].

More recently, attention has focussed on certain chemicals such as alkyl phenols and phthalates, commonly found in plastics used in food processing and packaging. Bisphenol A, an alkyl phenol commonly used in plastic drinking water jugs and in plastic liners of cans, is implicated as a chemical that may cause hormone disruption due to its estrogen-like activity in experimental animals (Nagel et al., 1997). Some types of phthalates are found in samples of composite fatty foods and have demonstrated reproductive, carcinogenic,

developmental and hormonal disruption effects in experimental animals (UK Ministry of Agriculture, Fisheries and Food, 1996; ATSDR, 1992; ATSDR 1990).

Potential sources of contaminants in food

In the movement of food from production to the consumer, contaminants can be introduced into food during food production, processing, packaging, storage and/or distribution. Also, contaminants can move within the environment, usually by aerial transport, and impact populations well removed from their points of release. For example, industrial chemicals such as pesticides, plasticizers, paint strippers, cleaning agents, and wood preservatives can be deposited by aerial transport onto agricultural lands and crops and then carried up the food chain for eventual consumption by humans.

Potential adverse human health impacts

The linkages between exposures to chemical contaminants in food and potential adverse human health impacts have not been well established, and therefore the risks of exposures are difficult to determine. In most cases, confounding factors such as poverty, smoking, malnutrition and heredity make it difficult to determine the risks independently associated with ingestion of chemical contaminants in food. However, scientists generally agree that there may be a synergistic effect associated with multiple exposures over a lifetime to chemical contaminants through multiple routes.

Three broad areas of concern for which evidence of potential adverse health impacts is mounting include: immune system suppression, specific types of cancers and hormone disruption. Each of these areas is briefly discussed below. It is beyond the scope of this report to provide a comprehensive assessment of current scientific evidence in these areas.

Immune System Suppression

The immune system is one of the biological systems under more recent scientific examination with respect to the impact of environmental influences. In a recent review of pesticides and immune system suppression, Repetto and Baliga present evidence from occupational and non-occupational exposures of the ways in which pesticides and other industrial chemicals may compromise immune system functions (Repetto and Baliga, 1996). Chemicals may reduce host resistance to cancer-causing viruses, promote a breakdown in immune system surveillance of damaged cells, induce autoimmunity, bind to receptor sites and block immune system functions, and provoke allergenic reactions.

Also, a link has been made in a number of studies between non-occupational exposures to immunosuppressive pesticides and certain types of cancers, including lymphomas and leukemias. Only about 8 pesticides are judged to be directly carcinogenic, but pesticides may suppress the activity of the cells responsible for eliminating cancerous cells, thereby allowing tumours to develop (Repetto and Baliga, 1996).

Cancer

Increasing rates of specific types of cancers in the developed world have spurred on the debate on the potential adverse human health impacts of long-term exposures to environmental contaminants. Some specific types of cancers have been linked to long-term exposure to environmental contaminants. For example, benzene is a known human carcinogen found in air and drinking water and has been linked to leukemia. Also, there is a growing body of evidence linking organochlorine compounds such as pesticides to

breast cancer. In 1995, the Ontario Task Force on the Primary Prevention of Cancer acknowledged the mounting evidence linking exposure to environmental carcinogens with cancer and recommended exercising a prudent approach to reduce overall exposure to contaminants classified as known or suspected carcinogens (Report of the Ontario Task Force on the Primary Prevention of Cancer, 1995)

Naturally occurring chemicals present in some foods have also been associated with cancer outcomes. For example, mycotoxins (chemicals produced by fungi that often contaminate grains and nuts) and plant alkaloids can cause cancer in experimental animals (Committee on Comparative Toxicity of Naturally Occurring Carcinogens, 1996).

Hormone Disruption

On a biochemical level, the role of hormone disruption in various reproductive and developmental outcomes represents the latest concern about industrial and agricultural chemicals (Colborn *et al.*, 1996). An emerging theory, led by scientists working with the World Wildlife Fund, is that these chemicals can, at very low levels, disrupt or mimic the actions of hormones. Hormones are messengers, providing information on cell growth, division and death (Wingspread Statement, 1991). When these chemicals are in the body, they may turn on cell activity at the wrong time or prevent the real hormones from doing their job.

The chemicals implicated in disrupting animal, fish and human hormonal systems include common agricultural pesticides such as: DDT, 2,4-D, aldicarb, atrazine, and synthetic pyrethroids and other industrial chemicals that may be found in plastics such as phthalates, polycarbonates (Bisphenol A), and styrenes.

The potential adverse impacts of these chemicals, demonstratrated primarily in experimental animals and wildlife include:

- reduced sperm counts
- hatching problems (in birds)
- delayed sexual maturity
- lack of interest in mating
- birth defects
- spontaneous abortions
- reduced size of sexual organs at maturity.

In humans, one of the areas of concern is the linkage between exposure to environmental chemical contaminants and reduced sperm counts. A number of studies from around the industrialized world have reported reductions in male sperm counts over the past 50 years.

Populations potentially at risk

Populations such as Aboriginal communities and children may be predisposed to adverse health impacts due to risk factors such as certain exposure patterns, physiological and/or cultural influences. For example, children are exposed to more chemical contaminants than adults on a per body weight basis. Those aged 1-5 years eat between 3 and 4 times more food per body weight than adults (Wiles and Campbell, 1993). Aboriginal communities who depend on a traditional diet known as Acountry food@ must contend with the presence of contaminants in their food and have been found to have elevated body burdens of PCBs, lead and mercury (Wormworth, 1995). Mercury is the one contaminant consistently exceeding guideline limits in fish for

subsistence consumption or commercial sale. Lake trout and Northern pike in the Canadian Shield lakes of the North West Territories and northern Quebec generally have the most elevated levels of mercury (Indian and Northern Affairs Canada, 1997).

Regulatory programs

Health Canada is responsible for developing Tolerable Daily Intake (TDI) values for chemical contaminants. A TDI is the quantity of a chemical that humans can consume daily over a lifetime, with reasonable assurance that their health will not be threatened. Exposure somewhat higher than the TDI may be associated with increased probability of adverse effects. The absence of all risk to all people cannot be assured at the TDI level. Priority needs to be given to systematic review of the adequacy of TDI values to protect human health. In particular, TDIs need to account for and protect populations that may be at increased risk of adverse health impacts.

Health Canada has analysed chemical contaminants in food as part of the Canadian Health Protection Branch Total Diet Study Program, a method for estimating human intake of chemical substances based on analysis in food as commonly consumed by the population. It is not known at this time whether Health Canada will continue to complete these analyses in light of media reports of the planned closure of its Food Directorate.

Future strategies

As our knowledge of the types and levels of chemical contaminants in food increases and as the scientific evidence regarding the potential for adverse health impacts associated with exposure to these chemicals increases, the onus will be on agriculture and agribusiness to work cooperatively with regulatory agencies to develop and implement sustainable food production policies and practices.

Potential areas of research, policy development and regulatory reform include the following:

- regulatory requirements for reduced use of synthetic pesticides and fertilizers;
- increased policy and program support for sustainable food production practices;
- research on magnitude of exposures to contaminants in food and the resultant potential adverse human health impacts;
- additional research on potential sources of food contamination such as migration of substances in packaging to food;
- enhanced systematic monitoring of food, particularly those included in Canada=s Guide to Healthy Eating and imported foods;
- continual assessment of existing TDI levels, reflecting the state of the scientific evidence, to ensure that they protect human health;
- development and delivery of education programs on topics such as sustainable food production and consumption.

4. Antibiotic resistant bacteria associated with food production and distribution

There is concern amongst public health officials that antibiotic resistant bacteria are an increasingly significant health problem - longer hospitalizations for patients affected by these strains, longer recovery periods, higher death rates and greater expense to the health care system.

Antibiotic use in agriculture

First introduced in the 1950s, antibiotics have traditionally been used in agriculture for three reasons:

Sub-therapeutically:

1. As growth promotants, usually at very low levels (a few grams per tonne of feed);
2. For animal disease prevention, usually 50 - 200 g / tonne of feed;

Therapeutically:

3. To treat animal diseases, at varying levels depending on the disease and its stage of development.

Penicillins and tetracyclines were the first antibiotics to be used in agriculture (Gustafson, 1991). Now a wide range of antibiotic classes are legally administered, including aminoglycosides, cephalosporins, fluoroquinolones, and sulfas (Addison, 1984; Cohen and Tauxe, 1986; Poppe et al., 1995).

Since the 1960=s it has been recognized that the unrestricted use of antibiotics promotes the development of antibiotic resistant strains of bacteria (Report of the Joint Committee on the Use of Antibiotics in Animal Husbandry and Veterinary Medicine, 1969; Food and Drug Administration Task Force on the Use of Antibiotics in Animal Feeds, 1972). Sub-therapeutic applications, excessive animal crowding, and the rise of global marketing of animal products have been cited as food industry practices contributing to the problem (Cohen and Tauxe, 1986). Using antibiotics as performance enhancers has been criticized for being effective only in animals kept in overly crowded, unsanitary conditions. In this view, this type of antibiotic use has facilitated excessively intensive animal husbandry practices and can be avoided by the observance of good animal care practices (Addison, 1984). Others have felt that the use of antibiotics in agriculture has contributed to a rise in the virulence of food borne pathogens and has impeded treatment and the control of their spread (Nolan et al., 1991).

Although some reductions in antibiotic use have come about the past few years, consumption remains high. The majority of these are used as subtherapeutic dosage feed additives and, historically, high percentages of livestock in conventional agricultural practice have been exposed to them. A mid-80s survey in the USA found that antibiotics were used as growth promotants in 60% of beef cattle, 90% of calves reared for consumption as veal, 90% of pigs, and in almost all poultry (Anon., 1987). Antibiotic consumption in agricultural feeds increased dramatically from 0.11 million kilograms in 1950, to 5.58 million kilograms in 1978 (Black, 1984). Half of all antibiotics consumed in the USA are used on animals (Holmberg et al., 1984). Forty-two percent of all antibiotics manufactured in the USA are tetracycline and penicillin. Fifty-five to sixty percent of these are used in subtherapeutic dosage in agricultural feeds (D=Aoust et al., 1992).

Canadian data are more difficult to come by, but in the 80s the situation was thought to be similar to the USA (Black, 1984).

The theory and evidence of resistance development:

It is generally believed that natural selection pressures create the resistance. A bacterium, initially sensitive to an antibiotic drug, may contain within its population a few mutants that are resistant to the action of the drug. For example, they may contain an enzyme that destroys the antibiotic agent. These mutant bacteria often have the capacity to transfer the genetic information encoding these resistances to their descendants who then have an evolutionary advantage over others. Rapid cell division then increases the size of the resistant population

until it becomes the dominant organism. This sequence of events can happen with organisms that are human pathogens, and ultimately lead to a loss of antibiotic efficiency in human medicine.

There is documented evidence of antibiotic resistant organisms in animal production. Antibiotic resistance was common in the strains of salmonella causing outbreaks in the USA in the 1980s (King-Thom and Murdock, 1991). Drug resistance was noted in 17 of the 52 outbreaks of salmonella reported to the American Centre for Disease Control (CDC) that occurred between 1971 and 1983. Overall 20 to 30 percent of all strains isolated in human salmonellosis were drug resistant (Holmberg et al., 1984).

The profile of antibiotic resistance has been shown to match the types of antibiotics that animals are given, and the types detected in animal tissues (Black, 1984; Cohen and Tauxe, 1986; D'Aoust et al., 1992). For example, a study of samples of healthy chickens, beef cattle and swine, from 1978 through 1981, showed salmonella resistance to streptomycin in 56% of samples and tetracycline in 33% of samples (Cohen and Tauxe. 1986).
Canadian data on the extent of the problem are less available than the USA. Only one nation-wide and statistically-controlled study has been done recently. The authors concluded that salmonella are resistant to many, mostly older, antibiotics used in the turkey industry. They studied 270 turkey flocks in 1994 and found salmonella resistance to neomycin in 14% of samples, resistance to spectinomycin in 97.6%, to ampicillin in 14.3%, to sulfamethoxazole in 58.1%, and to tetracycline in 38%. The authors also speculate that resistance may soon develop to some of the newer drugs being used, with an attendant potential to compromise medical treatment (Personal communication, Dr. Cornelius Poppe, Agriculture and Agrifood Canada, Sept. 20, 1995; Poppe et al. 1995).

From animals to humans

The route from Multi-drug Resistant (MDR) pathogens in animals to humans is most likely via consumption of contaminated animal products - meats, fish, poultry, milk, and eggs. For most of the population, this is the only means of contact with animals carrying resistant bacteria. It is also possible that some drug resistance in non-foodborne diseases may be caused by the use of antibiotics in livestock because antibiotic resistant bacteria may be able to transfer resistance from one bacterial species to another (Spika et al. 1987; Gustafson,1991; Diaz De Aguayo, 1992). Such cases, however, are much more difficult to trace.

Drug-resistant bacteria add an economic burden to the health care system. There is evidence that hospital stays for those affected by an antimicrobial-resistant bacterial strain are likely to spend nearly twice as long in hospital as those infected with non-resistant strains. Mortality rates are also higher. These outcomes are attributable to treatment failures, and not just to factors of age and susceptible populations (Holmberg et al., 1984).

How significantly medical treatment is compromised, and agriculture's contribution to it, remains contentious. It is generally acknowledged that medical practice is a far greater contributor to the problem than agricultural practices. One estimate places agriculture's contribution at less than 10% (Personal communication, Dr. John Prescott, Ontario Veterinary College, Sept. 20, 1995).

Responses to date

Although the issue has received considerable press in the past decade, it is unclear whether it has affected farm and veterinary practice. Certainly drugs in use have changed, veterinarians may now be more cautious about what they prescribe, and farmers are learning to use antibiotics more selectively. For example, the

Ministry of Agriculture, Food and Rural Affairs has a training program on strategic antibiotic use. Approximately 1500 farmers had taken the course to late 1995. (Personal communication, Dr. Neil Anderson, OMAFRA, Sept. 27, 1995).

Whether overall use has declined as a result of these modifications to practice is not known, and it appears that forces other than fears about antibiotic resistance are the primary factors. For example, in the dairy industry, farmers and veterinarians have been more cautious because of fears that antibiotics may be interfering with starter cultures for cheese and yoghurt (Personal communication, Dr. David Waltner-Toews, Ontario Veterninary College, University of Guelph, Sept. 20, 1995.). As well, quality control rules adopted in several animal industries have resulted in significant financial penalties for those who do not meet the standards (Personal communication, Dr. Neil Anderson, OMAFRA, Sept. 27, 1995).

The use in feeds of tetracycline as a growth enhancer has recently been prohibited by the federal government (Personal communication, Dr. J. Prescott, Ontario Veterinary College, Mar. 19, 1996). Generally, however, the use of approved antibiotics in agriculture remains largely unrestricted in Canada.

Future strategies

Because the evidence is not overwhelmingly conclusive, agreement is elusive regarding actions to take. One view is that antibiotic use in animals should be severely restricted, except for therapeutic reasons. It is this view that has, in the past, encouraged politicians to call for regulated restrictions on antibiotic use.

Another view is that depriving animals of regular feed antibiotics will both gradually reduce antibiotic resistance in the short term, and increase health problems for animals reared in conventional rearing operations. There is some evidence that when animals withdrawn from treated feed are subsequently given therapeutic doses, antibiotic resistance may return to previous levels (Gustafson, 1991). Consequently, proponents of this analysis believe that reducing antibiotic use may not lead to any long-term reductions in antibiotic resistance, particularly with older antibiotics such as tetracycline and penicillin. Resistance may, however, be increasing for more recently developed antibiotics, and it is with these products that preventive measures should be taken.

A third view is that much of agriculture's need for antibiotics is a result of often inappropriate feeding and rearing conditions. Therefore, significant reductions in the use of antibiotics will only be effective if the conditions that create the need for antibiotics are changed. Proponents of this view believe that animal population densities, feeding regimes, housing conditions, medications, and exercise regimes must all be altered to reduce disease incidence and antibiotic use (Boehncke, 1986; also David Waltner-Toews, Ontario Veterinary College, Personal Communication, Sept. 20, 1995). Such changes require significant transformation of many farming enterprises and support from government during the process of transition from current to alternative practices (MacRae et al., 1990a,b).

5. The emergence and re-emergence of food borne disease

The transition of communicable disease by food remains a major public health problem. The Ontario Ministry of Health estimates that one in six or 1.5 million people in Ontario suffer from food borne illnesses every year, costing the provincial government about a half billion dollars (OMAFRA, 1994). Food borne illness is responsible for hospitalization, lost productivity and often places a huge burden on society by the chronic, life-long consequences caused by some food borne pathogens.

Although many hazards threaten the safety of our food, certain food borne hazards are of particular public

health concern. Studies have shown that the predominant food borne microbial pathogens include: Campylobacter jejuni; Escherichia coli 0157:H7; Salmonella species; the parasites Toxoplasma gondii and Cryptosproidium parvum; and the Norwalk virus.

These food borne pathogens may give rise to diseases that are far more serious than the uncomfortable but relatively temporary inconvenience of diarrhea and vomiting, which are the most common symptoms of food poisoning. Food borne infections can result in very serious immediate consequences, such as spontaneous abortion, as well as long-lasting conditions such as reactive arthritis Guillain-Barre syndrome (the most common cause of acute paralysis in adults and children), and hemolytic uremic syndrome (HUS), which can lead to kidney failure and death, particularly in young children (USHHSA, 1997).

In addition to the concerns for healthy individuals, health authorities are also worried about effects on several susceptible population groups. These include persons with lowered immunity due to HIV/AIDS, those on medications for cancer treatment or for organ transplantations, as well as pregnant women (and their fetuses), young children, and elderly persons. Patients taking antibiotics, or antacids, are also at greater risk of infection from some pathogens. Other groups who may be disproportionally affected include homeless persons, and persons living in institutional settings, such as hospitals and nursing homes (USHHSA, 1997).

Food borne disease is obtaining increasing attention in the eyes of the public and, there is much publicity concerning salmonellosis, listeriosis and Ahamburger disease@ (enteritis caused by Escherichia coli 0157:H7, which is also found in other foods), and cryptosporidium. Foods previously thought to be safe are being discovered to contain pathogens, e.g., ice cream, soft cheese, shell eggs, and long-storage refrigerator items.

New food borne pathogens have emerged over the last 10 years. Many of these cannot be detected, others can be but with difficulty. Other microorganisms, previously thought to be innocuous, have emerged as more virulent. Newly recognized pathogens are causing serious disease outbreaks. Food borne pathogens are increasingly overcoming time-tested controls, such as heating and refrigeration, and are developing new virulence and new ways to evade our immune defences.

Factors influencing the emergence and re-emergence of Anew@ pathogens and Aold@ pathogens are numerous and reflect an interplay of biological and sociological forces (Table 3) (Toronto Board of Health, 1996). An emerging ecological view surmises that as we see increased centralization in the food system, there will be a concomitant increase in homogeneous ecological niches for infectious agents. Associated with this phenomenon, due to reduced diversity in animal and plant stocks on the farm, more dramatic increases in the number of food borne disease incidents than we have seen previously could result (Waltner-Toews, 1992).

There has also been a general decline in personal food skills in the population. In the past, women transferred their food knowledge to their children, but with societal changes, there has been increased use of convenience foods, take out meals and restaurant eating (31% of the food dollars is now spent out of the home). With changes in the structure of our economy, most households now require two incomes, so employment-related stresses encourage convenience eating. Children are eating fewer meals at home because many attend day care, before and after school programs, and remain at school for lunch. Little attention has been paid to the food safety implications of these trends.

Increasing fiscal pressures are also a consideration. Diminishing public resources are contributing to the changing role of government. Governments are moving toward an inspection system based on the scientific assessment of risk, and a risk-based allocation of resources (Government of Canada, 1997). Whether this

approach will be able to address the volume of problems, both current and potential, is unclear.

Table 3. Factors contributing to the emergence of infectious disease (CDC, 1994)

| Categories | Specific Examples |
|---|---|
| Societal Events | Economic impoverishment; civil war conflict; population growth and migration; urban decay |
| Health Care | New medical devices; organ or tissue transplantation; drugs causing immunosuppression; use of antibiotics |
| Food Production | Globalization of food supplies; changes in food production, processing, packaging, and preparation |
| Human behaviour | Sexual behaviour; drug use; travel; diet; outdoor recreation; use of day care facilities |
| Environmental changes | Deforestation/reforestation; changes in water ecosystems; flood/drought; famine; global warming |
| Public health infrastructure | Curtailment or reduction of prevention programs; inadequate communicable disease surveillance; lack of trained personnel (e.g. epidemiologists, laboratory scientists, and vector and rodent control specialists |
| Microbial adaptation | Changes in virulence and toxin production; development of drug resistance; microbes as co-factors in chronic diseases |

Case example: Escherichia coli 0157:H7

New diseases like Escherichia coli 0157:H7 appeared in industrialized countries in the mid 80's. A Anew@ pathogen, at least at the molecular level, it provides some interesting evidence demonstrating the link between

the industrialization/centralization of the food system and the emergence of new and old pathogens.

Several strains of the bacterium E.coli cause a variety of diseases in humans and animals. E.coli 0157:H7 is a type associated with a particularly severe form of human disease. E.coli 0157:H7 causes haemorrhagic colitis, which begins with watery diarrhea and severe abdominal pain and rapidly progresses to passage of bloody stools, and has been associated with Hemolytic-Uremic Syndrome HUS. HUS is a life-threatening complication of haemorrhagic colitis characterized by acute kidney failure, and is particular serious in young children.. E.coli 0157:H7 has its reservoir in cattle, but the dynamics of E.coli 0157:H7 in food producing animals are not well understood. It has been estimated that approximately 25,000 cases of food borne illness can be attributed to E.coli 0157:H7 each year in the US, with an estimated 6 deaths. E.coli 0157:H7 outbreaks have recently been associated with ground beef, raw milk, lettuce, and minimally processed and fresh fruit juices. The most recent outbreak, in the Fall of 1996, in 3 western states and British Columbia, was associated with unpasteurised apple juice and resulted in 66 illnesses and one death (USHHSA, 1997).

Did one strain of E. coli suddenly acquire new virulence genes, resulting in the occurrence of a totally new disease? Is it new to cattle or a cattle reservoir, or is it=s Anewness@ related solely to humans? If it is not a totally new organism, what factors have contributed to its recent appearance in human populations and its associated recognition as a major public health problem (Armstrong et al., 1996)?

Three potentially complimentary hypotheses are being considered to explain what may have led to the emergence/recognition of E.coli 0157:H7:

1. conditions for the spread of E.coli 0157:H7 from animal to humans have always existed, but the organism has only recently emerged in animal populations;

2. E.coli 0157:H7 has always been widespread in animal populations, but slaughter and meat processing has changed in such ways as to promote contamination of meat with this organism; or

3. E. coli 0157:H7 has always been present in the meat supply, but consumer practices have changed such that contaminated meat now leads to human infection.

The increased use of uncomposted manure slurries to fertilize pastures may have played a role in the emergence of E.coli 0157:H7 because it can grow in manure (Armstrong et al., 1996). There have been cases of E. coli 0157:H7 as a result of consumption of produce grown in fields fertilized with cattle manure.

As well, a well fed cow will have digestive activity that inhibits the growth of enteric bacteria in the rumen. Unfortunately new slaughtering processes mean most animals are starved before slaughter. They are starved for variable periods of time because animals are not usually fed in transit and animals with empty rumina (which accounts for one sixth of the ruminants weight) are easier to slaughter (Armstrong et al., 1996).

Changes in ground beef production may hold the key to this rise in E. coli 0157:H7. Ground beef is mass produced. The meat from several cows may go into one hamburger patty. Large commercial packers may purchase meat from several different sources from all over the world. The grinding machinery is used continuously without cleaning between lots (Armstrong et al., 1996).

Once sent to grocers, it is re-ground, and trimmed fat from more expensive cuts added. In the end one lot could be contaminated but the meat could come from several different suppliers so the source of infection

could be un-traceable.

Future strategies

In response to the changing face of food safety a new Canadian Food Inspection Agency (CFIA) was established in 1997. For the first time, all federally mandated food inspection (including fish and seafood) and animal and plant health activities have been brought together into one organization. The creation of the CFIA presents the opportunity to examine Canada=s inspection and quarantine systems within a rapidly changing environment and against a number of emerging pressures. The CFIA=s challenge will be to create more efficient and effective systems while integrating its programs and services with its financial and human resources in a way that will not compromise food safety or impede industry competitiveness in the marketplace (Government of Canada, 1997). A particularly difficult and important role will be establishing systems for monitoring and analysing these emerging pathogens.

6. Bovine Spongiform Encephalopathy (Mad Cow Disease)

Another highly visible food safety current concern, due to the recent British experience, is Bovine Spongiform Encephalopathy (BSE), also known as Mad Cow Disease.

BSE is a fatal disease of cows. It is a member of a group of diseases called Transmissible Spongiform Encephalopathy (TSE). TSE disorders include: scrapie (in sheep), bovine spongiform encephalopathy (in cattle), and in humans, Creutzfeld-Jakob disease (CJD), Gersunann-Strassler syndrome (GSS) and kuru (restricted to cannibals) (Wickham, 1996).

Since the 18th century, farmers have known that sheep suffer from scrapie. In the 1930's scientists discovered scrapie could be transmitted to other animals. By the 1980's it became clear that the infection could be transmitted to other animals by feeding them diseased parts of animals. Mad Cow Disease was first observed on a British farm in 1985 and officially identified a year later as a form of spongiform encephalopathy. An epidemiological study in 1987 pointed to a scrapie-like agent, with the most likely vehicle being meat and bone meal in the cow=s diet. By the 1990's, it was clear that TSE was not caused by a traditional agent (bacteria, virus), but a prion.

A prion is an infectious protein, with no DNA Prions are formed from prion-related proteins (PrP). PrPs are normal cellular constituents, produced mostly in the brain. Prions are produced by abnormally shaped proteins. These proteins have the ability to alter normal PrPs. The new PrPs are resistant to enzymatic breakdown so they aggregate causing plaques - spongy appearance in the brain (Society for Applied Philosophy, 1995). These plaques cause disruption of brain functioning. The recycling of infected bovine material is now thought to amplify this process (Nathanson et al., 1997).

The current consensus is that these transmissible spongiform encephalopathies have probably always existed at an almost undetectable incidence in cattle, sheep, ungulates, humans and very likely most mammals. Human intervention - feeding cattle diseased rendered cattle and the like - have led to the acceleration of this disease (Sly, 1997).

Feeding cattle animal remains began after World War II as a way to produce beef perceived to be of a higher quality. This practice was part of a larger set of techniques and technologies designed to rapidly increase beef production. Animal scientists altered the diet of beef cattle to increase their growth rate. Increasing the proportion of Ahigh quality@ animal protein was considered an essential strategy. Although cattle are ruminants

with a digestive tract designed for grass, the practice was sanctioned by livestock specialists who argued Aruminants are carnivores since they digest the protozoa which live symbiotically in their rumens@. (Society for Applied Philosophy, 1995).

In the 1970's and 80's, a crucial change in the rendering process resulted in a dramatic reduction in the use of hydrocarbon solvents for extraction of tallow. In addition, rendering plants did not bring product to a high enough temperature to kill even conventional pathogens (Society for Applied Philosophy, 1995). These two changes are thought to have contributed to the survival of the infectious agent and its wider spread in the animal population.

The use of a phthalimide-containing Organophosphate pesticide, phosmet, may also be implicated in disease development. It may have initiated a strain modification of the prion protein causing BSE (Purdy, 1996). In the UK, use of phosmet is compulsory, and is applied regularly to animals for fly control. Phosmet is fat soluble and bioconcentrates in the fat fraction of treated livestock. It is then recycled back into livestock via tallow (Purdy, 1996). Organophosphorous chemicals used also in sheep dip and similar products may damage the immune systems of both people and animals resulting in lowered resistance to BSE (Harman, 1995).

BSE has an incubation period of four years. The prions can survive incineration at 360 degrees for one hour, irradiation, autoclaving, burial in the earth for up to three years, and resist being broken down by corrosive chemicals. In fact, only steam under high pressure at very high temperature renders it uninfectious.

Can BSE in cattle harm humans?

A blue ribbon British panel chaired by Sir Richard Southwood, a famous zoologist and ecologist, released a report in February, 1989 that tried to allay fears by stating there was no evidence BSE could infect humans, in large part because cows were deemed to be dead end hosts for the infection. However, reports since have conluded transmission to humans is feasible, although the level of risk remains unclear (cf. Dealler and Lacy, 1991; Dillner, 1996; Raymond et al., 1997).

Creutzfeld-Jakob Disease (CJD) in humans is remarkably similar in pathology to the disease in cows. First identified in humans in the 1920's, CJD normally occurs in the 6th and 7th decade of life because of its long incubation period. Of concern is the recent identification of 10 cases of CJD in adolescents and young adults in Britain. These cases are thought to be a new variant of CJD brought on by the consumption of BSE-infected cattle. This variant has been likened to kuru, a disease almost exclusive to Papua New Guinea when ritual cannibalism was practised (Brown, 1996).

Some authorities predict there will be more cases of CJD in the 1990s resulting from consumption of sausages and burgers in the 1980s (Fox, 1996). Experiments have confirmed that the disease can be transferred by feeding brain extract from BSE infected cattle to mice, sheep and goats, but not pigs (Branswell,. 1996). A recent study in the US showed as many as 25% of patients diagnosed with Alzheimers actually had other forms of dementias including CJD. Only examination of brain tissue can establish a true diagnosis (Wickham, 1996).

Future strategies

In one UK poll, 71% of people said there needed to be more control in the methods farmers use; 82% said they favoured an increase in organic production; 79% said tax payers= support should only go to farmers who farm in ways that do not harm animal welfare (Lang, 1996).

There is still debate, particularly in the US and UK, about how to prevent the cycling of this disease. The UK government has committed $8 billion in a five year plan to destroy and incinerate 4.7 million head of cattle (Usher, 1996). The FDA has proposed a ban on ruminant to ruminant feeding. The plan does not include pork and poultry or milk, blood, tallow and other fats (Anon. 1997). The UK concluded a partial ban of ruminant to ruminant feeding was not really effective until there was a total ban.

Ruminant to ruminant feeding has been part of Canadian livestock production for some time (Redvers, 1996). Farmers in Eastern Canada use rendered offal more frequently than those in Western Canada. Despite Canada=s confidence in our beef supply, many changes are being recommended because of perceived risk (Tower, 1996). These include:

1. A ban of embryos and semen from Britain
2. No importation of meat from any country with a reported case of BSE (including Britain and France)
3. Destruction and incineration of herds when an animal in Canada is diagnosed with scrapie(there have been 53 sheep flocks identified in the last 10 years).
4. Agriculture and Agri-food Canada announced in early 1997 its intention to ban feeding of animal remains to cows.

In Ontario, the Ministry of Agriculture, Food and Rural Affairs (OMAFRA) has created an Alternative Feed Committee. The Committee, created in 1995, is a multi-stake holder group that will consider concerns about animal and human health, economic and environmental impacts. In addition, a Feeding Livestock Organic Waste Committee was established to look at the economics and procedures of using organic materials as substitute feed for farm animals.

The most obvious strategy is to change cattle and dairy practices so that animals are fed diets appropriate to their digestive tract, in this case primarily grasses and clovers. Beef cattle, for example, would be fed almost exclusively on hay and pasture, with some small grains at different times of their life cycle. This is largely the practice amongst organic beef producers. This approach is resisted, however, because cattle generally take longer to reach market readiness in comparison with conventional systems.

## 7. Food Biotechnology

Eighteen federally-approved engineered commodities are currently on Canadian supermarket shelves, including corn, canola, potatoes, tomatoes and soybeans. For the most part they are bioengineered for herbicide resistance, pest resistance, and delayed ripening. These commodities could potentially appear in thousands of different food products. As well, certain foods not registered for use in Canada, or registered but not currently for sale, appear in imported foods (e.g., recombinant Bovine Growth Hormone in imported American processed foods containing cheese).

There is tremendous concern about genetically - engineered food products. Health concerns fall into two categories: a) those related to immediate negative health outcomes (e.g., allergens and antibiotic resistance); b) those related to negative long-term impacts on ecosystems which could have repercussions for human health.

### Allergen concerns

Health specialists worry that manipulations at the DNA level will have direct or indirect impacts for some on allergenicity. An example of a direct impact is the potential allergenicity of organisms modified with genes from known allergens. Pioneer Hi-Bred International developed a genetically modified soybean using genes

from Brazil nuts. The product was abandoned before it arrived on the market because some people with nut allergies were allergic to the modified soybeans.

A less direct impact is that associated with the use of recombinant Bovine Growth Hormone (rBGH). rBGH application results in elevated levels of Insulin-like Growth Factor - 1 (IGF-1) in the milk supply (Hansen, 1990; Etherton et al., 1993). Bovine IGF-1 is identical in structure to human IGF-1 and is not destroyed by pasteurization although it is destroyed by processes used to prepare infant formula. The official position of regulators and some academic and medical bodies remains that IGF-1 levels, although elevated in milk from rBGH-treated cows, do not pose a health threat (Juskevich and Guyer, 1990). This conclusion has been reached despite recognition that we do not fully understand how IGF-1 functions (Page et al., 1989; Wallis, 1989), and contradictory evidence in the scientific literature regarding its biological activity in the human gut. Two reviews by Mepham (1992) and Feenstra (1993) concluded that this IGF-1 might survive the human digestive tract and be absorbed through the gut wall. A study by Xian et al. (1995) suggests that IGF-1 is not destroyed in the human gut because of the protective effects afforded by both milk casein and milk alkalinity.

Because bovine and human IGF-1 are identical and because IGF-1 appears to play a useful role in newborns, elevated levels of IGF-1 in older children and adults could trigger biological activity not normally found in older humans, including action as an allergen.

Mepham (1992:738) concluded that "it would be imprudent to assume that the increased concentration of IGF-1 in milk of bST[rBGH]-treated cows presents no risks to human health until more information has been obtained on a number of issues. These include: (i) accurate determinations of the effect of bST on concentrations of total IGF-1 in milk; (ii) the effect of bST on the percentage of IGF-1 in the free form in milk, and its physiological significance; (iii) the effect of bST on the concentration of -3N:IGF-1 in milk; (iv) the local action of IGF-1 on tissues of the upper gastrointestinal tract of consumers; (v) the degree to which IGF-1 is absorbed across the gut wall in consumers." This research agenda is not being actively pursued by industry and government regulators.

Marker genes and antibiotic resistance

Some scientists are concerned about the marker genes that biogeneticists are using to help identify whether new genetic information has been inserted in the right place. The concern is that these genes will be so ubiquitous that antibiotic resistance will evolve in a manner similar to that describe in an earlier section. For example, the BT-corn[5] developed by Ciba-Geigy contains a gene attached to the BT genes that confers resistance to ampicillin. In testing for a successful gene transfer, ampicillin is added to a cell culture. If cells survive then the scientists know that the BT genes have been successfully transfered.

Ampicillin is an antibiotic used in both medical and veterinary practice. Some fear the gene could be passed to bacteria in the cattle consuming the corn, and from there, spread to people eating beef. Both animals and humans could then be infected with diseases resistant to ampicillin. The United Kingdom Advisory Committee on Novel Food Processes recommended in a July 1994 report that "Genetically modified food micro-organisms which are intended to be ingested live in human foods ... should not be permitted to contain antibiotic resistance marker genes. Alternative markers, and procedures for the removal of antibiotic resistance markers, have been developed and should be used."[6]

There are some indications that biotechnology research, in response to these criticisms, is moving away from this approach to marking genes. Unfortunately, the technology is already in the food supply.

Ecological changes with potential negative long-term health impacts

Although biotechnology is promoted as a strategy for reducing negative environmental impacts, many ecologists believe that damage to ecosystems will increase. There are 5 main environmental concerns (Mausberg and Muldoon, 1997):

- creation of new pests
- an increase in the effects of existing pests
- disruption of natural ecosystems
- increased harm to non-target organisms
- disruption of ecosystem processes.

Rather than lead to reductions in pesticide use, as claimed by the industry, these ecosystem disruptions will likely result in greater agrichemical use. Biotechnology employs a scientific paradigm that is fundamentally at odds with environmental sustainability in agriculture. Some applications may lead to short-term reductions, but because they reinforce the existing design of agricultural systems, they will make the transition to truly sustainable strategies more difficult.

For example, the recently registered BT-potato[7], designed to reduce Colorado Potato Beetle damage, will likely contribute to already existing BT resistance[8], and discourage farmers, at least in the short-term, from practising crop rotation. There is evidence that potatoes can only be grown on the same land once every two to four years, if pest pressures are to be minimized (Coleman, 1989; Smith et al., 1994). Consequently, although Colorado Potato Beetle damage may be reduced in the short-term, resistance to BT will likely rise, as will the incidence of other pest problems that will require pesticides for control. Once resistance occurs, the variety will lose its value and the expensive infrastructure required to create it will be wasted. Such an outcome imposes both additional pesticide applications to compensate for the lost BT control, and an opportunity cost for less expensive management strategies.

As discussed in an earlier section, our recognition of the health risks associated with agrichemical use continues to rise. Given the range of unaddressed concerns, it is sensible to take a cautionary approach with biotechnology, especially since the problems that biotechnology purports to solve can all be tackled in different ways, at much lower risks. These approaches are rooted in the science of Agroecology (Altieri, 1987; Gliessman, 1990). Agroecology is concerned about the relationships between organisms, and their associated nutrient, energy and water flows. It is concerned about systems and their dynamics. It is a highly contextual paradigm, believing that all activities take place within a particular environment, which must be understood to know the more specific actions which take place within it.

When faced with a weed control problem, a sustainable agriculture practitioner asks such questions as: what environmental conditions are favourable to the growth of this organism? how are soil conditions promoting its development and what is the presence of this organism telling us about the "health" of the soil? what in the farmer's tillage and cropping practices enhances growth of this organism? how can all these conditions be changed in a manner that fits with the biological, economic and social constraints of the farmer's operation? In practice, sustainable agriculture systems rely more on crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, appropriate mechanical cultivation or minimal tillage to optimize soil biological and natural pest control activity, and thereby maintain soil fertility and crop productivity. In addition, resistant varieties, and biological, biorational, and cultural controls are used to manage pests, weeds and diseases. Synthetic agrichemicals are rarely used.

In sustainable food production approaches, the ecological and human health risks of synthetic pesticides are minimized, because they are used far less frequently than in conventional approaches (including those using genetically-manipulated seeds). It is in this area where substantial public investment should occur.

## 8. Conclusions and Recommendations

This report identifies significant public health problems associated with food. The evidence in support of changes to dietary patterns is very strong, and there are also emerging challenges to which all levels of government must pay attention, and implement new policy approaches.

In subsequent reports we intend to elaborate on the kinds of strategic interventions required to address public health challenges posed by food-related issues. A mix of interventions have been successfully used in other public health areas, and their successes provide ideas on where we should look regarding food.

### Policy and budget

A serious commitment to addressing problem areas is reflected in the existence of guiding policy and appropriate budget commitments.

In Ontario, a formal Ontario food and nutrition strategy has yet to be adopted. Direct provincial government spending on nutrition programs is estimated at $11-12 million annually[9]. Federal expenditures on nutrition are difficult to estimate[10]. The government has recently completed a National Plan of Action on Food and Nutrition, but no financial commitments have yet been made to implement the Plan.

Recommendations:

1. That the Ontario Minister of Health produce a Food and Nutrition Strategy and establish appropriate budget commitments. In developing such a strategy, the Ministry should give strong consideration to the food and nutrition strategy developed by the Ontario Public Health Association.

2. That the Minister of Health Canada increase funding for nutrition programs at the population-based level and for implementation of the National Plan of Action on Nutrition.

### Social Marketing

Social marketing has been very successfully employed in other areas, but expenditures on food and nutrition have been limited. In particular, little attention has been paid to point of purchase social marketing approaches.

Recommendation:

3. That, as part of the increased funding and programming, the Ontario Minister of Health and the Minister of Health Canada develop highly visible social marketing strategies that help to discourage people from consuming highly processed and fatty foods and encourage consumption of fruits and

vegetables.

Attributable messages

In the USA and more recently in Canada, an attributable message on packaging regarding health hazards of smoking has been an effective part of tobacco reduction programming. No such messages are used on foods, even though Canada has Healthy Eating Guidelines.

4. That the Ministers of Health Canada, Industry Canada and Agriculture and Agrifood Canada examine the feasibility of developing a positive attributable message on food labels that relates consumption of foods to Canada's Healthy Eating Guidelines.

Advertising

Food advertising is a multi-billion dollar industry. Product developers spend millions of dollars promoting new and existing products. Heavy advertising is believed to be one of the reasons why obesity is on the rise.

Recommendation:

5. That the Ministers of Health, Agriculture and Agri-food, and Industry Canada examine the feasibility of requiring Healthy Eating Guideline promotion within broadcast and print advertisements for foods and beverages.

Research and monitoring of emerging food issues

Obviously, given the complex of issues affecting nutritional health and food quality, there is a significant research agenda that needs to be pursued.

As well, regarding emerging food problems, greater attention needs to be paid to the processes by which agricultural products and procedures are approved. The effectiveness of the current regulatory system for addressing these kinds of emerging food-health issues has been questioned (Toronto Food Policy Council, 1995; Eggertson, 1997). Designed for an earlier period, critics believe that many regulations being used to evaluate the safety of pesticides, agricultural practices and genetically engineered foods are inadequate for the complex ecological and health interactions that scientists are gradually uncovering.

The lesson of these emerging challenges is the need for more effective early warning monitoring systems. In our view, there is little within the structure of health and agricultural institutions that allows for the kind of multidisciplinary monitoring and research required.

Recommendation:

6. That senior levels of government convene meetings with government and non-governmental monitoring and research agencies, working in the food-health field, to discuss new structures and processes for early detection of emerging problems, and appropriate research directions in the fields of food production and distribution and nutrition intervention to further our understanding of the public health implications.

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Endnotes:

1. No accurate figure is available from the ministry, but approximately 3% of the budget is spent on public health and health promotion. Nutrition programs are a very small percentage of public health budgets.

2. City of Toronto Department of Public Health (1996). Cancers, CVD, and digestive disease cost approximately 20% of all direct costs in Canada in 1986, according to LCDC (1991). We have applied this estimate to Ontario, assuming that the ratio of these diseases to the total for the province would be consistent with national figures. Note that this is likely an underestimate as the role of nutrition in contributing to diseases in other diagnostic categories, other than chronic, has not been included.

3. The latest year for which there is both City of Toronto and Ontario data.

4. See the annual Inter-Agency Reports on Residue Testing of Foods, published by Agriculture and Agrifood Canada.

5. BT is Bacillus Thuringiensis, a naturally occuring soil bacterium used to control certain insect larvae. The genetic sequences producing this effect on larvae has been inserted into corn and other crops.

6. Information in this section is assembled from news postings on the electronic news service AGnet of the University of Guelph.

7. Other BT-crops approved or awaiting approval in the USA include BT-corn and BT-cotton.

8. BT-resistance has been reported in Australia, the Phillippines, Taiwan, Thailand, Japan and the USA. The resistance is associated with repeated applications to crops and incorporation into crops (see The Pesticide Trust,1993). Although the FDA has responded to concerns about increased BT-resistance by requiring companies with newly approved products to have strategies for reducing BT-resistance, these requirements are widely thought to be ineffective (Union of Concerned Scientists. 1995).

9. Data from the Ontario Ministry of Health and Ministry of Agriculture, Food and Rural Affairs. Calculated by adding direct Nutrition Program expenses of the Public Health Branch ($8.6 million), the nutrition budget of the Health Promotion Branch ($0.6 million), 1/4 of the Demonstration Projects budget ($1.1 million), 20% of the Healthy Community grants ($0.4 million), and an unknown percentage of the OMAFRA budget. Again, this is something of an underestimate as nutrition programs are interwoven with other areas, particularly Healthy Lifestyles initiatives.

10. Health Canada officials did not provide an estimate.

Appendix A. Toronto Department of Public Health Food Program Initiatives

- food handling and infection control education to staff in schools and day cares;
- food quality workshops for daycare personnel given by a community nutritionist and environmental health officer;
- breastfeeding promotion and corporate breastfeeding policy; mother to mother breastfeeding support groups;
- preconception and prenatal education and health promotion;
- food coupons and food to ensure adequate nutrition for mothers in the prenatal programs;
- promotion of fruits and vegetables in community programs, such as markets, school meals, and parenting programs;
- co-ordination of school food programs in partnership with boards of education to provide nutritious meals/snacks to school children. Department of Public Health co-chairs the School Food Program Committees for both public and separate schools, assists with menu planning, provides food handler training, conducts facility inspections and participates in program reviews;
- administration of $1.9m of the Food Access Grants from City council which have expanded school food programs, increased food skills education and alternative food distribution systems and the formation of community networks which are increasing food access in their neighbourhoods. In addition, five community groups are running community economic development projects and a commercial Incubator Kitchen has been established;
- support to community, school and rooftop garden projects which provide additional food to families and information on home preserving;
- community development which helps groups and agencies to get funding, eliminate systemic barriers to healthy development and develop appropriate programs for disadvantaged groups;
- community economic development to provide skills on food preparation and business development
- prenatal and postnatal programs directed to improve mother=s nutrition, reduce smoking and alcohol drug use during pregnancy and to improve social support and a successful role transition to parenthood;
- postnatal programs which help mothers cope with stress and promote attachment (e.g., infant parenting, breastfeeding, home visits, response to early discharge);
- nutrition promotion with parents and in schools to assist with making healthful food choices;
- skills for Food Shopping is a community presentation for new immigrants to assist them make wise food choices in a new setting. AWhat Should My Children Eat to Be Healthy?@ is a slide presentation for youth by community groups following training by Department of public Health nutritionists;
- Parents for Better Beginnings, a primary prevention research demonstration project involving numerous organizations in Regent Park and Moss park areas combining infant home visiting, parent relief with community development and integration of services;
- Cooking Healthy Together is a nutrition education program for community groups that provide hands on experience in cooking, menu planning and safe food handling;

- Healthiest Babies Possible supports mothers at risk for having low birthweight babies by providing milk supplements, nutrition and lifestyle behaviour counselling by Department of public Health dietitians and health education and counselling by PHNs;
- The Parkdale Parents= Primary Prevention Project is a community collaborative in Parkdale that provides a variety of supports, including nutritional supplements, pre and postnatal counselling and supports, information sessions, parent relief with community development and co-operation among local services, arts and crafts as well as community economic development for women, etc;
- Perinatal nutrition and support programs. In 1995 more than 200 pregnant women and their families were served weekly by six prenatal food supplementation programs;
- Community kitchens are group education programs targeted to low income people, including single mothers with children, and assist with menu planning, food preparation and nutrition knowledge;
- call for enhanced social services support for supplies for breastfeeding mothers and to reduce fees such as the $25 charge for birth registrations;
- support the Food Policy Council which develops long-term strategies and short-term interventions to ensure access to adequate nutrition. One example is a recent discussion paper on AFood Retail Access and Food Security for Toronto=s Low-Income Citizens@ which recommends long-term strategies for ensuring more equitable access to food retail stores for all communities.