IMPLEMENTATION OF BIOTECHNOLOGY RESEARCH AND DEVELOPMENT POLICY: IMPLICATIONS FOR AGRICULTURAL SUSTAINABILITY

by

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ABSTRACT

Biotechnology has been represented as the key to agricultural sustainability and as a means of increasing world food supply. The thesis examines the implementation of agricultural biotechnology policies in Canada, specifically canola and the effects of these policies on research and development and implications for agricultural sustainability.

Concepts of sustainability were reviewed and a conceptual framework for assessing agricultural sustainability developed. Approaches to sustainable agriculture were divided into ; growth and conservation oriented approaches. Sustainability criteria were developed within a conservation-oriented approach. Public involvement was deemed necessary to identify priorities for sustainable agriculture and create a more socially responsive approach to policy making. Criteria for effective public involvement were identified through the literature.

Agriculture and Agri-Food Canada (AAFC) documents were assessed against the sustainability criteria. Most government documents subscribed to a growth- oriented, economic approach to agriculture which relegated sustainability concerns to secondary status.

AAFC's emphasis on economic growth has affected public involvement, research and development in agriculture, particularly new canola variety development. The process for variety registration of new canola varieties involves two influential interest groups; both have strong links to industry and are pro-biotechnology. As a result, biotechnology has been supported through the process, to the detriment of other technologies. None of the sustainability criteria were addressed in the recommendation for acceptance for new canola varieties to AAFC. AAFC, as the decision-makers, accepted recommendations of the interest

groups generally without question. Participation in the process was strictly limited and represented a narrow range of interests, largely the industrial sector.

Public and private sector biotechnology researchers were interviewed to ascertain their views of biotechnology in agriculture. Contribution to sustainability was not a primary motive for identifying research goals and the majority of researchers did not support public involvement in policy making or technology assessment.

Farmers, as users of biotechnology, were surveyed by mail. Results indicated that many farmers do not follow recommended agricultural practices and distrust government sources of information. AAFC does not have the information necessary for assessing the impact of biotechnology in agriculture.

The thesis suggests methods by which the public could be involved in setting priorities for agricultural research, policy development and technology assessment.

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Abbreviations

AAFC	Agriculture and Agri-Food Canada
ACPC	Alberta Canola Producers Association
BGH	Bovine Growth Hormone
CAB	Commonwealth Agriculture Bureau
CARC	Canadian Agricultural Research Council
CC	Consensus Conference
CCC	Canola Council of Canada
CEPA	Canadian Environmental Protection Act
CGIAR	Consultative Group on International Agricultural Research
CGM	Canola Growers Manual
EMAP	Environmental Monitoring and Assessment Program
FDA	Federal Department of Agriculture (US)
GATT	General Agreement on Tariffs and Trade
GRAS	Generally Recognized as Safe
IPM	Integrated Pest Management
NBAC	National Biotechnology Advisory Committee
NGO	Non-Governmental Organization
OECD	Organization for Economic Cooperation and Development
OTA	Office of Technology Assessment
PFRA	Prairie Farm Rehabilitation Association
PNT	Plant with a Novel Trait
MOSST	Minister of State for Science and Technology (Canada)
TA	Technology Assessment
UNCED	United Nations Conference on Environment and Development
USAID	United States Agency for International Development
WCCRRC	Western Canada Canola and Rapeseed Recommending Committee
WCED	World Commission on Environment and Development

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I. INTRODUCTION

Natural resource depletion and environmental degradation are occurring worldwide as a result of pressures caused by increasing population and material consumption levels. Modern industrial agriculture, has become associated with negative environmental and social impacts (French, 1995). In Canada, this problem is reflected in depletion of the natural resources required to support agriculture and has raised concern about the maintenance of our ability to produce food (MOSST, 1994). The need for alternatives to current agricultural practices, or at least strategies to mitigate the negative impacts, has been recognized. One alternative technology that has been identified and promoted in Canada as addressing some of these concerns is biotechnology.

In this thesis, I address the research question: *Will agricultural biotechnology, as promoted and developed in Canada have a negative impact on our progress towards sustainability?* In addressing this research question, I examine ways in which biotechnology and agricultural sustainability have been framed and implemented in Canada. Genetically engineered (transgenic)[1] canola varieties are the case study examined.

I focus on the role of biotechnology in sustainable agriculture because it has been represented as the next 'Green Revolution' and is predicted to have a significant impact on the future of agriculture, by groups as diverse as the United Nations Conference on Environment and Development, the Organization for Economic Cooperation and Development (OECD), the biotechnology industry, Agriculture and Agri-Food Canada

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[1] Transgenic plants are those which have been genetically engineered to contain DNA from other organisms (Mellon and Rissler, 1993).

(AAFC)[2], agricultural researchers and environmental groups (Agriculture Canada, 1990; OECD, 1992; UNCED, 1992). However, there is a difference of opinion in the literature as to whether the impact of biotechnology will be positive or negative. For example, Agriculture Canada sees biotechnology as a means (perhaps the only means) of achieving sustainable agriculture: "... the biotechnology used in the manipulation of genetic material for the development of new crops is required for the long term sustainability of agriculture" (Agriculture Canada, 1990, p 11). Other authors argue that biotechnology may in fact be detrimental to sustainability (Bender and Leone, 1990; Campbell, 1990; Clunies-Ross and Hildyard, 1992; Hobbelink, 1991).

Possible ecological risks associated with plant biotechnology were first identified in the late 1980's (Ellstrand, 1989; Ginzberg, 1989; Tiedje et al., 1989). The primary risks identified were; increased weediness/invasiveness of plants, recombination between transgenes and pathogens, risk of transgene spread to wild relatives and effects on non-target organisms (Regal, 1993; Rissler and Mellon, 1993; Tiedje et al., 1989). Although these risks were identified as early as 1989, little research has been conducted on the probability or consequences of these occurrences even though several transgenic canola varieties have already been registered for commercial release.

The controversy over whether biotechnology is the boon or bane of sustainable agriculture was what initiated this thesis and led to the research question stated on page 1.

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[2] Agriculture Canada changed it's name to Agriculture and Agri-Food Canada in 1994. It will be referred to as Agriculture Canada in documents before 1994 and as AAFC after 1994.

The research objectives for the thesis were:

1. To assess agricultural sustainability and biotechnology policy in Canada against sustainability criteria developed from a synthesis of the literature.

2. To characterize and assess the process by which new canola varieties are registered in terms of a multi-stakeholder process and incorporating the criteria for sustainability.

3. To examine the impact of the implementation of agricultural and biotechnology policy, through review and analysis of the process of variety registration on research and development in canola.

4. To evaluate the user environment into which biotechnology is being introduced.

5. To make recommendations that could result in the incorporation of sustainability into agriculture and biotechnology research and development.

Biotechnology provides a particularly useful focus in that it is a new developing technology which illustrates how the federal policy and regulatory system has evolved, particularly with regards to agricultural sustainability. Federal policy was considered because it is the level of government where most science policy is developed and where the overall needs of Canadian society (e.g. sustainability) are addressed. Canola was chosen as a case of biotechnology because it is an important crop in Canada (second only to wheat) , is the subject of much biotechnology research (the first genetically engineered varieties were approved for commercial use in 1995), and because of the prominence of State/group/ industry interactions involved in developing policy related to new crop varieties. Study of the registration process for canola varieties allowed for the identification of some of the specific impacts government policy has on research and development of biotechnology for

agriculture. The federal system of registration of new crop varieties has relevance to sustainability because of it's impact on research and development of new crop varieties.

1.1 Situation of Agriculture in Canada

A review of the economic, environmental and social situation of agriculture in Canada provides a context for the discussion of sustainability in chapter two.

1.1.1 Environmental Impacts

Canadian agriculture has developed rapidly in the twentieth century. Our agricultural practices are technology- based and dependent upon chemicals, fossils fuels and subsidies in order to function. The State of the Environment Report (Government of Canada, 1991) documented the impacts of Canada's agricultural production systems on the natural resource base. Soil loss and degradation, overuse of water, chemical contamination of soils, water, humans and wildlife, and loss of biodiversity are just a few of the negative environmental impacts which have been attributed to modern agriculture (Brown et al., 1994; Goudie, 1994; Government of Canada, 1991; Pretty, 1995; Soule and Piper, 1992). Although Canadian agriculture has been successful in terms of increasing production levels by conventional measures, many of the practices used today are unsustainable from social, economic and environmental perspectives.

Perhaps the two most notable environmental consequences of current farming practices in Canada are soil degradation and soil loss through erosion. For example, in some areas, soil loss may be exceeding formation by up to 60 times (Government of Canada, 1991,

p 9-11) . On the Prairies, wind and water erosion are estimated to cost up to $468 million per year in terms of reduced yields and higher costs to maintain production levels (Government of Canada, 1991). In addition, soils in the Prairies have lost 40-50% of the original organic matter, affecting nutrient holding capacity, soil structure, moisture retention and soil microbial diversity (Government of Canada, 1991). The above costs of soil erosion do not include off-farm impacts or costs or take into account the fact that topsoil is essentially irreplaceable in the short term. Off-farm impacts include water channel capacity reduced by silt accumulations, fish habitat altered or destroyed, plant and algal growth accelerated by excess nutrients, buildup of heavy metals, pesticides and other toxic substances, lowered recreational values and increased costs to render water fit for human consumption.

Recognition of the extent of the resource degradation that can be associated with agriculture has caused the Canadian Government to become concerned about our food producing capacity and sustainability.

1.1.2 Economic Situation

The economic health of farmers in Canada has not improved in decades and has notably deteriorated since the early 1980's (Figure 1.1). Huge costs associated with input intensive, mechanized agriculture have not been offset by increases in yields or prices for major crops. For example, the amount of fertilizer (tonnes) used in Canada increased exponentially since the 1960's until 1985 when it began to stabilize. (Government of Canada, 1991, p 9-20). However, the actual amount of nutrients being added to the soil has continued to increase since more land is being fertilized and the nutrient content of the fertilizer

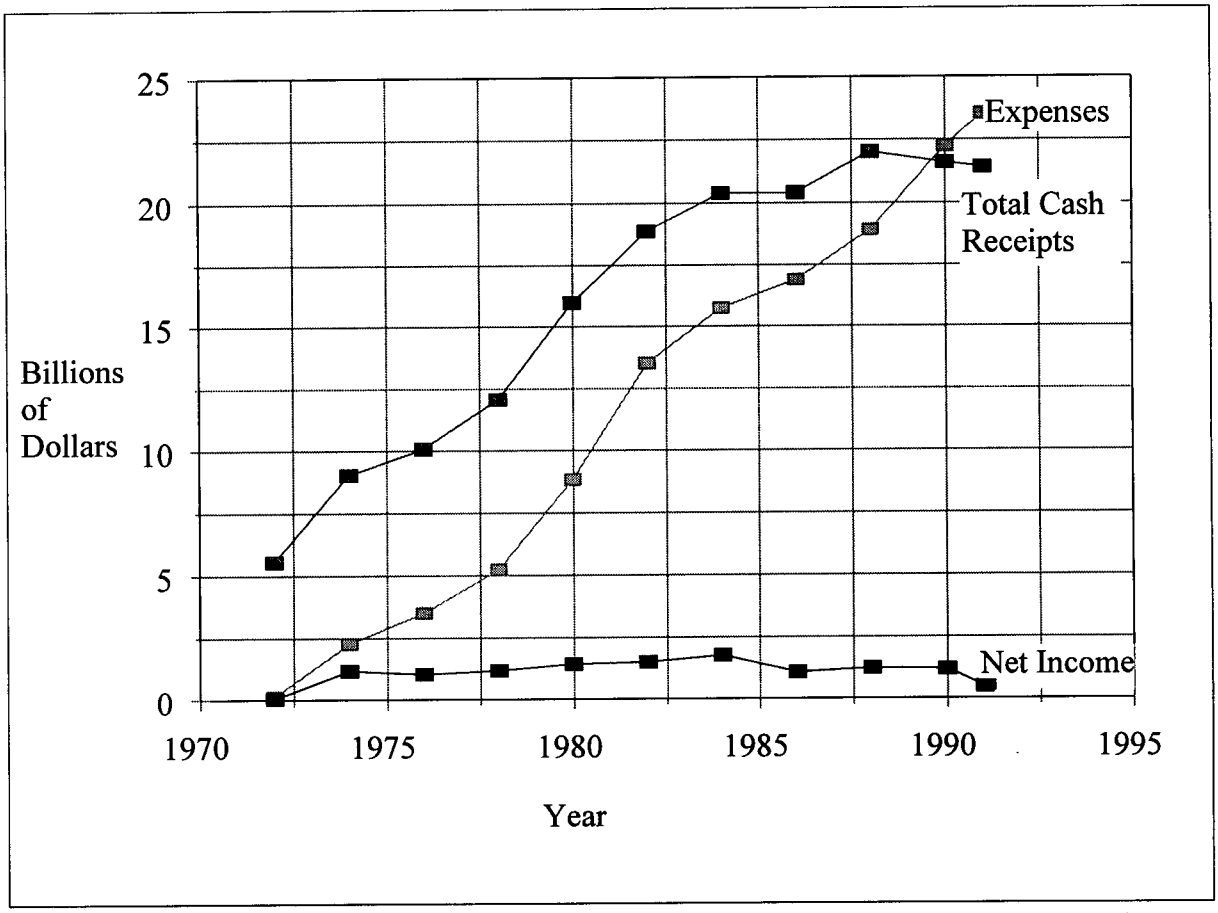

Figure 1.1: Cash receipts, expenses and net income (not including payments) of Canadian farmers in 1986 dollars (Source: Statistics Canada, 1993).

formulations has increased. The amount of money spent on fertilizers to maintain soil fertility levels and production capacity has increased correspondingly. Since the predominantly used inorganic fertilizers are based upon, or require the use of, non-renewable resources for their manufacture, this trend obviously cannot continue indefinitely.

Farm net income has not increased even though yields of major crops and the area of cultivated land (both in total and per capita) have steadily increased since 1920. In the last few years yields have stabilized but expenses have continued to increase. Figure 1.1 shows the closing gap between farm gate cash receipts and operating costs for farmers in Canada.

The last few years (1993-1995 which are not shown on the graph) have seen higher prices, resulting in higher cash receipts for wheat and canola, Canada's two largest exports. In fact, canola receipts rose 81% in 1994 over 1993 and the price for 1995 was even higher (Statistics Canada, 1995). However, the increase in total cash receipts from farming was partially offset by increases in the prices of inputs, particularly seeds, fertilizer, pesticides and feed[3]. Statistics Canada describes the economic situation in farming over the last two decades succinctly[4]:

> While nominal net cash income has been increasing over the last twenty years, last year's net cash income (1994)-after adjusting for inflation- represented only 52% of the adjusted 1974 level. After adjusting for the impact of inflation, 1994 receipts were just above 1974 receipts, but expenses were 40% higher, reflecting the industry's increasing dependence on purchased inputs (Statistics Canada, 1995).

The increased price of inputs has forced farmers to begin looking at ways to reduce costs. Increased fuel prices in the 1970's encouraged farmers to adopt conservation tillage, a trend which has been maintained. High prices for fertilizers and pesticides are encouraging farmers to consider integrated pest management (IPM), improving efficiency of application of chemicals and introduction of natural sources of nutrients and nutrient management. Fortunately, many of the practices farmers have turned to in order to reduce costs also cause less environmental damage. However, these measures to improve the economics of farming

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[3] Garry Coy, the Canola Council of Canada representative in the Peace River region estimated that fertilizer prices had increased by 25% in 1994 (personal communication, February 22 1995).

[4] The percentages listed by Statistics Canada here do not account for payments over the last few years (Statistics Canada, 1995). Although payments have been decreasing in the last five years, they are still much higher in 1995 than they were in 1974.

may be offset by further increases in the prices of inputs.

1.1.3 Social Trends and Perceptions

The number of people involved in farming in Canada has been steadily decreasing since the turn of the century and this has had a profound effect on rural communities (Government of Canada, 1991, p 9-5). Farmer/owners today comprise less that 4% of the national workforce compared with 20% in 1951. The decrease in farm populations has been accompanied by an increase in farm size and an increase in specialization (Government of Canada, 1991, p 9-5). For example, Alberta, Manitoba and Saskatchewan produce 97% of Canada's wheat while Ontario produces 75% of Canada's corn. Specialization has resulted in large areas of monoculture and reduced crop rotations. Large areas of monoculture significantly increase risk for the farmer as a result of price fluctuations and weather (i.e. some crops are more susceptible to frost, drought, etc.). A more diverse farm operation is more resilient to climactic variation, pest problems, and fluctuating prices (Parr et al., 1988; Thomas, 1993; Sindelar, 1995).

The changes in demographics have been accompanied by a change in the perception about what constitutes a successful farm. Characterisations of a successful farm range from a small scale, family enterprise to large scale industrial farming complex that operates like any other business (Martin, 1991). Martin (1991) points out a paradox in perceptions of farming in Canada: Although the family farm is seen as romantic, inefficient and outdated, proportionately more farms are now family oriented (owned and dependent upon family labour), than ever before. A family owned farm can range from a few hectares to thousands

of hectares. Farming involves significantly more risk than other businesses; few businesses run the risk of having their entire production destroyed in a year (or even three years in a row) by factors beyond their control. In addition, although other types of business operations may allow their equipment or supply of inputs to deteriorate, they are generally replaceable. In farming, the basic resources (natural capital) required to maintain production are not replaceable in the short term. Trying (economically) to treat farming as a business like any other is responsible for much of environmental and economic problems, and concomitant decline in the number of farmers that has been associated with modern agriculture.

If success in agriculture were measured only by the level of production, Canadian agriculture would be rated as extremely successful. However, if other criteria like economics, and environmental impacts are included in the definition of a successful agriculture, the Canadian system fares poorly.

1.2 Assumptions for the Thesis

Defining a 'successful' agriculture for Canada means one that is sustainable. Sustainability concepts were reviewed and sustainability criteria developed in chapter two. Both sustainable agriculture and biotechnology are issues that have global implications in terms of environment, social, ethical, and economic issues. For the purposes of this thesis, I am concerned primarily with agriculture in Canada as a food exporting and importing country. In addition, I will limit the discussion to sustainability of farming itself and not

address the food system, which includes transportation, processing, nutrition, trade, etc.[5] Several assumptions were made in conducting the thesis research that are stated below:

Assumption 1: That we wish to continue some form of agriculture in Canada even if Canadian agriculture proves to be 'non-competitive' economically. This assumption is in support of food security and the concept of carrying capacity. I believe that Canada should make every effort to maintain the agricultural capability to produce enough food for domestic consumption. If we do not produce our own food, we will have to import it from somewhere else. If we do not produce our own food, from a human ecological point of view, Canadians would be appropriating land for food production and therefore carrying capacity, from other countries through commercial trade (Rees, 1995). Since most food producing regions are suffering constraints on expansion (e.g. urbanization, water quality and quantity, pollution, etc.), the amount of food available for export may decrease in the future, thus driving up the price and increasing uncertainty of our food supply (Brown et al., 1994).

Assumption 2: If Canadian agriculture does prove to be competitive, international demand for Canadian agricultural products will continue to increase at least for the next decade. Increasing demand will place economic pressure on the Canadian agricultural system to produce more. However, there are limits to the amount of agricultural products Canada can produce, even in the short term, with unsustainable practices. At some point, decisions about

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[5] Although the thesis deals with the agricultural component of the food system only, it is recognized that sustainability is applicable to all aspects of the food system.

cropping and management which take ecological impact into account will have to be made independently of demand. I propose that we begin to examine the sustainability of agriculture now.

Assumption 3: Genetically engineered crops (including canola) will play an important role in the future of agriculture in Canada. The ethical issues associated with any form of genetic engineering and issues such as labelling of genetically engineered products, are acknowledged but will not be discussed directly in this thesis.

Assumption 4: Environmental sustainability in agriculture will contribute to economic stability and will enable us to achieve a desirable social structure of agriculture for the future. Systems that are not environmentally sustainable in the long run will not be economically stable, and therefore not contribute towards social stability. Sustainable agriculture may not be economically feasible *in the current economic system*, therefore society as a whole may have to support sustainable agriculture financially by sharing the costs of conservation. In an ecological economic system[6], sustainable agriculture would be the only economically successful, and competitive, option.

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[6] Economics has been criticised extensively on the grounds that it fails to take the externalities related to environmental impact into account. In response to these limitations, a new field called ecological economics has arisen. Ecological economics attempts to integrate ecology and conventional economics. For example, where conventional ecology deals only with interactions between non-human organisms, systems, and conventional economics only with humans, ecological economics covers the interactions between them (Costanza, 1991). In an ecological economic system, success would be measured not only in terms of returns and wealth creation, but would take into account the condition of the ecosystem.

Assumption 5: Informed debate and public participation in decision making about sustainability issues are required to identify values and priorities for sustainability. Sustainability represents a change in philosophy that could affect broader social, science and economic policies. Public participation is required to aid in the articulation of the philosophy and compatible policy objectives.

The specific research questions addressed in the thesis and the levels of analysis entailed are listed in Table 1.1.

1.3 Methods

The thesis question was approached as a study of policy implementation , and uses the general methodology outlined by Yin (1982). Yin points out that implementation studies are useful when:

> 1) The study involves a series of decisions over a long period of time with no clear beginning or end points.
> 2) Outcomes have direct and indirect implications that are too complex for single-factor theories.
> 3) There are a large number of relevant participants.
> 4) Situations are special in terms of agency context, historical moment in time or other key elements.

The area studied in this thesis meets all of the criteria presented above. The study of sustainability is inherently complex and involves many participants whose underlying philosophies may differ considerably. In addition, the process of implementing sustainability initiatives is ongoing.

Table 1.1: Levels of analysis and research questions for the thesis.

Level of Analysis	Research Questions
Policy	- what is the current state of agriculture in Canada? - how has sustainability been framed in the literature? - does AAFC, or the Government of Canada have a coherent policy for promoting sustainability? - what policy does the government have towards biotechnology? - what factors (ie. national and international reports) contributed to the development of sustainability and biotechnology policy? - have the environmental or economic impacts of these new technologies (in particular, herbicide tolerant canola) been adequately assessed? - are there major interest groups with an influence on government policy towards biotechnology and development of new canola varieties in particular? - does this influence affect policy?
Process	- is the process by which new canola varieties are evaluated fair and consistent with sustainability and public involvement criteria? - have interactions between AAFC and interest groups affected this process?
Research and Development	- have government policies and State/group interactions affected research and development of biotechnology? - how does the research community conceptualize sustainability and the role of biotechnology in agriculture? - what role does the research community envision for scientists and the public in policy development?
Farm Level Impact	- does the government have the information is needs to make adequate assessments of herbicide tolerant crops and the farm level? - do farmers follow recommended practices? - what sources of information do farmers rely on? - what are farmers attitudes towards biotechnology research priorities, herbicide tolerant canola and requirements for sustainable agriculture?

Yin identified unstructured discussions, structured interviews, documents and news reports, participant observation, and field observation, as means of collecting information for

implementation studies (Yin, 1982). Four steps in the process of policy implementation were identified:

> 1) Pre-analysis, involving data collection and selection and the evolution of categories or classifications.
> 2) Piecing together of the facts and major events like organizational changes, critical meetings, personnel turnover by describing chronologies of events.
> 3) Merging of evidence from various sources.
> 4) Testing of alternative explanations for why the implementation occurred as it did.

The pre-analysis stage of the thesis involved identifying the research questions, identifying major participants or interests in agriculture and biotechnology in Canada and developing criteria for assessing sustainability and public involvement processes. Major interests in agriculture studied include federal government; organized groups (e.g. the Canola Council of Canada and the Western Canada Canola and Rapeseed Recommending Committee), the research community, and farmers.

In chapter two, a review and synthesis of sustainability literature led to the development of a conceptual framework covering major themes and concepts in sustainability. A definition, and criteria for sustainability was advanced. For some criteria, there is consensus in the literature (for example, long term preservation of resources) as to their contribution to sustainability. Others were chosen on a normative basis to reflect my belief that the world's resources are limited, thus a conservation oriented approach is necessary. A framework was developed from the literature for assessing the effectiveness or appropriateness of public involvement programs for achieving sustainability and is presented in chapter two.

In chapter three, the sustainability criteria were applied to Canadian government

documents pertaining to agricultural policy and sustainable agriculture. The first step involved coding the documents for the mention of sustainability criteria (Appendix 1). All documents mentioned most of the criteria, but gave them very different emphases, especially in relation to economic growth, competitiveness and market-development. Therefore, the documents were reviewed in more detail to assess the relationships between the sustainability criteria and growth oriented approaches. Quotes from the documents were provided to lend support to the relationships identified. Documents pertaining to biotechnology policy and regulation were reviewed to characterize the role that the Canadian government has identified for biotechnology in agriculture and how it approaches regulation, particularly environmental impact.

Many of the policy documents reviewed supported some form of public consultation for assessing technologies or developing programs. This led to the analysis of a particular multi-stakeholder process; variety registration and recommendations for new canola varieties (chapter four). The process was assessed against the criteria for appropriate public involvement established in chapter two. Information presented in chapter four was collected through informal interviews with two key informants, review of the published minutes of meetings, document analysis and participation in meetings.

The conceptual framework and sustainability criteria were used to develop interview questions for public and private sector researchers, working primarily with herbicide tolerant canola (chapter five). The purpose of the interviews was to explore the relationships between a growth-oriented philosophy and sustainability. The interviews were structured, but open ended. Interviews typically ran for about one and a half hours and all interviews were

transcribed. Verbatim quotes are presented in the text, to illustrate the researchers' conceptualization of sustainability and it's relationship to economics, the impact of biotechnology in agriculture, and the role of public involvement in policy making.

Pertinent results of a mail survey of farmers (as the end users of biotechnology products) in the Peace River Region of British Columbia and Alberta are presented in chapter six. A complete copy of the survey is included in Appendix 4. 185 responses were received and a summary coding analysis is presented in Appendix 6. Responses were analysed using descriptive statistics only. Open ended responses to the last question of the survey were coded for recurrent themes and several representative, verbatim quotes are included in the chapter.

Finally, a model for involving the public in a broad discussion about priorities and directions for agriculture, and a technology assessment process are discussed.

2. ANALYTICAL FRAMEWORK FOR ASSESSING SUSTAINABILITY AND PUBLIC INVOLVEMENT PROCESSES

2.1 Sustainability

2.1.1 Underlying Philosophies of Sustainability

A review of how sustainability has been framed in the literature allows for the development of sustainability criteria and provides the context for the discussion of the role of biotechnology in sustainable agriculture (chapter three). Definitions of sustainability abound. There is a consensus that sustainability is essential; as Francis (1990) asks, " who would advocate non-sustainable agriculture as a goal?" However, differences in underlying philosophies result in widely differing perceptions of what sustainability means in practical terms. The roots of these philosophical differences lie in different perceptions of the supply of global resources or of the ability of science and/or human ingenuity to overcome all apparent limitations. Hardin (1993) argues that historically, humans were well aware of the resource limitations of the environment around them and that it wasn't until the advent of 'modern' science and the emphasis on technological progress that an alternative world view of an earth of limitless resources (or at least unlimited substitutability), became imprinted on the public consciousness.

Plato identified an ideal number of people that could live comfortably on a certain area of land, in possibly the first recorded conceptualization of carrying capacity:

> A suitable total for the number of citizens cannot be fixed without considering the land and the neighbouring states. The land must be extensive enough to support a given number of

> people in modest comfort, and not a foot more is needed (Plato, Laws V:quoted in Focus, 4(1): 4, 1994).

In the intervening centuries, although people were aware of the limitations of a particular geographic region, there was a growing perception that the earth contained an unlimited amount of uncultivated land and resources with which to generate wealth. This belief was one of the driving forces behind colonialism and emigration from countries like England and Ireland where the reality of resource scarcity was all too familiar.

The beginnings of the industrial revolution in the late 1700's and early 1800's gave rise to utopian visions of societies devoted to leisure activities made possible by the replacement of labour by machinery (Hardin, 1993). It was believed that economic growth supported by technology was necessary in order for society to accomplish these goals. The first formal correlation between economic growth and increased standard of living came with Adam Smith's "Wealth of Nations" in 1776. According to Smith, economic growth would come primarily from capital accumulation and technical progress which would be reinforced by the greater health and vigour of the labour force resulting from higher living standards (Pavitt, 1973, p 137,138).

Malthus was responding in part to these utopian ideals when he wrote his treatise on population in 1798 which re-introduced the idea of limits to growth to the public consciousness (Malthus, 1798). Malthus argued that no matter how much land, resources or economic growth there was, eventually the population would grow to a point that human population, or their level of consumption would exceed the ability of the available resources to provide for them. He further argued that it was the hardships associated with a lower

standard of living that actually put limits on population growth, and the absence of hardship (as predicted by Smith, for example.) would result in unlimited population expansion until there were hardships again, ultimately destroying any possible benefits, and indeed halting economic growth.

The industrial revolution in Europe and concomitant improvement in the standard of living, and lifespan, along with increases in population seemed to refute dire Malthusian claims and established the role of science and technology as the liberator from worries of resource limitations. Capitalist and socialist thinkers alike embraced technology as the 'emancipator of man' (Eckersley, 1992; Pavitt, 1973). Interestingly, many diverse authors predicted eventual stagnation in economic growth, albeit for different reasons than Malthus. For example, Mill and Keynes (Pavitt, 1973) both predicted that economies would stagnate, but as a result of most of the population becoming free from economic necessity and able to pursue leisure activities rather than production.

The debate over limits to population and economic growth (and increased production and consumption as a consequence) resurfaced in the 1970's with the United Nations conference on population in Stockholm in 1972 and the Club of Rome's Report; "The Limits to Growth" (Meadows, et al., 1972) . However, as in Malthus's time, there were those who believed that despite the claims of the ecologists, there is no possibility of man exhausting natural resources (Peikoff, 1991)[1]. This view was especially touted by the "Green Revolutionists" who pointed to increases in yields obtained by plant breeding as the end to

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[1] Many authors who believe that natural resources are inexhaustible are considering marketable commodities only and not non market resources or waste sinks (W. Rees, personal communication).

hunger. Twenty five years later, hunger is still with us. Collins and Lappe (1977) argue that hunger is a function of socio-political factors rather than an inability to keep up production. This may have been true in the past, but in the last ten years, increases in world agricultural production have failed to keep up with population growth (Brown et al., 1994; Meadows et al., 1992; Silver and DeFries, 1990)

These differing world views of the earth's resources continue today and are the basis behind the different approaches taken to implementing sustainability by governments, farmers, non-governmental organizations (NGO's) and others. The underlying world views discussed above give rise to two basic streams in the conceptualization and implementation of sustainability; the development or conservation (negative growth or growth neutral) oriented and the growth oriented approaches (see Figure 2.1)[2]. In this context, biotechnology is an interesting focus because of the controversy surrounding its possible role in sustainability. In some sectors, it has been touted as the next 'Green Revolution' and as absolutely necessary for agricultural sustainability (World Bank, 1990). The Canadian Government embraces the positive role of biotechnology as a matter of fact without explaining how biotechnology will contribute to sustainability[3]. On the other hand, much has been written about the negative effects of the Green Revolution and the possibly adverse consequences of the upcoming Biotechnology Revolution in terms of quality of life and

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[2] Figure 2.1 was developed on the basis of a review of literature on agricultural sustainability.

[3] In later documents, AAFC is more specific about the contribution of biotechnology, but relates it primarily to economics (AAFC, 1995c).

environment (Campbell, 1990; Dahlberg, 1979; Hobbelink, 1991).

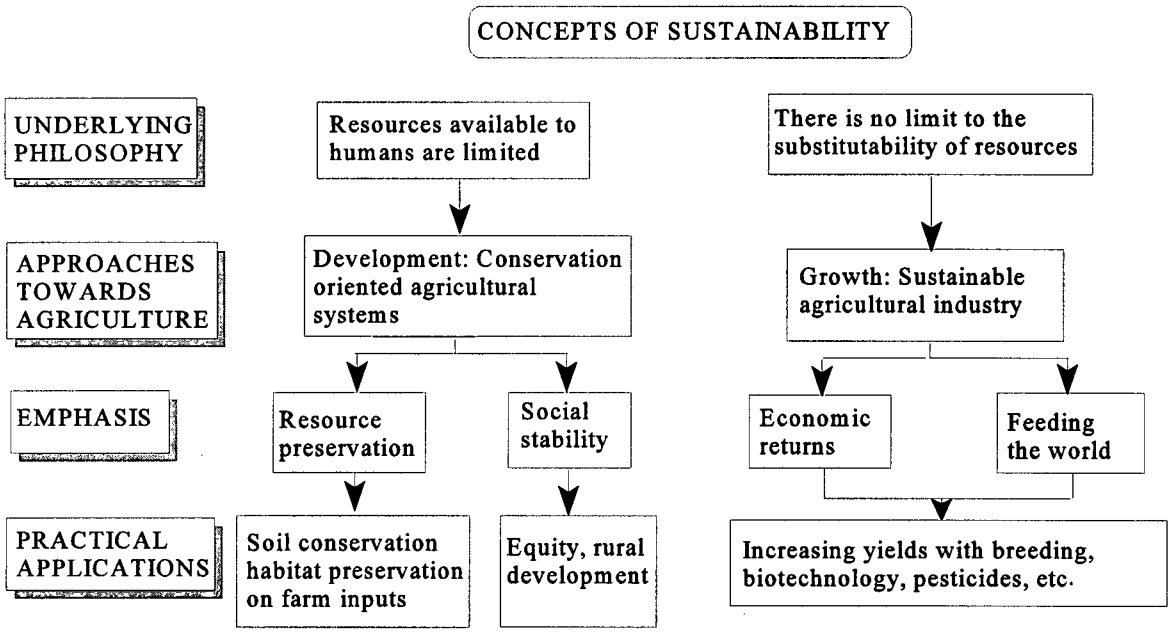

Figure 2.1 Concepts and world views of sustainability.

2.1.2 Overview of Sustainability Definitions

Definitions of sustainability reflect each author's underlying philosophy, but most contain aspects relating to economic, social and ecological sustainability. The primary difference lies in the priority given to the three components, which reflects the underlying

worldview of the proponent. Figure 2.1 shows how the unlimited earth's resources world view gives rise to a growth oriented approach to agriculture which emphasizes an expanding sustainable agricultural industry. The growth oriented approach can be distinguished for its emphasis on; promoting industrial growth as a means of increasing economic returns, and growth in production as a means of providing for an increasing population. Thus, under a growth-oriented approach, sustainable agriculture is one that is able to continually increase productivity. An alternative view of agricultural sustainability involves a more conservation oriented, growth neutral or negative growth approach. Proponents of this approach are interested in conserving or maintaining ecological integrity and/or certain social structures. A conservation-oriented agriculture should be sustainable if the environment was preserved or desired social structures maintained.

Biotechnology is characterized as a growth-oriented approach to agricultural sustainability, because it is generally seen as a means of increasing productivity to provide economic returns which will, in turn, support growth in the agricultural industry (AAFC, 1995c). Proponents of biotechnology, and herbicide tolerant canolas in particular, argue that the use of herbicide tolerant crops will reduce herbicide use, thus representing a more conservation-oriented approach. However, the use of herbicide tolerant varieties is a short term improvement over current varieties and practices at best. At worst, it will increase dependance on off-farm inputs and result in the spread of herbicide tolerance into weeds (Mikkelsen, 1996).

The terms 'sustainable agriculture', ' agricultural sustainability' and 'sustainable agricultural industry' are often used interchangeably. However, by examining the definitions

and practical applications, it is often possible to identify the emphasis or underlying world view. In the following sections, I review approaches to sustainability described in the literature

Growth Oriented Approaches

Two growth oriented approaches towards sustainable agriculture were identified, which are justified by different rationales (Table 2.1). In the first approach, the emphasis is on the need to increase productivity in order to provide adequate nutrition for present and projected populations. In developing countries, proponents of this approach are generally

Table 2.1 : Characteristics of growth oriented approaches to agriculture.

Emphasis	**Developing countries**	**Developed countries**
Increased production for meeting nutritional needs	Increasing domestic food supply to feed population	Increasing food supply to assist developing countries (food aid?)
Increased production for income	Increasing production for domestic sale and export as a means of increasing income	Increasing production, primarily for export

in favour of taking North America's high yielding, input intensive agriculture to developing countries to boost their productivity. There is also a contingent within developed food exporting countries, who believe that it is the responsibility of those countries with surplus food to aid in feeding the world's hungry.

Many developing countries have malnourished populations and are dependent upon food imports, or food aid. Ensuring adequate food supplies can occur through improving

income (through agriculture or other industries) so that citizens can purchase adequate food (perhaps supplied by food exporting countries) or achieving some level of self-reliance in terms of food production[4]. Many developing countries pursue the dual goals of increasing food production to meet nutritional needs and increasing income for rural people simultaneously. These dual goals are also pursued by international development organizations and research groups. For example, the goal of the Consultative Group on International Agricultural Research (CGIAR) reads:

> Through international agricultural research and related activities, to contribute to increasing sustainable food production in developing countries in such a way that the nutritional level and general economic well being of low income people are improved (Plucknett, 1990, p 34).

The CGIAR perspective is important because it funds many international research institutions worldwide and is seen as the conveyer of new technologies (particularly biotechnology) to the developing world. One of the listed aims of the CGIAR suggests that the focus should be on long term sustainable production and not on technologies that "sacrifice ecological stability for short-term gains in productivity." (Plucknett, 1990, p 35). However, later in the chapter, in a seemingly contradictory statement, Plucknett states that one of the aims of sustainable agriculture is:

> A gradual evolution towards greater productivity from balanced systems which may require progressively higher levels of purchased inputs to ensure that the requirements of sustainability

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[4] An argument is made for the importance of self-reliance in food production later in the chapter.

are met (Plucknett, 1990, p 37,38) [5].

The phrase " progressively higher levels of purchased inputs" implies an infinite increase in input use. It is not clear how continually increasing input use would be sustainable economically, unless the prices of the commodities being produced increased concomitantly. Continually increasing food prices would require continual increases in the incomes of consumers.

Agenda 21, the document produced as a result of the United Nations Conference on Environment and Development (UNCED, 1992) also addresses the issue of sustainable agriculture. The aims of sustainable agriculture are stated succinctly in chapter 14 of Agenda 21:

> The major objective of sustainable agriculture and rural development is to increase food production in a sustainable way and enhance food security (UNCED, 1992, volume 2, p 71).

In this chapter of Agenda 21, maintaining and improving the capacity of the higher potential lands to support increased populations is stressed. Provision of employment and income generation to alleviate poverty are also mentioned in this chapter.

The above definitions reflect the apparent desire of many developing countries to increase productivity in an attempt to increase self-reliance in terms of food production. achieve self sufficiency in terms of food production.

In developed countries, increased productivity and production is seen by some as an

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[5] A number of characteristics of sustainability are mentioned in the article including; conservation of genetic resources, increased yields, IPM, soil and water management and various socioeconomic and legal considerations (Plucknett, 1990, p 36).

alternative to feeding populations in developing countries. The American and Canadian 'mid-wests' have been referred to in the past as the 'World's Bread Basket' because of their high agricultural productivity. Many farmers and others involved in agriculture believe that those countries which have excess agricultural capability have a moral obligation to produce as much food as possible in order to feed the developing world. For example, Libby, (1993) states:

> As the world's largest food exporter, the US has the special capacity to reduce, even eliminate world hunger. The real limitation is the collective will to do so (Libby, 1993).

The agricultural industry has also taken up the challenge of increasing food supplies in food exporting countries. Fraley (1992), a Monsanto agricultural biotechnologist, suggests that sustaining the food supply through increased investment in new technologies (particularly biotechnology) is the answer to the world's projected food needs. However, neither Libby's comment on the US's capacity to eliminate world hunger nor the industry perspective as articulated by Fraley address the issue of whether developing countries can meet their own food needs. The damaging effects of food aid on the local agriculture and economies in developing countries have been well documented (for example; Berardi and Geissler, 1984; Dahlberg, 1979). Even if developed countries or industries are willing to donate their technologies to developing countries, there is on-going debate as to whether Western-style input-intensive agriculture and large scale monoculture is consistent with agricultural sustainability (Berardi and Geissler, 1984; Brown, 1994; Ruivenkamp, 1987; Sousa-Silva, 1988). The Green Revolution was the first attempt to bring Western style agriculture to developing countries. In India, Vandana Shiva traces ecological problems and

violent conflicts in the Punjab to ecological and political demands of the Green Revolution (Shiva, 1992). In addition, Dahlberg (1979) mentions economic exploitation, loss of wild food plants, severe resource depletion, plant diseases and increased pest outbreaks as a result of the Green Revolution.

In developing countries, treating agriculture as a sustainable industry can be differentiated from the goal of increasing income to alleviate poverty. By focussing on agriculture as an industry, the emphasis is on exports to increase national income (Tussie and Glover, 1993). In this approach, improving the economic situation of farming is seen as a pre-condition to addressing social and ecological issues. Both developed and developing countries are interested in economic growth from a sustainable agricultural industry. Currently, success in a sustainable agricultural industry is measured primarily in terms of increased returns and wealth creation which are calculated using classical or conventional economic analysis. For example, the US Agency for International Development (USAID) states:

> AID particularly encourages country leaders to consider policy alternatives that can increase the productivity and incomes of small scale rural farmers (Brady, 1990).

Agriculture and Agri-Food Canada (AAFC) has some interesting approaches to sustainability. The definitions and emphases placed on various components of sustainability vary considerably depending upon when, and in which branch of the Department, the documentation was produced. The Agriculture and Agri-food Canada Research Branch states as their goal:

> To contribute to the long term competitiveness of a diversified and environmentally sustainable Canadian food and agriculture sector, including non-food uses of agri-food products, by developing and transferring innovative technologies related to our four areas of business (Agriculture and Agri-Food Canada, Business Plan, 1995, p 3).

In this statement, competitiveness and environmental sustainability are given equal weight[6]. However, competitiveness is defined by AAFC as " ... the sustained ability to profitably *gain* market share in domestic and/or export markets" (Agriculture Canada, 1993). An on-line (InfAgBiotech Home Page) document prepared by the Strategies and Planning Directorate (part of AAFC Research Branch, July, 1995) in response to Agenda 21, reiterates the dual goals of promoting competitiveness (through sustainable growth) and environmental sustainability and comments that the Research Branch works to ".. integrate the goal of environmental sustainability with the attainment of sustainable growth".

Conservation/Development-Oriented Approaches

In contrast to the growth-oriented approach, conservation agriculture identifies persistence of continuity of the ecosystem or social organizations as the primary goal. Soule and Piper (1992) state the problem identified by many conservationists:

> Thus, a predominantly economic interest in agricultural science, along with an approach to science that tends to take the world apart and simplify it to understand it, and a cultural world view that places humans as irresponsible masters over nature have combined to *create an agriculture that resembles an industry more than an ecosystem* and that is not sustainable (emphasis mine) (Soule and Piper, 1992, p 78).

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[6] However, Rennie (1993) states that the efforts of the agri-food industry (comprising about 80% public research) on research and technology transfer are split so that 50% of the effort is directed towards competitiveness, 20-24% towards environmental sustainability and 8-13% towards food quality and nutrition.

The underlying theme of many ecological conservation approaches is protection of the environment *from* agriculture as opposed to protecting the environment *for* agriculture. A focus on conservation and environmental protection implies a lower level of inputs and impacts than at present, and as a result, a lower level of production (Altieri and Hecht, 1990; Bushnell, et al., 1991; Odum, 1989). Proponents of conservation oriented sustainable agriculture criticize the preoccupation of society with the application of technology to continually increase yields even in the face of surpluses and deficits (wheat is a good Canadian example). Edwards sums up the problem:

> The current use of fertilizers and pesticides is predicted to continue to increase almost exponentially unless there are fundamental changes in the philosophy that crop yields should continue to increase irrespective of the plight of the small farmer and environmental deterioration (Edwards, 1990, p 249)[7].

Considerable debate exists over the economics and sustainability of many alternative agriculture practices. Some authors maintain that low input agriculture is more profitable whereas others insist that yields, and net returns, would be reduced drastically (for example see: Anderson, 1990; Ikerd, 1993; Tweeten and Helmers, 1990). The divergent estimates for yields under alternative agriculture conditions could reflect differences in management practices used, condition of the land or previous crop rotations, micro-climate etc. The economics of farm operations are currently measured in terms of classical economics, which does not take into account the costs of externalities or the state of the resource base

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[7] Since 1990, additions of fertilizer have levelled off world wide, however, this is due primarily to withdrawals of fiscal subsidies (e.g. in the former Soviet Union) rather than a change in philosophy (Brown, 1994). An improved economic climate could result in further increases in the former Soviet Union and China in particular.

(Costanza, 1991). As a result, conventional farming techniques *may* display superior economics to alternative, lower input systems. Using an ecological economics accounting system, alternative, lower input systems would presumably perform better than conventional ones even if yields were somewhat lower.

The Agriculture and Agri-food Canada Indicator program and the Environmental Monitoring and Assessment Program (EMAP) in the US are conservation oriented programs created to deal with the environmental impacts of agriculture. Both programs are reactive in that they are intended to track the damage done by agriculture in an attempt to mitigate these impacts and both are concerned primarily with ecological impact. The EMAP indicator program defines ecological sustainability as follows:

> An agroecosystem is *ecologically* sustainable if it maintains or enhances its own long term productivity and biodiversity, the biodiversity of surrounding ecosystems and the quality or air, water and soil (Campbell, et al., 1993, p 2).

The indicators chosen by the EMAP team in this preliminary document include: soil quality, soil biotic diversity, crop productivity, biodiversity of agricultural landscapes, land use, insect biodiversity, a biological ozone damage indicator and possibly other factors including farm pond condition, wildlife indicators, and visual damage to plants. In a similar program, Agriculture and Agri-Food Canada is in the process of developing a series of indicators which include agricultural soil resources, genetic diversity, surface and ground water quality, wildlife habitat, air and climate, water quantity, energy use, nutrients and pesticides (trends in risks associated with nutrient and pesticide use) as well as other relevant issues including input costs to yield ratio, yield variability and maximum sustainable yield

(Agriculture Canada, 1994). Although most of these indicators are ecological, some, such as the energy use and nutrients and pesticides, relate to management. Since their programs are primarily reactive in nature, AAFC has given reductions in the use of agricultural inputs a low priority because agricultural inputs are seen as a cause rather than an effect which an indicator can measure (AAFC, 1994). The Environment Bureau makes no suggestions as to which branch of AAFC could take charge of attempting to encourage reductions in the use of agri-chemicals. Both the EMAP and AAFC indicator programs are meant as sources of information to policy makers and are not actually geared towards changing management practices.

Other authors define sustainability in terms of supporting social structures and concentrate on development in a more general context, which incorporates agricultural sustainability as a component of sustainable development. The report of the World Commission on Environment and Development (WCED, 1987) defined sustainable development with the ultimate goal of providing for humans:

> In essence, sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations (WCED, 1987, p 47).

Note that the definition mentions both human needs and aspirations. These two concepts are vastly different. The use of the term 'needs' implies that there are specific limited requirements for human life whereas aspirations implies human desires, which are essentially limitless.

In addition to defining sustainability in terms of ecological systems outlined above, the EMAP program also describes social and economic sustainability at different levels[8]:

> A farm is *economically* sustainable if it is economically viable over the long term. An agricultural system is *socially* sustainable if it meets the basic food and fibre needs of society and maintains or enhances the quality of life for farmers and rural communities (Campbell, et al., 1993, p 5).

Robinson et al. (1990) also define sustainability in terms of human institutions:

> Sustainability is defined here as the persistence over an apparently indefinite future of certain necessary and desired characteristics of the socio-political system and its natural environment (Robinson et al., 1990).

Although the socio-political system and issues like equity and justice are certainly important for sustainability, they would be difficult to achieve in the absence of environmental sustainability. Environmental degradation in developing countries has led to social instability as levels of agricultural production fall and are no longer sufficient to support the population (Shiva, 1992). Therefore, a socio-political system must be structured in order to recognize the realities of the natural system it inhabits.

A move away from an expansionist philosophy (unlimited substitutability and growth) towards a more steady state or ecological (conservation oriented) philosophy is required for the implementation of sustainability (Rees, 1995). This change in philosophy entails a new set of values or ethics. Table 2.2 displays in more detail some of the practical

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[8] Although EMAP does describe economic and social sustainability, its indicator program does not address these aspects. They are included here for interest-given the specific scales social, ecological and economic sustainability are framed by.

Table 2.2: Differences in goals and ethics of growth oriented versus conservation oriented agriculture (adapted from Dahlberg, 1993).

	Growth	**Oriented**	**Conservation**	**Oriented**
	Goals	*Ethics*	*Goals*	*Ethics*
Farmer	Income for family	Individualism	Support for family and community	Rural community Family/group self reliance
	Stewardship of the land	Practicality	Conservation of energy/soil and local resources	Harmony with nature
	Production to fight world hunger	Moral concern	Social justice and distribution	Moral concern
Agriculture Sector	Expanding foreign markets and stable prices	Corporate and market economy	More local and regional markets and sustainable production	Local and regional self reliance and regenerative systems
National	Increase well being through increasing wealth	Economic growth	Having healthy/ nutritious food	Sustainable economic farming
International	Elimination of hunger through trade and aid		Elimination of hunger through local production	

and ethical differences between growth and conservation oriented approaches to agriculture. Changing values and ethics can give rise to different goals, e.g. increased production for export vs prioritizing the production of healthy, nutritious food. Even if the ethics behind an action are similar, the world view of the individual or institution may affect the actions taken. For example, farmers motivated by moral concern could either focus on

increasing their production in order to address world hunger or on working towards self reliance and social justice (Table 2.2).

2.1.3 Sustainability Definition and Framework for the Thesis

The 'Need' for Sustainable Agriculture in Canada

Changes are required in the way we practise agriculture in Canada if we want a successful agriculture which includes criteria like environmental, economic and social well being. Public debate around new crops or technologies often focuses on safety and human health issues, which although important, obscure questions such as: *do we 'need' that particular technology*? Sustainability Inc. an environmental consulting company in the UK suggest that in addition to the traditional market requirements or hurdles of safety, efficacy and quality, socio-economic impact and need must be assessed in the development of new technologies. They place socio-economic impact and need as the fourth and fifth hurdles respectively with need being the highest hurdle. I propose that 'need' be examined more rigorously and as the first requirement in the development and application of new agricultural technologies. The bovine growth hormone (BGH) debate has brought issues of need to the forefront. Public interest groups have questioned the need for a new technology that has proven negative effects on animals, possible negative effects on human health and economics of small farms, which allows us to produce more milk in a time of surplus milk production (Grobe and Douthitt, 1995; Marquart et al., 1995). The European Economic Community, placed a seven year moratorium on the use of BGH because of estimated socio-economic impacts of the use of the hormone on smaller farmers. Although safety is also an issue in this

case, I believe that this concern would be considerably diminished if there was a perceived need for this technology. A perceived need for a level of technology affects the level of risk and responsibility (for example in terms of funding for public research) that society is willing to accept for the development and use of that technology. Vaccines are one example of where people are likely to accept a certain level of risk if the benefit is assured protection from disease.

In the context of this thesis, 'need' would be defined in part as having a positive contribution towards sustainability and would be identified using public input (criteria for public involvement are developed in the next section). The research question could thus be re-stated: *Do we need herbicide tolerant canolas (or biotechnology in general) in order to achieve sustainable agriculture in Canada*?

Defining Sustainable Agriculture

In a food production system, yield (with its most general connotation) is the common indicator of success. The goal of agricultural sustainability is to ensure that the yield of an agricultural system is sustainable. However, many factors affect yield and these are what define whether the system is sustainable. The concept of sustainability has an implicitly infinite time horizon associated with it. Obviously then, sustainability cannot be measured *per se*. Unsustainability on the other hand, can sometimes be detected. This idea is analogous to treating sustainability as the "null hypothesis". That is, the null hypothesis would be that an agricultural system is sustainable. In some cases we would be able to reject the null hypothesis, e.g. in cases where irrigation dependant systems are depleting ground water, and leading to a decrease in yield over time. In other cases, where we are not able to identify

unsustainable practices, we do not reject the null hypothesis. However, we can never accept the null hypothesis because we are never able to prove a system is sustainable due to the implicit infinite time frame involved.

To address the time scale problem, we must approach sustainability as a process[9]. Achieving sustainability would involve a process of identifying and eliminating obviously unsustainable practices and progressively reducing ecological impact of agricultural practices, while concurrently taking into account social and economic considerations (including need and demand). The Brundtland report also defines sustainable development in terms of a process of change in which exploitation of resources and uses of technology are made consistent with future as well as present needs (WCED, 1987). Although, strictly speaking, sustainable development would be the process towards the goal of sustainability, the temporal dimension involved blurs the distinction.

Our specific goals for sustainability must be flexible and amenable to change as more information becomes available. These goals must also identify levels of production, since sustainable agriculture cannot be achieved with a continually increasing level of production (i.e. infinite increases in production in a finite world). Social, economic and environmental sustainability are inextricably linked, but rest on maintenance of ecological systems[10]. Our social and economic systems must be structured to fit within ecological limits (Rees, 1995).

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[9] In reality, sustainability would be a steady state, where the stability of the ecological systems is maintained.

[10] It is acknowledged that all forms of agriculture disrupt the pre-existing natural system (Batie, 1990). However, there are degrees of impact and some are essentially irreversible, e.g. desertification, salinization, loss of topsoil.

Crews links economic sustainability to social conditions and sustainability of the system to ecological impacts:

> We argue here that the profitability of sustainable agricultural systems is constrained by the social structure of agriculture but that sustainability itself is constrained by the ecological conditions of agriculture (Crews et al., 1991).

In addition, Senanayake writes:

> .... as the basis of society is agriculture for most of humanity, the sustainability of the agricultural system becomes vital to the sustainability of the social system, whatever the current social values in force (Senanayake, 1991).

Prioritizing maintenance of ecological systems in agricultural ecosystems is consistent with a conservation-oriented, rather than a growth-oriented emphasis. While the prospect of growth is not eliminated, I believe that it is subordinate to ecological concerns. Any definition of sustainable agriculture must also take into account the scale of such impacts or interactions and the relationship between agriculture and other ecosystems and natural resources (from farm level to global impacts) as well as social and economic concerns.

I developed criteria by which an agricultural system could be considered sustainable through a synthesis of the literature.[11]

1. Long term preservation of the natural resources which support agricultural production (conservation-oriented).

Land: Preservation of prime agricultural land for agriculture is essential (e.g. from urban encroachment, pollution). Using inferior land requires more outside inputs and may

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[11] Main references used: Agriculture Canada, 1944; BCMAFF, 1995; Benbrook, 1990; Campbell et al., 1993; Goudie, 1994; Parenteau, 1988; Pretty, 1995; Rees, 1994; Rees, 1994; Soule and Piper, 1992).

cause more environmental damage. Global influences such as acid rain, ozone depletion and global warming will also affect the land and should be reduced as much as possible.

Soil: Maintenance of quality, quantity and organic matter. This requires the use of appropriate tillage practices, nutrient and residue management, etc.

Water: Available water resources must be managed appropriately, maintaining water quality and not overusing ground water, through use of practices that conserve aquatic resources and minimize the risk of pollution.

Genetic diversity of crops and livestock: The genetic diversity of crops and livestock used should be enhanced to reduce risk and ensure that more locally adapted crops are available. Landraces or older varieties of crops should be preserved. For example, diversity in crops could be introduced and maintained through local development of varieties and crops suited to particular areas.

Biodiversity of wild species: Biodiversity of wildlife, insects and other species, should be preserved as much as possible. It is recognized that all forms of agriculture will result in a reduction of species diversity to some extent. Preservation of many species requires a maintenance of the quality and quantity of wildlife habitat.

2. A more independent agriculture.

Reduced dependance on off-farm inputs and non-renewable resources: Reductions in dependance on non-renewable resources is necessary to improve economics and the environmental impact of agriculture (i.e. the fossil fuels sed for machinery and fertilizers and pesticides).

Self-reliance in food: We must ensure that Canada is self-sufficient in basic foodstuffs and self-reliant in as much food as possible. This does not eliminate trade in agricultural products, but serves to ensure that Canadians will have an adequate, affordable food supply in the future.

Local agricultural research and development: As funding for public research in Canada is reduced, Canadian agriculture is becoming more dependant on multi-national agri-chemical and biotechnology companies to conduct agricultural research. Sustainability must be addressed at different levels or scales; the farm, the region, the ecozone, nationally and internationally. Smaller scale, local research projects are required to address local or regional agricultural needs. These needs will not be addressed by multi-national corporations. Therefore a re-examination and commitment to incorporation of local agricultural knowledge

and publicly funded agricultural research is required.[12]

3. A more socially responsive approach to policy making.

Public consultation and involvement in policy-making: Moving towards sustainable agriculture may require a fundamental shift in philosophy, away from a growth-oriented approach, to a more conservation-oriented one. Achieving such a shift would require a partnership between policy makers and the public in order to facilitate knowledge sharing and the establishment of priorities for sustainable agriculture. Involving the public is challenging, but an effort should be made to include as many different perspectives and interests as possible. This criteria is an important contributor to sustainability and is explored in more detail in a later section.

Technology assessment: All new, emerging technologies, including biotechnology should be assessed in terms of sustainability (i.e. against the criteria presented here) in a process which involves the public in an informed debate. This process should be seen as fair and transparent and should be flexible and amenable to change as new questions and information arises.

4. A more socially just agriculture

Adequate income for farmers: Farmers must be able to receive an adequate income from farming whether through appropriate pricing, reduced dependance on off-farm inputs, penalties for those using unsustainable practices, financial support or a combination of these. Focussing on international economic competitiveness does not address the issue of farmer income. An adequate income is an important step towards achieving an acceptable quality of life.

Consideration of public health: Provision of a safe, healthy food supply and acknowledgement of, and reductions in environmental causes of health problems.

These criteria are not meant to be exhaustive, but will guide my assessment of AAFC's sustainability and biotechnology policies.

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[12] The consequences of a reduction in publicly funded agricultural research are presented in more detail in the next section on barriers to sustainability.

2.1.4 Barriers to Sustainability

Although I have stated that ecological sustainability is the cornerstone of agricultural sustainability, most of the barriers to agricultural sustainability at present are social and political in nature. We have knowledge of many agricultural practices which would result in a more environmentally sustainable agriculture, (e.g. preservation of land, soil, water and genetic resources) but we fail to use them. Pretty (1995, p 243) states that "... most, if not all of the policy measures used to support agriculture currently act as powerful disincentives against sustainability". Much research exists on institutional barriers and disincentives to sustainability, focusing primarily on price and income supports, commodity programs, the structure of research and extension programs which focus on technological solutions, marketing boards, crop insurance, target prices, pesticide licensing, etc. (Antle, 1991; Batie, 1990; Doering, 1992). Suggested solutions to these problems include; taxing external inputs, the polluter pays principle, changes in the agricultural extension service, eliminating subsidies and incentives for environmental practices (Batie, 1990). Many solutions focus on changing the producer's behaviour in terms of agronomic practices and require the development of new and alternative practices, crops or technologies. New technologies directed towards improving sustainability must be developed by either the public or private sector. In the US and Canada, agricultural research and extension is, in many cases, carried out by private companies (particularly agrichemical companies). The government has encouraged the move towards private sector agricultural research by reducing funding for public agricultural research and using the remaining funds and resources to focus on participation in industry *led* research (AAFC, 1995c). It has been suggested that private

industry may not conduct the type of research required to support a transition to a more sustainable agriculture (Lacy et al., 1988). This means that encouraging farmers to adopt sustainable practices will be unsuccessful if appropriate technologies are unavailable.

The long term consequences of industrial involvement in public research are uncertain. Basic research at some level is required to 'advance the science' but it is unclear who will perform this research in the future. The growing role of the private sector in agricultural research has raised the questions: *Are the goals of private research congruent with the wants and needs of society, especially with respect to sustainability? Should the public financially support the private sector if the results of the research do not directly or indirectly benefit society? and will increased public/private sector collaboration result in less communication as a result of trade secrets or less accessibility as a result of patents?*

Reasons for the decline in public investment in research are complex. Several studies have indicated that the returns to investment for public research in agriculture in Canada are on the order of 40-60% (Evensen et al., 1979; Ulrich et al., 1985). With such a high rate of return to investment, the question arises; why is Canada reducing its investment in public sector agricultural research? Rausser and Zilberman (1991) argue that the main interest groups affected by public research in agriculture include consumers, farmers, farm labour groups, environmentalists, intermediaries (e.g. food processors, exporters) input suppliers and government. The impact of the introduction of new technologies affects these groups differently and consequently, they approach the issue of public investment in agricultural research differently. In Canada, consumers benefitted the most from agricultural research in the past because domestic consumption was predominant, resulting in a relatively inelastic

demand (Rausser and Zilberman, 1991). As exports of agricultural products increased, demand became more elastic (because consumers had more choice), and consumers became less willing to accept investment in public agricultural research. Environmental groups and farm labour groups may also be unwilling to invest heavily in research because of possible labour displacement and environmental impact. Intermediaries, such as food processors generally benefit from the introduction of output-increasing technology and thus are supportive of public research in agriculture. Input suppliers have varying interests depending upon the nature of the input. However, intermediaries and input suppliers are often large international corporations and thus unlikely to directly support public research in Canada. As a result, there is little public pressure to increase or even maintain expenditures on public research, especially in the current climate of cost cutting and deficit reduction (Rausser and Zilberman, 1991). However, there are arguments for maintaining public sector research.

Public sources of technology and research are necessary if research which is of high social value, but has a small market, or exhibits a high degree of geographical and ecological specificity, is to be conducted (Rausser and Zilberman, 1991). Justification of public research into agriculture generally falls into five categories; the public good nature of research outcomes, externality problems, differences between public and private risk and time preferences, relative advantage and industry structure (Rausser and Zilberman, 1991).

Externality problems arise when the knowledge generated has applications in areas other than that which the research was originally directed towards . In this case, the private sector will often under-invest because they do not take benefits to other operations into

account, especially if the research has the potential to benefit many groups. Private over-investment can also occur as a result of financial externalities. For example, with the introduction of a new technology such as drip irrigation, the value of land previously unsuitable for cultivation may rise (Rausser and Zilberman, 1991). The developer of the new technology could make more money by speculating on the land. This situation is analogous to the development of herbicide tolerant crops. Generally speaking, the companies which are developing the new crop varieties are the same ones which own rights to the herbicides. In fact, is could be argued that the main reason behind the development of these varieties is actually to get a greater market share of the herbicides (sales from the seeds is an added bonus).

Differences between public and private risk and time preference is another justification for public research (Rausser and Zilberman, 1991). In general, government behaviour in agriculture research can be characterized as risk neutral whereas the private sector is more risk averse in this respect. Therefore, research projects with a high degree of uncertainty but with high expected social benefits will likely be avoided by the private sector.

Public research institutions may have a relative advantage over the private sector in terms of economies of scale (Rausser and Zilberman, 1991). In some types of research, where materials or facilities are very expensive, only a large public research body will be able to achieve the most efficient scale. A related issue is industry structure. In the absence of public research, an industry will only carry out research if the scale of operations of their buyers is large enough. For example, the scale of farming operations that justifies

research may be much larger than the socially optimal scale of farming operations.

The above discussion reviews some of the more general possible consequences as a result of a move towards more privately funded agricultural research. Lacy et al. (1988) identify specific consequences of agricultural biotechnology for agricultural research which imply that agricultural biotechnology, by its very nature, will result in more industry involvement in public sector research (Figure 2.2).

1. A shift in disciplinary emphasis in the agricultural research community from traditional breeding and agronomy to molecular biology.

2. A reduction in research on systems, ecology and the social sciences.

3. Increased concentration of research funds at a small number of larger institutions.

4. General reduction of long term research in the public sector.

5. Increased collaboration between industry, government and universities resulting in a restriction of scientific communication (e.g. trade secrets).

6. A change of the primary goals and agendas of public research.

7. Increased concentration in the agribusiness sector and the industrialization of the food sector

Figure 2.2: Consequences of agricultural biotechnology for public and private agricultural research and the structure of the food system (from Lacy et al., 1988).

With the move towards private sector research, the new techniques and crops required to implement changes in agronomic practice to support sustainability may not be available to farmers in the future. Government should both devise incentives and regulations that would encourage the private sector to invest in the development of alternative cropping systems and maintain public sector research. A re-commitment to public sector research could be achieved

if it had widespread public support through the involvement of the public in determining research goals (see next section). Industry has long argued that regulations have a profound effect on their research programs. Although this argument acknowledges the impact of regulation on private sector research programs, industry generally supports less regulation rather than re-directed regulation.

2.2 Public Involvement

The third sustainability criteria listed earlier, calls for more public involvement in determining policy directions for agriculture and in decision-making about new technologies as a means of prioritizing sustainability initiatives. Calls for public involvement in determining policy and decision-making have been increasing in Canada, particularly for environmental issues (Tester, 1992).

2.2.1 Reasons for Increased Calls for Public Involvement

Rowson (1993) identified from the literature, several reasons for increased calls for direct public participation:

> 1. Disillusionment with elected officials. This could arise as a result of government misidentifying public desires.
>
> 2. Increased alienation experienced by the general public. For example, alienation due to increasing government centralization and removal of local decision-making power, or of the existence of conflicting interests in society, which government has been unable to respond to adequately.
>
> 3. A decline in the perceived legitimacy of hierarchical authority, patriotism and religion, and positivist science, leading to a decline

in confidence in institutions in general.

4. A shift in the balance of political skills between the elites and the masses. As the public becomes better educated and politically aware, they demand more input into decision making.

5. A case of positive feedback: Steps towards openness and public participation won by environmental activists have led to a general expansion of public expectations about being consulted.

Increased public involvement in decision-making can address the problems listed above by improving the credibility and legitimacy of decisions. In addition, the public may have new and innovative solutions to problems that have not been considered by decision-makers (Roberts, 1995). In agriculture, increased public involvement may also serve to educate the public about some of the issues facing farmers (particularly economic constraints) and therefore cause them to become more willing to support public investment in agriculture or research and development.

There also been a crisis in the perceived legitimacy of science. When concern with environmental issues first arose in the early 1970's, there was a sense that most problems, and assessments of impact and risk, could be addressed on a purely technical basis (Petersen, 1996). However, in the last twenty years, the 'objectivity' of science has been called into question. Most questioning of the objectivity of science has come from academics, particularly constructivists, who argue that science is a mutually accepted societal construct rather than representing objective truth[13]. The complex nature of environmental problems (with their attendant uncertainties) have revealed the limitations of the ability of science to

[13] Extensive research has been done on the role of values in science and constructivist approaches that will not be considered here (see for example: Brunk, et al., 1991; Edge, 1995; Jasanoff, 1990; Nelkin, 1987; Wynne, 1992).

predict impacts. Science certainly has nothing to say about the management of those impacts (i.e. distribution risks and benefits, compensation). It is difficult to ascertain how much the public at large understands and identifies with the constructivists, but it may be one reason for a decline in the perceived legitimacy of science and decisions based on science.

Several authors have suggested that the role of values in science based assessments be acknowledged and made explicit (Brunk et al., 1991; Kasanmoentalib, 1996). For example, Kasanmoentalib, (1996) comments:

> To make more responsible decisions regarding risk and to understand controversies in risk assessments, it is important to know how and where values are infused into risk assessment and how they are embedded in the conclusions.

Public involvement in a broadly based technology assessment process could ensure that a range of values are represented in the assessment and management of new technologies and address the credibility problem being experienced with science based decisions.

2.2.2 Levels of Public Involvement

Public involvement in decision-making can range from a purely representative democratic model, where the public is educated or informed, to a direct democratic model, implying citizen control over decision-making (Table 2.3). Consultation between decision-makers and the public is placed near the centre of this spectrum. Roberts (1995) comments:

> Ideally, public involvement bridges the gap between participatory and representative democracy by allowing individuals some opportunity to influence decisions normally decided by higher authorities.

Rowson (1993) points out:

> In a democracy, the level of participation should be in accordance with the wishes of the general public and this should constitute the working definition of effective participation. This definition of effective participation is likely to be transient over time.

Table 2.3: Levels of public involvement in decision-making (adapted from Roberts, 1995).

Persuasion and Education →	**Consultation and Information feedback** →	**Delegated Authority** →	**Self Determination**
• No direct involvement beyond communication	• Consideration of information received from public • Two way communi-cation process	• Transfer of res-possibilities to the public from the agency	• Public makes decisions which are accepted by the agency

Rowson interviewed participants in an environmental decision-making process and found that most participants were satisfied with a consultative approach (Rowson, 1993). On this basis, I advocate a consultative approach to decision-making, where elected officials are obligated to ensure that recommendations arising from consultation are taken into account. This approach addresses the issue of accountability for the negative impacts of decisions, which can be unresolved in a participatory democracy (i.e. who takes responsibility)..

2.2.3 Forms of Public Involvement

Public involvement can take various forms, depending upon the organization of the policy community surrounding a particular issue. In general, policy networks can be described as state directed, pressure pluralist, corporatist or concertation (Table 2.4).

The organization of interests in a policy community dictates, to some extent, the form that consultation will likely take (Pal, 1992). Pros comments that pluralism is more common

Table 2.4: Models of group/state agency interactions (the state is assumed to be strong and autonomous in all of these examples) (adapted from Pal, 1992, p 112).

State Directed → Network	**Pressure Pluralist → Network**	**Corporatist → Network**	**Concertation Network**
• Interest groups are weak and dispersed-no direct public involvement	• Many groups compete for agency's attention	• A few large and powerful groups participate in policy formulation and implementation	• A single dominant organization is an equal partner in long-term planning and policy-making.

Canada than other forms of interaction (Pross, 1992). However, in some areas of agriculture policy, Skogstad has argued that a few strong lobby groups interact with regulatory and policy making agencies in a corporatist network (Skogstad, 1990). I will argue that in canola policy, a single group acts in concert with the state.

A group must be highly institutionalized in order to act in concert with the state (Pross, 1992). Pross (1992) evaluates the degree of institutionalization of an interest group in terms of politically salient group characteristics and policy capacity. Politically salient group characteristics include membership, resources available, organizational structure and outputs (communication, mobilization and revenue related services). Policy capacity is characterized by the amount of resources the group devotes to policy activity, resources and outputs (information, lobbying and mobilization).

Table 2.5 outlines the steps that will be followed in chapter four ro characterize the form of policy network, and degree of institutionalization of the groups involved in the

variety registration and recommendation process for new canola varieties in chapter four.

Table 2.5: Procedure for studying public participation (adapted from Smith, 1987).

Providing the Context
1. Historical background
2. Institutional arrangements • political structures and processes • legislation and regulations • administrative structures
3. Features of regulatory agency and central groups • status and function • terms of reference • financial arrangements
Describing the Process
1. Goals and objectives for participation • mandate given to the participation • objectives of the participants
2. Number and nature of publics involved • who are they? • how representative are they? • how organized are they?
3. Methods employed for the process
Evaluating the Outcome
1. Effectiveness of the process in terms of creating effective public involvement and addressing sustainability concerns
2. Results and implications of the participatory exercise

2.2.4 Criteria for Assessing Public Involvement

Some forms of public consultation are more likely to address sustainability concerns than others. Table 2.6 presents characteristics which are used to describe consultative approaches in the literature and the corresponding criteria evaluate the process in relation to

how appropriate they would be to address sustainability concerns. (Jain, 1981; Roberts, 1995; Rowson, 1993; Smith, 1987):

Table 2.6: Characteristics of a consultative process and criteria for assessment.

Characteristics of a consultative process	**Criteria for assessing a consultative process**
1. Degree of power sharing between elected representatives and the public.	Decision-making agencies are obligated to incorporate the results of participation into decisions, but retain ultimate authority.
2. Determining who is allowed to participate and whether everyone in the process has equal legitimacy.	For broad policy discussion, all interested members of the public should be allowed to participate. For continuity, ongoing decision-making processes require the identification of appropriate stakeholders which represent those affected by the decisions made and who are willing to commit to the process.
3. Whether access to resources, including time, money, institutional support, and expertise, are comparable for participants.	The minimum required for participation should be provided to all participants by the agency involved.
4. The stage of decision-making that the public is being involved in.	The public should be involved both at the early stage of policy development and later on, at the technology assessment stage.
5.The scope of the process: What kinds of issues are being considered.	Involving the public at both policy development and technology assessment stages should ensure that the scope of the issues addressed is very broad: and includes social, environmental and economic considerations.

Since a representative democracy ostensibly represents all of the public, it is important that elected officials retain ultimate decision-making authority. This facilitates accountability for the negative impacts of a decision, which is difficult to assign for a decision made through a multi-stakeholder process. Deciding who is allowed to participate in

a process is perhaps the most difficult decision faced by agencies. Ideally, all interested parties that can demonstrate that they have a stake in the outcome of a particular policy or decision, and are willing to commit to participating in the process (in the case of long term processes) should be allowed to participate and provided with the minimum resources required to do so. However, some processes would be extremely unwieldy with a large number of participants. In these cases, the decision-making agency should consider all applicants and ensure that all major stakeholders are represented (probably by interest groups). A process which meets the criteria represented here would be equipped to address sustainability concerns.

The sustainability and public involvement criteria developed in this chapter will be used to assess agricultural sustainability and biotechnology policy in Canada, and to characterize and assess the process by which new canola varieties are registered in terms of a multi-stakeholder process and incorporation of the criteria for sustainability.

3. GOVERNMENT POSITIONS ON SUSTAINABILITY AND BIOTECHNOLOGY

In this section, I review chronologically the evolution of government policy on agricultural sustainability and biotechnology and assess policies against the sustainability criteria developed in chapter two (see also Appendix 1 for preliminary analysis). AAFC has the primary responsibility for implementing agricultural sustainability initiatives, regulating agricultural biotechnology and financing and conducting public agricultural research in Canada. The relationships between sustainability criteria and economic growth, competitiveness and market development in the documents are examined. I have selected those issues from government documents which relate to the sustainability criteria outlined in chapter two: long term maintenance or preservation of the natural resources which support agricultural production, a more independent agriculture, a more socially responsive approach to policy making and a more socially just agriculture.

Environment Canada is also involved in assessing overall sustainability and regulation of some biotechnology products. Environment Canada's primary mandate is environmental protectsion, which affects all of its policy development. The difference in emphasis between Environment Canada and AAFC has caused some disagreement between the two departments, particularly in the regulation of biotechnologies. The approaches of AAFC and some key federal committees to sustainability are discussed below.

3.1 Sustainability and Biotechnology Policy in Agriculture and Agri-Food Canada

3.1.1 Sustainability

Within AAFC, environmental initiatives are carried out primarily by the Prairie Farm Rehabilitation Association (PFRA) and the Environment Bureau of the Policy Branch (Figure 3.1). The PFRA focuses primarily on rural economic development and technology transfer related to soil quality and erosion (PFRA, 1992). The programs of the Environment Bureau are primarily reactive in nature and directed towards measurement of environmental damage. The Environment Bureau also responds (in writing) to initiatives like the Government of Canada's Green Plan and Agenda 21 (UNCED, 1992).

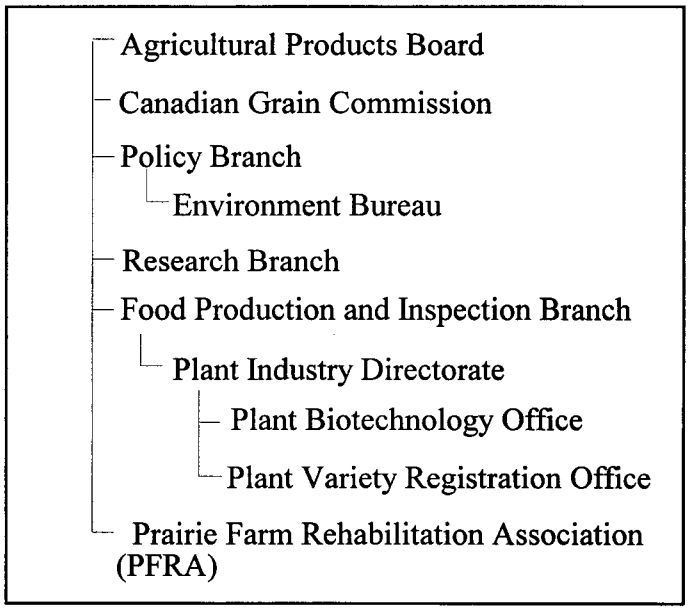

Figure 3.1: Partial organization of Agriculture and Agri-Food Canada.

A National Agriculture Strategy was developed in 1986 by the Federal and Provincial Ministers responsible for agriculture to face challenges in agriculture. The purpose of the strategy was to help create a long term thrust towards a market based agriculture and food industry, while alleviating hardships caused by distorted foreign markets (Agriculture Canada, 1986). The key elements of the strategy involved improving farm financial security,

improved protection against climatic and economic risks, soil and water conservation, protection and enhancement of the resource base, technology development and transfer related to competitiveness and improved inter-provincial trade. The strategy focused on the economics and the competitiveness of Canadian agriculture in world markets. The report listed the objectives for government action in the agriculture and food sector as; "...increasing income and employment, development of a market oriented agriculture and providing farmers with the means to survive price and climactic variations"(Agriculture Canada, 1986).

In the 1986 report, conservation and preservation of resources was seen as the primary responsibility of the producer, direct resource management was seen to be the responsibility of the provinces and conservation of the resource base and environmental and health concerns as the jurisdiction of the federal government:

> The primary responsibility for land falls upon individual producers, whereas direct resource management falls under provincial jurisdiction. It is the responsibility of the federal government to protect the overall interests of Canadians by conserving the resource base and by taking into account environmental and health concerns (Agriculture Canada, 1986, p 9)[1].

The report goes on to stress the importance of co-ordination between the federal and provincial governments. Although the above quote suggests a broad, long term consideration of environment, suggestions relating to preserving the resource base are limited to soil and water conservation programs (for the purpose of maintaining production). The report does not

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[1] Unfortunately, the report does not stipulate what distinguishes land, resources and the resource base.

mention sustainability in a more general sense and is primarily aimed at helping the agricultural industry cope financially.

The Brundtland report (World Commission on Environment and Development, 1987), brought to the forefront the concept of sustainable development, which included environmental, social and economic factors. Agriculture Canada used some of these concepts in the policy review it initiated in 1989 (Agriculture Canada, 1989). The review was initiated primarily in response to a call by the federal and provincial agriculture ministers to build on the National Agriculture Strategy. Again, the focus of the policy review was to look for ways to create a more market-oriented agri-food industry. However, the environment had slightly more emphasis in this report, which stated that agriculture must conserve its resources over the long term in order to be sustainable (Agriculture Canada, 1989, p 31). The report also went beyond soil conservation to recognize other issues such as contamination of water resources, preservation of genetic diversity or crops and livestock, urbanization, dependance on fossil fuels and purchased inputs, the applications of chemicals and public health concerns. The document defines sustainable agriculture: "The primary objective of sustainable agriculture is to ensure a more environmentally sensitive agricultural industry", and goes on to prioritize goals of sustainable agriculture:

> Promoting an agriculture and food industry that is economically viable and profitable, and that provides for basic human food needs while enhancing the quality of life for farmers and society as a whole are key goals. In addition, sustainable agricultural development promotes conserving or enhancing, for the use of future generations, the quality of the environment and the resource base upon which agriculture depends (Agriculture Canada, 1989, p 67).

In the above sequence, conserving or enhancing the resource was presented as a secondary goal for sustainable agriculture or agricultural development. The report also effectively ruled out the possibilities of large scale organic agriculture with the statement:

> We should recognize that agriculture is not sustainable without the use of much that is referred to as modern technology, and accept the challenge of finding the safest ways of using it (Agriculture Canada, 1989, p 31).

In a further statement of its support for technology in general, the policy review stated: "This new era of technological development has both caused and resulted in consumers becoming more affluent, knowledgeable and sophisticated"(Agriculture Canada, 1989, p 33). The fact that no negative effects of technology were mentioned may be significant and linked to the level of support that AAFC has thrown behind the biotechnology industry.

The "Growing Together" document which initiated the policy review in 1989 appeared to be a step forward in terms of recognizing environmental sustainability as important for the future of Canadian agriculture but, issues like economics, market development, financial stability and technology transfer and adoption were still the primary objectives of the policy review.

Two reports arose from the agri-food policy review initiated in 1989 that were specifically related to sustainability. The first was prepared in 1990 by the Federal-Provincial Agriculture Committee on Environmental Sustainability, who were assisted by a Working Group of federal, provincial, industry and university representatives (Agriculture Canada, 1990). The Committee focussed primarily on sustainability issues most closely linked to

natural resources and environmental quality with the rationale that economic and social issues were being addressed by other task forces and processes (other issues listed were; food safety, pesticide registration, competitiveness and farm safety nets). The objectives for sustainable agriculture in the report are listed in Figure 3.2.

1. To conserve and enhance the natural resources that agriculture uses and shares
2. To be compatible with other environmental resources that are affected by agriculture
3. To be proactive in protecting the agri-food sector from the environmental impacts caused by other sectors and factors external to agriculture

Figure 3.2: Goals of sustainable agriculture listed by the Federal-Provincial Agriculture Committee on Environmental Sustainability.

The third goal in Figure 3.2 reflected increased concern about the effects of global warming, pollution and ozone depletion on agriculture in Canada. Policies that attempted to address these objectives were reviewed, and policy measures suggested in eight main areas to further promote the objectives. Two areas mentioned in the report related to my sustainability criteria; the reduction of dependence on fossil fuels (including fertilizers and pesticides) and maintenance of genetic diversity of crops. The report took the concept of sustainability one step further than previous reports by emphasizing " a more holistic approach to the management of our natural resources" and suggested that this type of approach must be adopted, particularly in education and research to ensure long-term improvements in sustainability (Agriculture Canada, 1990, p 2). Under the recommendations for a framework for action the report also acknowledged the fundamental importance of environmental sustainability:

> The challenge has become one of developing holistic management strategies based on the use of inputs and practices which maintain the integrity and quality of agricultural soil and water resources and all other components of the environments including air and climate, that sustain agro-ecosystems, while at the same time, ensuring that the overall system is socially and economically viable (Agriculture Canada, 1990, p 31).

With this statement, the Federal-Provincial Agriculture Committee has recognized that environmental sustainability is the primary criterion that other concerns rest upon. However, the report still focuses on economic growth by defining sustainable development as " ...economic growth that meets the needs of the present without compromising our ability to meet future needs." (Agriculture Canada, 1990, p 9).

The reports examined so far appear to represent an evolution in thinking towards sustainability as defined in this thesis. However, it must be noted that most of these reports were actually written by committees (appointed by government) that were outside the policy making bodies of AAFC. The government itself has failed to adopt many of the ideas presented in these reports. The next two documents reviewed were " The Path to Sustainable Agriculture" (Government of Canada, 1992) written by the Standing Committee on Agriculture and the "Government Response to the Report of the Standing Committee on Agriculture" (1992).

The Path to Sustainable Agriculture report was the first to explicitly indicate a need for public consultation regarding expectations for Canadian agriculture and the food system (Figure 3.3). These suggestions relate to the desired role of agriculture in our society: and address the underlying philosophy behind agriculture (i.e. do we want growth or

- to provide a safe, indigenous food supply
- to provide a viable livelihood for 300,000 farm families? 150,000 farm families
- to be a sustaining part of the rural community
- to provide a substantial contribution to our trade balance
- to play a major role in preserving a healthy and attractive rural environment
- to contribute to wildlife habitats
- to provide an inexpensive food supply

Figure 3.3: Possible expectations of Canadians with regard to the food system (Government of Canada, 1992, p xiii-xiv).

conservation-oriented agriculture?). Addressing these issues represents the first step towards sustainability, especially with regards to a more socially responsive policy making, and a more socially just agriculture. The range of expectations listed indicate that the Standing Committee on Agriculture was aware of the multifaceted nature of agricultural sustainability.

Some of the recommendations of the Standing Committee on Agriculture listed in the "Path to Sustainable Agriculture Report" and the government responses are listed below (see Appendix 2 for a complete list of recommendations). The Committee requested a response from the government within 150 days. Individual recommendations and responses which are informative about the government philosophy or approach to sustainability are listed in italics, followed by analysis.

Recommendations:
1. The Committee recommends that sustainable agriculture be recognized as an essential part of Canadian life.
2. The Committee recommends that recognition of sustainability include meeting farming needs for economic, social and environmental sustainability.

Response:
Two recent initiatives provide excellent examples of how the government has implemented this approach. The reforms being implemented by the Pesticide Registration Review system will improve the competitive position of farmers. As a second example... Agriculture Canada is assessing the impact of regulations on the competitiveness of the industry and addressing the issue of environmental impact.

In response to recommendations one and two relating to recognition and identification of sustainability above, the government cited two examples (Agriculture Canada, 1992, p 3). With these examples, the government is clearly emphasizing economic competitiveness in their interpretation of sustainability. In addition, their interpretation of the two recommendations is very narrow. It seems unlikely that the Pesticide Registration Review enabled sustainable agriculture to be recognized as an essential part of Canadian life or to meet social and environmental needs.

Recommendation:
4. The Committee recommends that the federal government involve all segments of Canadian society in a dialogue that will recognize the intrinsic value of food production and promote the formation of a long-term policy for agriculture.

Response:
Beginning with the Agri-Food Policy Review, the government has been broadening its consultations to include the widest range of stakeholders with an interest in sustainable agriculture. Such broad based consultations are seen by the government as underpinning the development of a long term policy for the agri-food industry.

The government response to recommendation four cites several examples of

integration of public participation in policy making and appears committed to the concept. However, the next chapter of the thesis illustrates how stakeholder participation can be manipulated to involve individuals with goals that are compatible with pre-existing government goals.

Recommendation:
5. The Committee recommends that one of the goals of the food strategy should be domestic food security.

Response:
Through an effective functioning of the world trading system, under clear international rules, Canadian consumers have access to multiple sources of supply for each food.

By encouraging diversification and creating more value-added at home, and by further strengthening the world trading system, Canadian producers will have improved access to markets and better terms of competition. This will help to ensure the future of Canadian agriculture and maintain food security.

The Standing Committee elaborates on the idea of domestic food security by stating:

> It is acknowledged that food security needs can be met without a country having to be completely self sufficient. However, a significant dependance on food export and import commodities could leave Canada vulnerable to international market shocks (Government of Canada, 1992, p 11).

The Committee goes on to stress that Canadian agriculture should be in a position to supply our basic food needs. In its response, the government states that is not realistic to require that Canada produce all its foodstuffs and that effective functioning of the world trading system will ensure that consumers have access to multiple sources of food. This is a very short term outlook which eases the pressure on the federal and provincial governments in Canada to preserve and protect farmland. Most other food producing countries are experiencing the same pressures on agriculture as those faced in Canada (e.g. urbanization, soil degradation,

lack of water, etc.) therefore, it is likely that global production will decrease or stabilize, and with increasing demand, food production and products will continue to get more expensive. Since Canada is fortunate enough to have an adequate supply of agricultural land, the prudent response of government at this stage might be to preserve this land for agriculture and to encourage domestic food security in basic food stuffs. In order to do this, the government could undertake an exercise to identify food needs versus food wants and should ensure that Canada can at least meet its own food needs.

Recommendation:
12. The Committee recommends that the federal government give priority to implementing an integrated approach to agricultural research and development.

Response:
The government has taken steps to implement this integrated approach to agricultural research and development. Agriculture Canada is presently staffing research scientist positions and post-doctoral fellows with backgrounds in farming systems research, whole farm research and experience with expert systems research.

Some research programs involve a high degree of technical expertise and are not directly applicable to an integrated approach at this time. For example the biotechnology used in manipulation of genetic material for the development of new crop varieties is required for the long-term sustainability of agriculture.

Recommendation twelve suggests an integrated approach to agricultural research and development, specifically an examination of the relationships between production and management systems holistically. The government endorses this recommendation and cites several examples of programs which are taking an integrated approach to farming . However, the government points out that " Some research programs involve a high degree of technical expertise and are not directly applicable to an integrated approach at this time." (Government

of Canada, 1992, p 11). As an example, the document cites biotechnology (particularly crop variety development). It is unclear why crop varieties developed by biotechnology are exempt from an integrated (or whole farm system) approach since they will presumably be introduced into the same environment as other technologies. This point is interesting because it illustrates one of the challenges with applying biotechnology (or other technologies requiring a high level of expertise). Researchers in biotechnology require a high degree of training, the majority of which is focussed in the laboratory. Plant biotechnologists usually have little or no training in agronomy, and often do not have a clear idea of the problems faced by producers. Thus, it is unlikely that an integrated approach to research will come from the researchers themselves. With the government discouraging an integrated approach to biotechnology, it is not clear how it can be ensured that biotechnology does in fact make a contribution to sustainability, especially since the government did not endorse a recommendation to appoint an independent auditor to assess progress towards sustainability.

Many of the recommendations outlined in the "Path to Sustainable Agriculture" are compatible with the definition and goals of sustainability described in this thesis. The government responses to the recommendations are indicative of AAFC's apparent lack of commitment to sustainability, particularly as it is reflected in their approach to biotechnology research.

In the "Path to Sustainable Agriculture", one of the committee members pointed out that the "old philosophy of 'grow, grow, grow' is outmoded but the debate on its replacement has just begun" (p xv). By 1995, the "grow, grow, grow" philosophy was back in style (AAFC, 1995b). The vision for agriculture stated in "Agenda, Jobs and Growth" is:

> A growing, competitive, market oriented agriculture and agri-food industry that is profitable and responds to the changing food and non-food needs of domestic and international customers; is less dependent on government support; and contributes to the well being of all Canadians and the quality of life in rural communities while achieving farm financial security, environmental sustainability, and a safe high quality food supply (AAFC, 1995b, p 1).

Since the Growing Together report of 1990, the Government appears to have reverted in terms of consideration of sustainability to pre-National Agriculture Strategy. In terms of support for the vision, most suggestions are economic in nature and consideration of environmental sustainability is relegated to an additional goal. The document mentions the concept of sustainable economic growth in the agri-food sector. For example, the document states that Canadian producers and processors have set a goal to increase agri-food exports by 33% by the year 2000 to meet the opportunities presented by international trade agreements (AAFC, 1995b, p 4). The possible environmental impacts of such an increase in exports is not mentioned, nor is consideration of food security. The proportion of AAFC's budget devoted to 'encouraging growth' was increased at the expense of other areas, such as research. With regards to research, AAFC states its intention to increase industry *led* research (AAFC, 1995b, p 6).

A report was released in August 1995, which was prepared for the Federal and Provincial Ministers of Agriculture and intended to develop a national environment strategy for agriculture and agri-food (AAFC, 1995a). The document places economic sustainability as the basis of environmental and social sustainability:

> While the strategy focuses on environmental sustainability, its fundamental premise is that the agriculture and agri-food sector can only be sustainable if social, economic and environmental objectives are balanced. The sector must be economically viable if it is to conserve the environment and support the social systems upon which it is based.

The last statement in the quote suggests that economic viability is required for environmental and social sustainability. Since the current economic system does not take environmental impacts of agriculture into account and indeed has no mechanism to assign value to these impacts (e.g. reduced biodiversity), this statement serves as a means of maintaining the current emphasis on increased production. The document also mentions " balancing the need for environmentally sustainable practices with the necessity to remain competitive in domestic and international markets" (AAFC, 1995a). International trade agreements like the General Agreement on Tariffs and Trade (GATT) have been criticised for possible effects on environmental standards (Arden-Clarke, 1992; French, 1993). There has been some concern that the cheapest products will gain more market share, regardless of the practices used to produce them.

The document goes further in defining environmental objectives as a corollaries of other objectives:

> Environmental objectives will be unique and must be adapted to the production and management objectives of each individual enterprise for maximum effectiveness (AAFC, 1995a, p III).

Sustainability as outlined in this thesis would require that production and management objectives be adapted to environmental objectives and realities. Within the context of the

AAFC strategy document, several goals are listed including; minimization of the negative effects of agriculture on water quality and atmosphere, preserving genetic resources, encouraging energy efficiency, minimizing waste, reducing risks associated with agricultural practices and public involvement. These initiatives would support a transition to a more sustainable agriculture only in a regulatory climate that emphasised these concerns over economics.

The World Commission on Environment and Development report of 1987 and the United Nations Conference on Environment and Development in 1992 appear to have had an influence on committees struck to address agricultural sustainability in 1989 and 1992 in placing environmental sustainability concerns in a prominent role. However, by 1995, the influence of these reports and the concepts they espoused have diminished. The resulting AAFC policy on sustainability is obscure and somewhat contradictory. The emphasis on growth and ensuring competitiveness raises several questions: *Will Canadian agriculture ever be competitive enough? What if addressing negative environmental or social impacts makes agriculture less competitive? Who decides which issues take priority?*

Spriggs (1994) provides some interesting insight into policy making in AAFC which may explain why the Ministry has consistently ignored recommendations for sustainability put forward by expert committees. Spriggs separates policy information needs into a "discovery phase" which involves generation of objective policy information on alternatives for support debate on policy and a "negotiating phase" which is designed to support the Minister in negotiating policy (i.e. to support the Minister's position). Spriggs states that the Policy Branch has largely concentrated on the negotiating phase and gives little support to the

discovery phase[2]. This emphasis on the negotiating phase has implications for sustainability. If the Minister has a pro-economic growth or pro-free trade position, policy research into alternatives is discouraged (e.g. food security or restraining growth to ensure environmental sustainability) as it does not support the Minister's position. This may be why the reports with recommendations for sustainability written by expert committees outside the Policy Branch of the AAFC have, to a large extent, been ignored by AAFC.

Cobb and Elder (1972) describe two policy agendas which may also help explain why AAFC has not consistently pursued sustainability. They point out that there are systemic and action agendas. The systemic agenda is essentially a discussion agenda including topics deemed to merit public attention. The action agenda, on the other hand, is where resources are actually committed to addressing a policy problem. It appears that sustainability has been arrested at the systemic agenda, and this may have resulted in the lack of support for research into alternative policies described by Spriggs as the discovery phase.

3.1.2 Biotechnology

As mentioned in the introduction, biotechnology has been represented by many groups as the answer to sustainable agriculture (Agriculture Canada, 1990; Fraley, 1992; OECD, 1992; UNCED, 1992). Support for biotechnology in Canada has been evident since 1980, shortly after the 'potential' of biotechnology was generally recognized. At the time,

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[2]Spriggs describes a political equilibrium model approach to decision making used in the negotiating phase; 1) Identify the stakeholders; 2) Identify the extent of their influence and pressure for change and; 3) Reach a decision that re-establishes political equilibrium (Spriggs, 1994).

biotechnology was seen by the Canadian Government as a means of diversifying the economy from a primarily staples economy to encompass high technology industries.

In 1980, the Institute for Research on Public Policy and the Science Council of Canada sponsored a workshop on biotechnology[3]. The council stated that, at the time, most biotechnology research was being conducted in public labs and that Canada was 3-4 years behind the US in terms of industrial development. Government funding for the industry was seen as essential because private investors would be unlikely to invest sufficiently. The majority of the workshop participants agreed that the promotion of biotechnology by government was essential and supported the following recommendation by consensus:

> Biotechnology should be supported in principle and aggressively pursued by the three constituencies involved in its promotion-government, universities and industry (Science Council, 1980, p 49).

The report also called for studies on the impact of commercialization on "scientific scholarship and productivity" and an independent risk assessment of social effects of biotechnology like changes to quality of life and employment (Science Council, 1980, p 50). To my knowledge, neither of these studies were undertaken.

The Science Council report was followed by a report of the Task Force on Biotechnology to the Minister of State for Science and Technology (MOSST, 1981). The task force was made up of industry, government and university representatives, who

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[3] The first indications of possible negative impacts or concerns about biotechnology in Canada were raised at this workshop. The concerns included; the possibility of laboratory accidents, deliberate misuse of the technology, unexpected interactions with the environment and the possible harmful effects of commercialization on the academic molecular biology community (Science Council, 1980).

recommended the development of a National Biotechnology Development Plan to direct the development of biotechnology in Canada and an advisory committee to oversee implementation of the plan. The objective of the biotechnology development plan was: "... to create in Canada the climate which will encourage the establishment and growth of a variety of industries which are built upon biotechnology (MOSST, 1981, p 30).

Elements of the plan included a long term commitment to biotechnology, funding and tax write offs for industry, developing infrastructure and manpower, international collaboration and establishment of a national oversight body (the National Biotechnology Advisory Committee). Under the recommendation, the task force suggested that guidelines for the handling of recombinant DNA, animal viruses and cells remain as voluntary guidelines. This view suggests that biotechnology (which has the potential to have significant impacts on human and ecological health), be exempt from legislation, instead relying on voluntary guidelines.

On the advice of the Task Force on Biotechnology, a National Biotechnology Strategy was created and the National Biotechnology Advisory Committee established (MOSST, 1984). The elements of the plan were described in the first annual report of the National Biotechnology Advisory Committee and included identification of strategic priority areas, establishment of networks, allocation of federal funds and support to federal departments (NBAC, 1984).

By 1990, the NBAC felt that significant progress had been made in terms of development of the biotechnology industry in Canada but stressed that more development and regulatory reform were needed (NBAC, 1990). The committee again suggested that research

in the field remain overseen by voluntary guidelines since legislation and excess regulation could create delays in commercialization and cause industries to carry out their research elsewhere. The committee also showed concern with the penalties for infractions under the Canadian Environmental Protection Act (at the time):

> The penalties associated with minor infractions of the Act are very severe and they could well have an inhibiting effect on innovation (National Biotechnology Advisory Committee, 1990, p 18).

The preceding comment by the National Biotechnology Advisory Committee seems to suggest that innovations arise from defying legislation.

In all documents related to biotechnology, AAFC consistently emphasizes the benefits of biotechnology to consumers while playing down possible risks[4] (AAFC, 1995c). For example, an on-line document from the AAFC home page states that "Biotechnology will also have major payoffs for Canada's economy" and mentions better food quality, nutrition and greater selection. When concerns are mentioned, AAFC assures the reader that the government has carefully assessed these products (AAFC, InfAgBiotech Home page).

Biotechnology is regulated, in part, by the Canadian Environmental Protection Act (CEPA). CEPA requires notification and assessment of toxic substances (Part II, sections 11-48). At present, genetically engineered plants are classified as toxic substances. However, CEPA has provisions that if relevant departments (i.e. AAFC) have a process for assessing

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[4] Possible risks of biotechnology are not dealt with in detail in this thesis. Many authors have dealt with the possible risks of biotechnology and inadequacies in current risk assessment protocols (e.g. Ginzberg, 1989; Mikkelsen et al., 1996; Regal, 1994; Williamson, 1992).

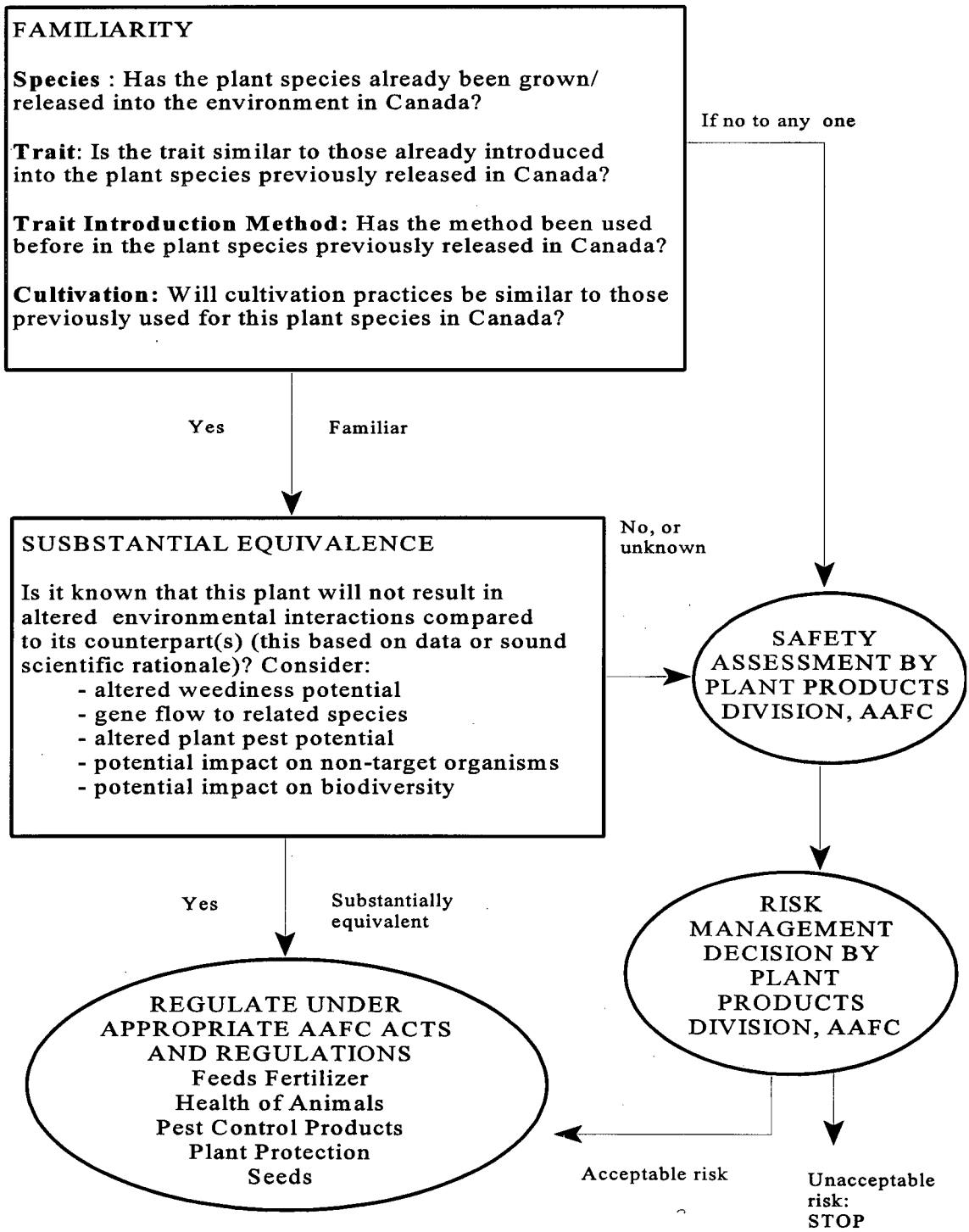

Figure 3.4: Safety based model for the assessment of plants with novel traits (from AAFC, Directive 94-08)

safety of these organisms, then they are effectively exempt from CEPA[5]. The regulation of biotechnology is very complicated and involves several Act and Regulations and Departments. The Acts that regulate biotechnology products within AAFC are: Seeds Act, Plant Protection Act, Fertilizers Act, Feeds Act, Health of Animals Act, Meat Inspection Act and Canada Agricultural Products Act (AAFC, 1995c) . Figure 3.4 is taken from the AAFC publication "Assessment Criteria for Determining the Environmental Safety of Plants with Novel Traits" and describes the process that determines whether plants with novel traits (PNT's) must undergo an environmental assessment[6]. I will only discuss PNT's here, and not other genetically engineered organisms. Note that Environment Canada is not directly involved in the process.

Herbicide tolerant canolas are classified as plants with novel traits (PNT's) and are regulated under the Seeds Act, and are currently required to undergo an assessment of environmental safety. All PNT's are required to undergo the environmental safety or risk assessment before they can be field tested or commercialized. A plant is identified as a PNT on the basis of familiarity and substantial equivalence. Familiarity is described in Figure 3.5. If a plant fulfills all of the criteria listed then it is forwarded for consideration of substantial equivalence. If any one criteria is not satisfied, then the plant must undergo an environmental assessment. Only the first generation of a particular type of plant would fail to meet the familiarity requirements. The next generation (e.g. of herbicide tolerant plants) would be

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[5]This doesn't mean that the organism is not assessed, only that it is assessed by the relevant department rather than Environment Canada.

[6] A PNT could be a plant developed with traditional breeding techniques.

familiar. The substantial equivalence criteria is based upon whether that plant has altered biology or environmental interactions.

Applicants are asked to describe the method used to create the plant and the characteristics of the gene (Parts A-C of the safety assessment). Part D of the directive requires an assessment on the basis of whether the biology of the plant has been altered in unpredictable ways[7]. The biology of the plant is measured in studies of replacement and dormancy, compared with the parent plants for a maximum of three years. If the new plant does not differ significantly from its parent, then the plant is deemed safe in this category. The problem with this type of approach is that it assumes that species and varieties that have been introduced previously are safe even if no environmental assessment was performed on them in the past. For example, in many cases, domesticated plants can be quite invasive within an agricultural ecosystem (for example canola) (Crawley and Brown, 1995; Mikkelsen, 1996). Since the parent plant is the reference, the genetically engineered plant could actually be quite invasive and deemed safe, even though the plant has new characteristics like herbicide tolerance.

- The plant species has already been grown or released into the environment
- The novel trait is similar to traits already introduced into plant species in Canada
- The method used to introduce the trait into the plant has been used before in this plant species
- The cultivation practices used in production of the PNT are similar to those previously used for the plant species

Figure 3.5: Definition of 'familiarity' in terms of plants with novel traits (AAFC, Directive 94-08).

PNT's are also assessed for their effects on soil micro flora and fauna (termed

[7] How one assesses whether an organism behaves unpredictably is not evident.

residual effects). No clear methodology is given for assessing residual effects of the genetically engineered plants on soil organisms. Nodulation studies and "other relevant observable or measurable differences" are suggested (AAFC, 1994, Directive 94-08). Thus, it is up to the applicants to search for, and identify impacts. In terms of changes in agricultural and silvicultural practices, applicants are asked to describe any changes in cultivation practices and to provide information on the effects of these changes on sustainability (pesticide use, frequency of tillage, soil erosion and consequential changes in energy). Although this criterion appears to be a positive step at first glance, it could serve as a way of maintaining the status quo. PNT's are not required to make any improvements in these areas, only to have no more impact than their parents. In addition, applicants have the option of waiving information requirements if valid scientific rationale is provided.

Several herbicide tolerant canola plants were approved in 1995 after completing this process. The depth to which the applicants performed the required experiments is not known since the Plant Biotechnology Office is not required to release copies of the applications as a consequence of the Privacy Act [8]. Decision documents were released which stated that the PNT's were found safe (Dir 95-01-04).The question of whether the environmental impact of herbicide tolerant canolas has been adequately assessed is difficult to answer.

3.2 Conflicts in Biotechnology Regulation and Sustainability

Since AAFC is a strong supporter of biotechnology, the question of a conflict of

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[8] The Freedom of Information Act is of no use in this case because information shared between industry and government can be classified as 'Confidential Business Information" and is exempt.

interest may be raised: *Is a department that strongly supports a particular technology, in principle and financially and which is actively involved in developing biotechnology products, the most appropriate department to carry out relevant environmental assessments?* A recent Optima survey; Understanding the Consumer Interest in the New Biotechnology Industry[9] , indicates that members of the public may also perceive a possible conflict of interest in these types of situations (p 32). Over 80% of respondents agreed with statements that the government should be involved in regulation, determining safety, and public consultations about biotechnology. However, only 37% agreed that the government should financially support biotechnology (33% were neutral and 29% disagreed) and 33% agreed that the government should be developing biotechnology products for commercial purposes (28% neutral and 37% disagreed).

A recent report by the Standing Committee for Environment and Sustainable Development recommended that CEPA be amended to include a special section on biotechnology and to establish national guidelines for the safety assessment of biotechnology:

> Recommendation 68: The Committee recommends that CEPA be amended to include a new Part to deal specifically with products of biotechnology. This new part will include minimum notification and assessment standards for *all* products of biotechnology released into the environment, including those regulated under other federal Acts. Other federal statutes shall prevail over CEPA in regard to environmental impact assessment of products of biotechnology only if their notification, assessment and regulatory standards are at least equivalent to those prescribed under CEPA.

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[9] The survey was supported by the Consumer Policy Branch of Industry Canada and undertaken on behalf of several government departments including AAFC, Natural Resources Canada, Health Canada, Environment Canada, Department of Fisheries and Oceans and the Intellectual Property Directorate.

> Recommendation 69: The Committee Recommends that CEPA be amended to require the Governor in Council to publish a list of statues considered at least equivalent to CEPA with respect to their assessment process for products of biotechnology (Government of Canada, 1995).

The Committee is, in effect, recommending that national standards for assessment be developed and applied to all biotechnology products regardless of the other regulations or statutes they are subject to. The report notes the response of some of the witnesses that appeared before the committee regarding this issue. The Canadian Environmental Industries Association supported this type of change to the Act, whereas the Industrial Biotechnology Association were in favour of maintaining the status quo (Government of Canada, 1995, p 123).

In the preamble to responding to these two recommendations, the Government again reiterates the benefits of biotechnology, citing for example " plants such as vegetables that retain their fresh quality longer" (Government of Canada, 1995b, p 51). Herbicide tolerance is not mentioned, even though herbicide tolerant flax and canola are commercially available in Canada at present. In responding to the two recommendations, the Government essentially chooses to ignore them (Government of Canada, 1995b). The recommendation for a new part for CEPA is supported for living products of biotechnology, but not for products of biotechnology that " are or may be regulated under other Acts of Parliament" (Government of Canada, 1995b, p 52)[10]. The reasoning given is that the Government wishes to avoid

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[10] The Government recommends that CEPA " establish criteria for biotechnology products based upon existing criteria for toxicity" (Government of Canada, 1995b, p 52).

duplication in regulation. The Government suggests that CEPA will supply a "safety net" where regulation does not already exist. Thus a recent attempt to make biotechnology subject to standardized environmental assessment failed. The industry is hailing the Governments decision to maintain the status quo as a positive step for the biotechnology industry.

AAFC has made some attempt to address sustainability issues raised in international forums (e.g. the World Conference on Environment and Development and the United Nations Conference on Environment and Development) within a general pro-growth framework strategy. Various committees stuck by government have suggested a more holistic approach to sustainable agriculture that involves the public in decision making but the government response has been to emphasize economic competitiveness and growth in agriculture. Biotechnology is seen as having the potential to contribute significantly to Canada's economy and economic competitiveness and therefore is vigorously supported. Recent suggestions to incorporate biotechnology into CEPA to provide a unified approach to biotechnology assessment and regulation was rejected by government, perhaps indicating resistance on the behalf of AAFC to developing a more transparent and consistent approach to biotechnology regulation.

Consequences of AAFC's support for biotechnology and economic growth in agriculture on research and development of new canola varieties are discussed in the next chapter.

4. SPECIAL INTEREST GROUPS AND THE INTRODUCTION OF NEW CANOLA VARIETIES

The roles of the Canola Council of Canada (CCC) and the Western Canada Canola and Rapeseed Recommending Committee (WCCRRC) as important and influential interest groups in canola policy, research and development and were identified through discussions with canola researchers at Agriculture and Agri-Food Canada's Beaverlodge Research Station during the summer of 1994. In addition, Kneen's (1992) book "The Rape of Canola" provides a comprehensive history of the development of canola in Canada, and the industry structure, and identifies some key informants. Don Woods (personal communication, August 1994) described the variety registration trials and the WCCRRC. I attended a WCCRRC meeting in Saskatoon in December 1994, which was followed the next day by the annual Canola Industry Meeting. I subsequently attended the CCC's annual general meeting with their Japanese customers in Vanvouver in March, 1995. The central role of these two groups in the research, and development and process of commercialization of new varieties of canola, which became apparent to me at the December meeting, will be described in this chapter. This chapter examines the influence and degree of institutionalization of the CCC, its direct role in agriculture policy as well as its' indirect influence on the research, development and process for registration of new canola varieties in Canada through the Western Canada Canola and Rapeseed Recommending Committee (WCCRRC) . The information in this chapter was gathered through:

1. Informal telephone interviews with Dr. Keith Downey of the Agriculture and Agri-Food Canada Research Station in Saskatoon[1] (September 1995), Don Woods from the Beaverlodge Station (July 1994, September 1995), and discussions with Nick Underwood of the CCC (December 1994), Eugene Dextrase of the Alberta Canola Producers Commission Director (December 1994).

2. Review of the published WCCRRC meeting minutes 1991-1995.

3. Attendance at the WCCRRC, Canola Industry and CCC meetings in 1994 and 1995.

4. Review of CCC published documents.

The implications of the role of the CCC in terms of influence on a public involvment process, and the contribution of biotechnology to sustainable agriculture are discussed. The CCC does not have a specific sustainability policy or position statement. However, given its influence on government policy in some areas, and its attitude towards biotechnology, its lack of a statement on sustainability constitutes a position in itself.

4.1 Role of the Canola Council of Canada as an Interest/Pressure Group

The CCC is a non- profit organization whose main goal is market development and increasing production and quality of Canadian canola (CCC, 1995). The CCC originated as the Rapeseed Association of Canada in 1967 and changed its name to the CCC in 1980 to

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[1] Dr. Downey has been active in the field of canola breeding and commercialization for fifty years (Downey, personal communication, Sept. 1995). In 1992, two canola varieties developed by Dr. Downey constituted almost 100% of the Western Canadian canola grown (Kneen, 1992).

reflect the development of canola from rapeseed (Kneen, 1992)[2]. The mandate of the CCC is to represent the interests of the entire canola industry and to encourage the use, production and marketing of canola (personal communication, CCC Main Office staff member, June 1996).

The Council holds policy positions in several areas ranging from research to international trade (Figure 4.1) . Council revenues come from several sources including export and processing levies, grower organizations, corporate sponsors, exporter project funds and government (about 22% of total funding). Membership in the CCC includes: crushers and exporters of canola products, producer groups, agrichemical companies, plant breeders, seed producers and trade associations, provincial and federal government representatives and international buyers.

- Support of tariff free trade
- Encourage trade linked food aid policies
- Elimination of margarine colouring restrictions
- Establish new canola definition in 1997
- Support variety licensing with high quality standards
- Regulations for contract production of specialty varieties
- Regulations for use of transgenic breeding techniques
- Canola grading and international trading standards
- Product labelling should identify the specific oils
- The availability of rail cars for canola seed and meal
- Fair trade through GATT with China and the EU

Figure 4.1: Areas in which the Canola Council of Canada holds policy positions.

The CCC represents the entire canola industry and interacts with AAFC in concert in

[2] Canola varieties are defined based on the amount of glucosinilates and erucic acid in the seeds. The acceptable levels have changed over the years and the CCC is planning to change them again for 1997 (CCC, 1995).

areas of canola policy. Although some of the member groups (e.g. producer associations, seed trade, etc.) also interact with government, they do not have the influence of the CCC in representing the entire industry (Kneen, 1992). An example of the influence of the CCC on variety testing and registration of new canola varieties will be examined in a later section.

In terms of membership, the CCC ostensibly includes all those with a stake in the canola industry in Canada including canola growers through producer groups[3] and to some extent, international interests, through the membership of Japanese processors. The financial resources of the group are considerable, with a budget of over $5 million in 1994. The group is also highly structured (Figure 4.2) and pursues its own objectives in terms of funding research projects and market development through international trade missions. The CCC has an impressive track record and a good reputation within the industry (personal communication, Eugene Dextrase, December 1994). It has, in fact, been extremely successful in it's goal of increasing domestic and international demand for canola. Canola hectarage in Canada has increased from about two million hectares in 1979 to over four million hectares in 1994 and is second only to wheat in terms of area of production (Statistics Canada, Cereal and Oilseeds Review, 1994)[4]. In part, this increase is the result of the efforts of the Canola

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[3]A levy on all canola sold is automatically paid to the Alberta Canola Producers Commission (Eugene Dextrase, Alberta Canola Producers Commission Director, December 5, 1994). Farmers can then get their money back if they do not wish to remain members.

[4] The CCC has taken issue with Statistics Canada data for canola production. They claim that Statistics Canada routinely underestimates acreages. For 1994, the CCC estimate that about 5.6 million hectares of canola was grown (N. Underwood, personal communication).

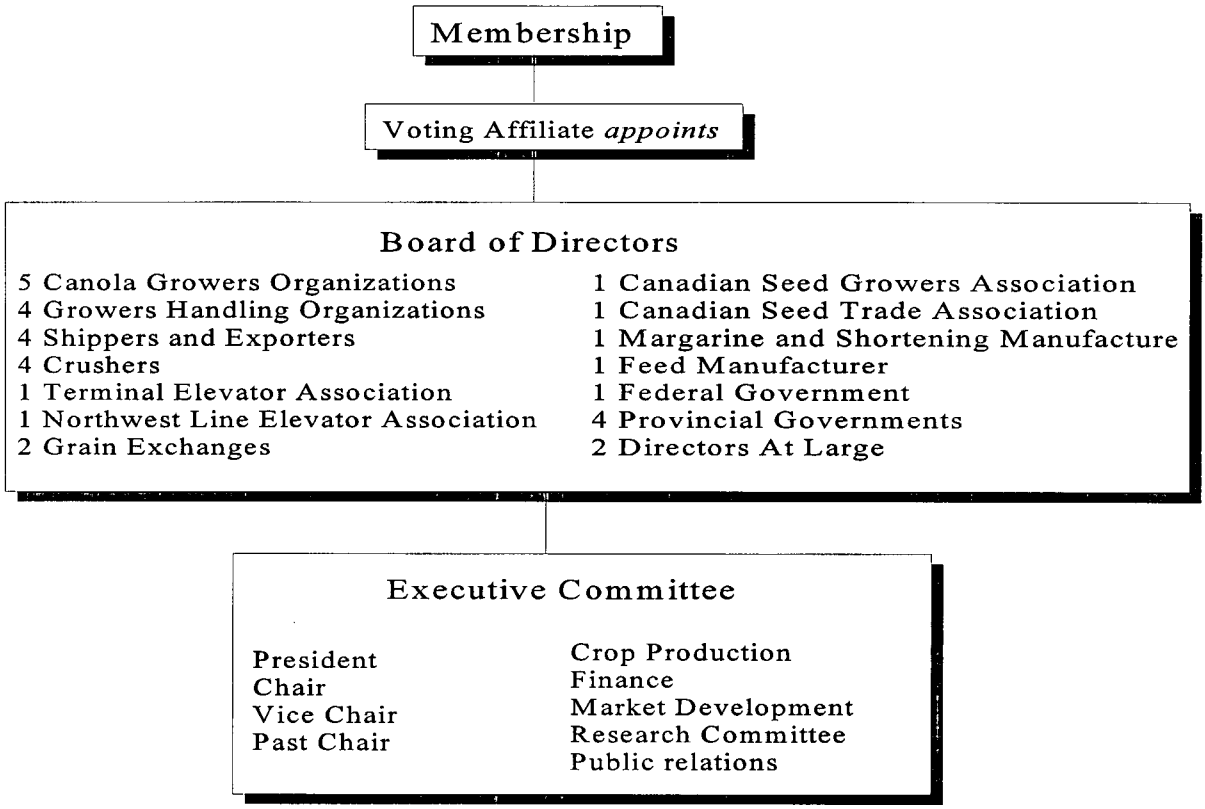

Figure 4.2: Organization of the Canola Council of Canada (CCC, 1995).

Council on raising awareness about the benefits of canola oil and developing international buyers. For example, its lobbying of the US Food and Drug Administration (FDA) to acquire 'Generally Recognized as Safe Status' (GRAS) for canola oil in food in the 1980's expanded the market for canola considerably (CCC, 1995).

The organizational structure characteristic of a group refers to the extent to which the group's structure can be used to give the group political influence, and includes internal communication, the ability to forecast and plan ahead, mobilization of members and ability to

create coalitions (Pross, 1992, p 105). The CCC communicates with its members through newsletters, a Canola Growers Manual and regular publications. The list of policy positions and their success in meeting their goals in the past indicate the degree to which the council has been able to realize its potential for influence (i.e. in obtaining GRAS status and increasing hectarage).

In terms of policy capacity, the CCC devotes about 27% of its budget specifically to policy activities, including market development, public relations and corporate affairs with another 8.6 % towards administration (CCC, Annual General Meeting Financial Report, March 1995). The Council is quite active in consultations and interactive with government. For example, the CCC has participated in technical missions to several Pacific Rim countries which included representatives from Agriculture and Agri-Food Canada, the Canadian International Grains Institute, Canadian Wheat Board and the Canada Special Crops Association (CCC, Annual General Meeting Financial Report, March 1995). The CCC is also a member of a committee consisting of representatives from AAFC, and Health Canada, which is planning to submit a petition to the FDA for GRAS status for canola oil in infant foods.

In the above discussion, the Canola Council has been presented as a single interest group with a unified position on issues of canola policy. However, there are different views within the group, some of which have more influence on the policies that the Council pursues and emphasizes. For example, Dwight More (CCC president) stated; "The Canola Council is, and will probably remain, more controlled by the Canadian crushers, or Continental and Cargill as exporters, who will tell us that their customers are looking for this or that in the

product" (quoted in Kneen, 1992, p 23)[5]. In addition, Kneen (1992) comments that the Japanese buyers may also have influenced the agenda for canola since 1967. The influence of the crushers and exporters in the variety testing and registration process for new canola varieties will also be examined.

4.2. Influence of Groups on Canola Related Policy: Variety Testing and Registration

The process of testing and registration of canola varieties is a specific area of policy where the CCC has influence on the process and criteria for assessment. This influence affects the identification of research goals of public and private breeders both in Canada and internationally and has had a particularly strong effect in promoting biotechnology.

4.2.1 Process for the Introduction of New Canola Varieties

For a breeder to introduce a new canola variety into the market, the plant material must be tested in variety trials, to ensure that new canola varieties meet established criteria (Figure 4.3)(WCCRRC, 1991)[6]. These trials were administered by AAFC until 1995, when the Canola Council took responsibility for the trials. Proponents of a new variety must

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[5] Kneen (1992) points out that at the time More made this comment (1990) many 'Canadian' crushers were in fact owned by transnational corporations.

[6] The name "canola" was first applied to specific varieties of rapeseed (*Brassica napus* and *Brassica rapa*) in 1980 which had low erucic acid in the oil and low glucosinolates in the meal (Canola Council of Canada, 1995). All new varieties must meet these criteria.

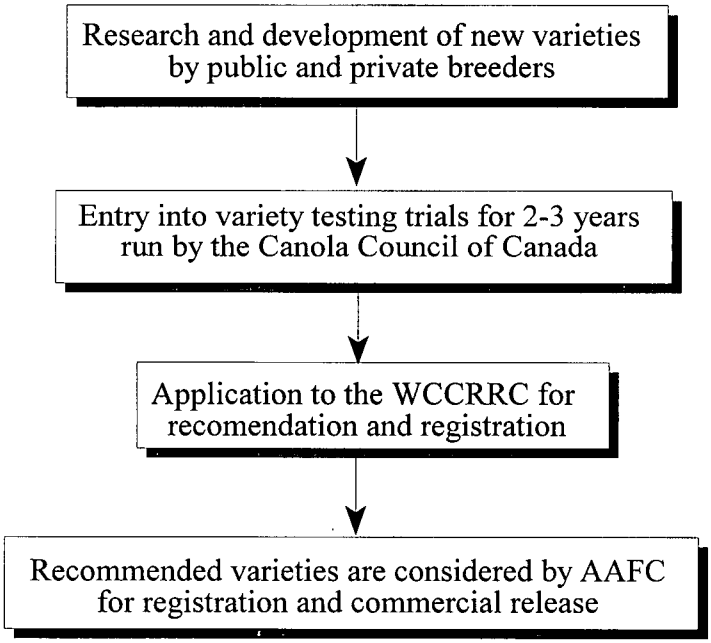

Figure 4.3: Process for the commercialization of new canola varieties in Canada (WCCRRC: Western Canada Canola and Rapeseed Recommending Committee; AAFC: Agriculture and Agri-Food Canada).

provide information on the performance of the variety in order to be admitted to the trials and participation in the trials is mandatory for commercial distribution. Variety trials are conducted at 24 sites representing long season zones, mid season zones and short season zones and are carried out by research groups, institutions and private companies. Co-operators are expected to use "good farm practices" which are generally conventional, high input agriculture (K. Downey, personal communication, September 6 1995)[7]. The agronomic practices used in the variety registration trials are the first example where industrial influence has created a disincentive to the development of canola varieties suited to low input or

[7] Co-operators are farmers or research groups that conduct the trials for AAFC or the CCC in 1995.

organic agriculture. Each co-operator will use slightly different practices based upon their area and specific management problems but are generally expected to use fertilizers and pesticides as needed. Therefore, there is no requirement or opportunity to assess the performance of varieties under low input conditions. Varieties adapted to low input conditions may well perform more poorly than check varieties under high input conditions. The bias towards varieties adapted to conventional agricultural practices is also reflected in the research programs of canola breeders in Canada and internationally. Kneen (1992) pointed out that there were no published studies of organic cultivation of canola. A recent search of international databases in July 1995 (CAB and AGRICOLA) similarly yielded no published reports of organic canola or of canola as part of an alternative cropping system[8].

Varieties are assessed a merit score based upon their performance in the co-op trials and various quality characteristics (Figure 4.4). In addition to the merit calculation, varieties have to meet the 'must' criteria which actually differentiate canola from its predecessor, rapeseed (erucic acid and glucosinolate content), and at least some 'should' criteria (minimum oil and protein content, disease resistance and maturity). Varieties start the trial with no merit points and then accumulate or lose them based upon their performance compared to standard check varieties. Merit scores are calculated on the basis of yield, oil and protein content, and blackleg resistance (Figure 4.4). The nature of the criteria for assessing plant performance (i.e. one merit point for each 1 % difference in yield, five merit

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[8] There are, however, some organic canola producers in Alberta and Saskatchewan, but they are doing it without the benefit of agricultural extension or other research support (L. Busch, personal communication, January, 1995; A. Griffiths, unpublished results).

Merit Score=IPyield + IPoil + IPprotein +IPblackleg

IPyield: +/- 1 merit point for 1% yield decrease/increase

IPoil and IPprotein: subtract mean oil content (or protein) of the checks from the average of test varieties and multiply difference by 5.

IPblackleg: scored 0-5 (5 is most susceptible) for blackleg resistance, subtract score of candidate from mean score of the checks and multiply by 3.6.

IP: Index of Production

Example calculation:

	Check variety	**Test variety**	**IP**	**Score**
Yield	32 bu/ac	31 bu/ac	97%	-3
Oil	42%	43%	1 x 5	+5
Protein	21%	20%	-1 x 5	-5
Blackleg	3	4	-1 x 3.6	-3.6
Total	-	-	-	-6.6

This test variety would not pass

Figure 4.4: Process for calculating merit scores for canola varieties in the variety testing process (WCCRRC, 1994).

points for each 1% difference in protein or oil) represent the second barrier to the development of alternative varieties. New varieties must be similar in productivity, quality and agronomic characteristics (under conventional agricultural practices) to the checks in order to accumulate merit points, therefore selecting for homogenous variety characteristics. If a variety accumulates +eight merit points after two years of testing or has a score of zero after three years of testing (a score of zero means that the new variety is equivalent to the checks), then it is submitted to the Western Canada Canola and Rapeseed Recommending

Committee (WCCRRC) for recommendation for registration. The WCCRRC is the agency which develops the guidelines for co-op testing and recommendation for registration and thus is the pivotal institution in the process. With few exceptions, WCCRRC recommendations are accepted by AAFC.

4.2.2 Role of Government in the Process: AAFC[9]

Historically, in Canada, co-op trials and registration of new canola varieties were conducted by AAFC and University breeding programs. Most varieties were also developed by pubic sector breeders and the registration process was overseen by 'Expert Committees" made up of University and government researchers, which reported through the Canadian Agricultural Research Council, to the Deputy Minister of Agriculture (L. Lavkulich, personal communication, May, 1996). However, in the mid 1980's, as more private companies became involved in breeding canola varieties, they began to lobby the government to open up the registration process to other interests. Producer groups joined the private breeders in their attempts to participate in the registration of new varieties. These groups felt that the Expert Committees were an "old boys" network and that registration decisions were unfairly weighted towards the public breeders. In responding to these concerns, AAFC set up the WCCRRC to separate the functions of public sector research from regulation of research within one agency. Thus, a variety testing and registration process has been developed which ostensibly incorporates the interests and involvement of several groups or stakeholders.

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[9] The information in this section was obtained in informal telephone interviews with Dr. K. Downey (September. 6 1995) and Dr. Don Woods (September 6 1995).

Consequently, the direct role of the government has been reduced significantly.

4.2.3 Western Canada Canola and Rapeseed Recommending Committee

The Western Canada Canola and Rapeseed Recommending Committee (WCCRRC) is a non-profit organization whose membership is intended to reflect stakeholders in the

Voting Members

3	Public sector canola/rapeseed plant breeders Appointed by the Western Expert Committee on Grains
3	Private sector canola/rapeseed plant breeders Appointed by the Canadian Seed Trade Association
1	Representative of the Canadian Seed Growers Association
1	Representative of the Canola Council of Canada (Treasurer)
2	Representatives of the Canola Crushers of Western Canada
3	Representatives, one from each producer association on the Prairies
2	Individuals knowledgeable in the field of canola/rapeseed oil and meal quality Appointed by the Western Expert Committee on Grains
4	Individuals knowledgeable in canola/rapeseed pathology Appointed by the Western Expert Committee on Grains

Non-Voting Members

1	Provincial oilseeds specialist from each of the four western provinces (4)
1	Test co-ordinator
1	Representative of the Seed Division of the Food Production and Inspection Branch of AAFC

Figure 4.5: Membership of the WCCRRC.

Canadian canola industry (Campbell, 1994; WCCRRC, 1991)[10]. Membership in the

[10] The information about the WCCRRC included in this section were obtained through review of the articles of incorporation of the WCCRRC (1991) and interviews with Drs Downey and Woods (September 6 1995).

WCCRRC was specified by AAFC when the Committee was set up (WCCRRC, Articles of Incorporation, 1991) (Figure 4.5). The CCC has signing authority for the finances of the WCCRRC, provides the secretariat, has a representative on the WCCRRC and administers the variety trials). The committee consists of nineteen members, with a minimum of three from the public sector. There are an additional six non-voting members of the committee from AAFC and Provincial agriculture ministries. Canadian agricultural research policy (both in government and University) actively promotes collaboration and partnerships with the private sector (AAFC, 1995b, p 6; AAFC, 1993, p 3). As a result, many of the public sector representatives on the committee may be supported by , or collaborate with private sector committee members. The combination of strong industry representation on the committee and the congruent goals of the CCC and AAFC results in the manifestation of industrial goals of increasing yields, production, and crop quality as a means of maintaining 'competitiveness'. Although the committee could, in theory, approve an alternative, low input variety (with a 2/3 majority vote to overturn the rules), it would be highly unlikely given the membership and goals of the committee.

The articles of incorporation give the WCCRRC a mandate to " act in the best interest of the overall Canadian canola industry" (WCCRRC, 1991, Article 10). The committee has interpreted the interests of the industry as: increasing yields and quality, in order to meet increasing demand (WCCRRC, 1993,1994). The committee also supports biotechnology (transgenic crop plants) and herbicide tolerance. The first varieties of transgenic canola plants with herbicide tolerance were approved for commercial release in March 1995. The committee's attitude towards biotechnology is revealed in the minutes meeting:

> Bill Robertson made the observation that the committee had been asked to make a political statement. He wondered whether we shouldn't be backing the companies in their attempts to bring herbicide tolerant varieties to the market place (WCCRRC, February, 1994, p 9).

The comment was made after the committee rejected motions to set aside the rules for recommending several herbicide tolerant varieties. In his statement, Bill Robertson is suggesting that by putting aside the rules for herbicide tolerant varieties, and making registration easier, the WCCRRC would be supporting the efforts of the companies. In a further display of the WCCRRC's support for biotechnology, the committee agreed to submit a report to Health and Welfare Canada, Environment Canada and AAFC to address delays in regulation of genetically engineered plants to the effect that:

> The WCCRRC is encouraged with the progress (*in terms of developing regulations for biotechnology*) made during the past year but is concerned that the development of guidelines continues to delay Canada from exploiting opportunities inherent to transgenic canola (WCCRRC, February 1994, p 9).

Thus, the WCCRRC is defining its role in supporting particular technologies and influencing both the policy process, and research.

Notwithstanding the committee's support for biotechnology, Japanese oilseed buyers informed the Canadian industry at the 1995 Annual General Meeting of the Canola Council of Canada, that they would not accept transgenic canola (Ichikawa, 1995). The Japanese oil processors stated that the regulations were not in place in Japan and that they did not feel that public acceptance was adequate:

> .. in the case of canola, there seems to be a danger of negative *(public)* response that genetically transformed canola brings about benefits first to the chemical manufacturers and second to the farmers but no benefits to the rest of the people, particularly the consumers (Ichiwaka, 1995).

As a result of the Japanese objections, transgenic canola was approved for use only in limited areas so that the Canadian canola industry could ensure that no transgenic canola was exported to Japan this year. The transgenic canola that was grown in 1995 will remain in Canada or be exported to the US[11].

The extent to which private sector interests and mandates (i.e. those of the CCC) have control over the process was further demonstrated in an appeal launched recently by one of the private breeders. In the last few years, several genetically engineered, herbicide tolerant canola varieties have been participating in the variety registration (co-op trials). When these varieties came up for registration, the WCCRRC voted to give them eight extra merit points for the herbicide tolerance trait alone and then assess them on the basis of their other characteristics (WCCRRC, February 1994). The herbicide tolerant varieties were given extra points because the WCCRRC felt that these varieties were important for the industry and that they did not want to present barriers to their commercialization. However, the committee felt that the varieties still should meet the seed oil content and protein meal content requirements. This requirement was strongly supported by the processors and oilseed exporters, who face pressure from their Japanese buyers in terms of quality. One of the three

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[11] At present, labelling is not required on foods derived from transgenic crops, therefore Canadian and American consumers are not given the opportunity to choose whether they wish to consume these foods.

varieties did not meet some of the 'must' requirements and was not recommended for registration. The company launched an appeal and was successful. According to the articles of incorporation, an appeal is allowed only if data was found to be incorrect or the WCCRRC did not follow the proper procedures. Since neither of these criteria were met, an appeal should not have been possible. Dr. Keith Downey (a non-voting member of the WCCRRC and prominent public sector plant breeder) commented that the rationale used by the appeal board was that recommending the variety was for the "good of the entire industry" (K. Downey, September 6, 1995). A private sector appeal was therefore allowed to bypass the entire WCCRRC registration process. AAFC accepted the appeal board's decision without written comment.

The variety testing and registration process for canola in Canada demonstrates how a regulatory process has been captured by narrowly focussed industry interests. The fact that labelling is not required on foods derived from transgenic organisms excludes public involvement even at the market level.

This example also demonstrates why sustainability must be conceptualized and operationalized as a process, as outlined in the introduction to the thesis. When canola was first developed and promoted in the late 1970's, it represented a promising new alternative crop for Prairie grain producers. Canola production allowed grain farmers to diversify their production and income. However, in 1995, it was generally recognized that Canada had reached the maximum canola acreage possible given current varieties, land suitability and the requirement for a four year rotation to prevent disease buildup (Arason, 1995). If canola is at its maximum acreage, government, WCCRRC and CCC goals of further increasing acreages

are inappropriate. Also, international demand will likely continue to increase, probably beyond Canada's capability (short or long term) to meet all of the demand. Even those with a growth oriented perspective will concede that there is a physical limit to the amount of canola Canada can produce. I propose that this limit be determined by a long term assessment of what level of production is sustainable rather than the maximum we can produce in the short term.

In terms of addressing sustainability criteria, none are addressed directly in the variety registration process for canola. The primary criteria of concern to the WCCRRC are yield and quality characteristics. The assessment criteria for new varieties work against maintaining diversity in canola crops and do not encourage the development of low-input varieties. During the discussion about the number of points to be awarded for herbicide tolerance at the December 1994 WCCRRC meeting I attended, an audience member asked why net income using new varieties couldn't be a criteria. The question was not responded to by the Committee, indicating that this was not a primary concern for the WCCRRC.

The use of a multi-stakeholder group (the WCCRRC) for recommending future directions for agriculture is seen as a positive step towards sustainability in terms of developing a more socially responsive approach to policy making which includes public involvement. However, the variety testing and registration process does not meet all of the criteria in chapter two for an appropriate public involvement process.

WCCRRC has complete control over the development of protocols for testing and assessing new canola varieties. AAFC holds the final decision-making authority over whether a recommended variety is approved for commercialization, but has rarely been know to reject

a recommend variety. At the December 1994 WCCRRC meeting I attended, Committee members questioned an AAFC representative about a WCCRRC recommended variety that had not been accepted by AAFC in 1993. The reason given by the AAFC representative was that the variety was essentially the same (genetically) as one that was already registered. Several Committee members expressed concern that this rejection could be seen as a vote of 'non-confidence' by AAFC in the work of the WCCRRC. This indicates that the WCCRRC expects that all varieties they recommend will be accepted by AAFC and brings the authority of the AAFC into question.

The members of the WCCRRC share similar interests and thus do not truly represent alternative, societal views in agriculture. The current structure of the process and the mandates of the organizations involved have a profound effect on both public and private research into new crop varieties, promoting biotechnology and effectively excluding research into low input varieties.

In the next chapter, the results of interviews with individuals involved in the research and development of biotechnology are presented. The interviews were intended to gain some insight into the perceptions of those involved in research and development of biotechnology in terms of sustainability and the role of biotechnology.

5. RESEARCH COMMUNITY PERCEPTIONS

Research and development of new technologies and management practices is required to support a transition to a more sustainable agriculture in Canada. I conducted interviews with members of the biotechnology research and development community in order to identify their attitudes towards the role of biotechnology in agriculture. Based on the review and analysis of AAFC policy towards biotechnology, it was expected that agricultural biotechnology researchers would be motivated more by economics and growth than a conservation- oriented approach to sustainability. The interview questions were constructed to explore economic motivations and a growth-oriented philosophy in more depth than that allowed by the document analysis.

The information obtained in the interviews was treated as one source of empirical information to gain insight into how federal agriculture and biotechnology policies affect research, development and commercialization of new agricultural technologies. The interviews were semi-structured. There was some variation in how the questions were worded and how respondents interpreted the questions. Interviews were taped and verbatim transcripts were prepared for analysis. The transcripts were divided into sections for analysis. The sections are:

1. Motivations for conducting research and arriving at research goals.
2. Public vs private sector research goals.
3. Expectations of economic returns to research.
4. Responses to criticisms about biotechnology.
5. Perceptions about the present state and future of agriculture in Canada.

Each section of the analysis is headed by the relevant questions from the interview. Overall themes for answers are identified where possible and example quotes given. In cases where answers were substantially different, quotes from each interviewee (numbered one to ten as in Table 5.1) are presented. Explanatory remarks are italicized and in brackets.

The biotechnology industry in Canada is relatively small and research facilities are concentrated in Saskatoon. Due to travel constraints, it was decided that all interviews would be conducted during a single trip to Saskatoon. Interviewees were selected by identifying public and private sector researchers involved in canola biotechnology research with the exception of one researcher working on herbicide tolerant flax. Potential interviewees were identified through informal discussions with Canola Council of Canada staff and through a literature review to determine who was working on canola, and particularly herbicide tolerance, in Saskatoon. Ten interviews were conducted in March 1994. All interviewees were male, five were in the public sector, four were research scientists and one was an administrator (Table 5.1). The other five interviewees were in the private sector (one in a co-operative organization) and

Table 5.1: List of interviewees, affiliation and position.

Interview	Affiliation	Position
1	Private	Research Scientist
2	Private	Research Scientist
3	Public	Research Scientist
4	Public	Research Scientist
5	Public	Director/administration
6	Public	Research Scientist
7	Private	Research Director
8	Co-operative	President/ administration
9	Public	Research Scientist
10	Private	Marketing/ Commercialization

included two research scientists, two administrators and one individual involved in commercialization of biotechnology. The respondents answers were compared (to some extent) to ascertain if there were any fundamental differences between public and private sector answers (especially for the questions relating to rationale and primary targets for research), but the primary purpose of the interviews was to gain insight into what influences biotechnology research and development goals and how sustainability is conceptualized.

The interview was initiated with the statement:

> The interview is divided up into sections; in the first section, I will ask you about your specific research; then ask you to respond to common criticisms levelled against biotechnology and herbicide tolerance specifically; finally, I will ask you questions about how you perceive the current situation in agriculture and what you foresee for the future.

A copy of the entire interview and the consent form signed by respondents is presented in Appendix 3[1].

5.1 Motivations for Conducting Research and Arriving at Research Goals

The first section of the interview contained questions related to specific research goals, motivations for conducting research, direct applications and targets of research. The purpose of this section was to identify the rationale for conducting biotechnology research and whether agricultural sustainability was a consideration.

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[1]The purpose of the thesis indicated in the consent form (March 1994) represents an earlier research focus. The thesis evolved considerably after my attendance at the WCCRRC meetings in Saskatoon in December 1994.

Questions:
- *What are your main motivations behind doing this type of research?*
- *What are the direct applications?*
- *Who would you say is the primary target of your research?*

All of the private sector interviewees named returns on investment, increased market share for herbicides and making money from conducting commercially successful research as their main motivations for conducting (or promoting) biotechnology research. Examples of motivations for research for two of the interviewees are presented below:

> Overall goal is a return on investment. Second overall goal- the worldwide market for plant protection is shrinking. The only exception will be North America and Asia, therefore to keep your position, you will have to move into a new area. We want to secure our position by applying new technology (1).

> Obviously as a company, you are looking for markets to put your stockholders money in. With regards to herbicides, my perspective, not the company's - there aren't any large niches in weed control left in agriculture. The environmental movement has forced regulation on the companies such that you have to have pretty worthy products in order to bring it to the market- so there isn't really a big market there for developing new chemicals (2).

Both of these interviewees refer to market share or making money for the company as a goal and also to the fact that the development of new herbicides is difficult and that companies have to look for different ways to achieve these returns. Another interviewee also mentioned seed sales as a source of return to investment. Seed prices can vary quite considerably for canola and can have a significant effect on the economics of farming (Canola Council of Canada, Western Report, 1992)[2].

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[2] Seed prices can range from $0.85 per pound for older canola varieties to $3.17 per pound for newer, hybrid varieties, which can significantly affect input prices (Canola Council

Motivations other than returns to investment were given by some private sector respondents. For example, one of the interviewees gave a personal motivation and another a more general motivation, linked to supporting the whole agricultural industry:

> I was always looking for applied agriculture, not necessarily ivory tower research. I want to do research that can be applied afterwards or even sold (1).

> The main motivation for this work is to help enhance the agricultural industry in Western Canada and to ensure that we remain a viable industry in the long run and globally competitive The project has to make sense from a commercial standpoint. What's the market?... does this product make sense? Is there an opportunity for the producer, farmer to benefit from having that product; is there an opportunity for the food chain? the processor has to benefit and ultimately there has to be a benefit, either directly or indirectly to the consumer (10).

A private sector administrator gave an extended explanation as to why his company actually began working on herbicide tolerance in canola. Since this company was the first to begin working on herbicide tolerant canola and probably influenced other companies and public sector researchers to follow suit, an extended transcript from this interview is presented here:

> Herbicide tolerance was a goal from the early 1980's- we saw the future of weed control as a balance between chemicals and biology- that was a corporate decision (2).
>
> In 1986, we knew we could do tobacco and canola (*referring to transferring herbicide tolerance*). We decided as a company not to do tobacco because it was the wrong signal for a food company (2).

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of Canada, 1992).

> The fact that we are being forced environmentally a bit into this area means that you look at a chemical like *(name deleted)* with its environmentally friendly profile- you've already found the chemical, now you just have to find the crops that will tolerate the chemical- it looked like a route that would be easier to register (*than new chemicals*). It was unproven science wise at the time but it looked like it was going to be tough to find a herbicide that was more effective and environmentally friendly- now we just have to find the crop (2).

The chronology of events in the development of herbicide tolerant canola represented by the above transcript could be reconstructed as shown in Figure 5.1.

1. Development and registration of the herbicide
2. Ability to transfer tolerance into plants
3. Identification of an appropriate bacterial tolerance genes
4. Search for appropriate crop to put the tolerance gene into
5. Creation of herbicide tolerant canola and field trials
6. Registration of herbicide tolerant canola for commercial use

Figure 5.1: Sequence of events leading up to the development and commercialization of herbicide tolerant canola.

Herbicide tolerance was one of the first characteristics developed in transgenic plants, partly because many herbicide tolerance genes are single dominant traits as opposed to the multi-gene traits associated with characteristics like drought or frost tolerance (Stalker, 1991). The transcript and chronology of events presented in Figure 5.1 indicates that the original 'problem' addressed by this research was how to increase market share for the herbicide rather than identifying a need for this research in agriculture. If the product does benefit farmers, it is secondary to the intended benefit for the companies.

All of the public sector respondents gave similar economic reasons or the general

betterment of agriculture as the main motivation for their research, but referred to economics for farmers, and Canadian agriculture in general rather than specifically to returns on investment. For example:

> Prime motivation is to improve the material that we are working with so that it is of greater value and usefulness to the producers, industry and consumers- the betterment of Canadian agriculture (3).

> To help the Saskatchewan and Western Canadian farmers out of their current hardship situation (9).

Although both public and private researchers gave economic justifications for their research motivations, there was some difference in their goals in terms of who reaps the economic benefits of the research. For most private researchers, economic benefits were seen as directed towards the companies whereas for public researchers, economic benefits were seen to be more widely dispersed through the agricultural industry. Improving environmental sustainability as a research goal or mandate was not mentioned at this point in any of the interviews. However, the issue of sustainability was pursued in more detail in later questions.

Nine of ten respondents listed producers or farmers as one of the primary targets of their research. Two private sector respondents also mentioned crushers or processors, one mentioned plant breeders and one mentioned consumers. Interestingly, consumers were mentioned specifically as a primary target only by three of the public researchers (although consumers were mentioned at other points in several interviews)[3]. Herbicide

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[3] One interviewee, representing the marketing company mentioned consumers indirectly by saying that their work cut across the whole food chain from farm gate to grocery store (10).

being conducted to alter the nutritional quality of canola oil and meal (Canola Industry Meetings, Saskatoon, December 5, 1994). The fact that only one of the private industry representatives mentioned consumers as a primary target for research may reflect the viewpoint that the processors rather than consumers are considered as the ultimate end users of a product. This may be related to the industry's apparent unpreparedness for the Japanese Oil Processors statement regarding the acceptability of genetically engineered food products by consumers in Japan (see chapter four)[4]. One public sector interviewee mentioned the Japanese buyers specifically in terms of them paying a higher price for improved canola varieties. Another public sector interviewee emphasized intermediaries (processors, crushers and seed companies) as opposed to farmers as the main targets of the research. The increasing importance of intermediaries as targets of agricultural research was discussed earlier.

5.2 Public vs Private Research Goals

It was argued in chapter two that it is the responsibility of the public sector to pursue research and technologies that contribute to sustainable agriculture.

Questions:
- *Do you think public and private research goals in agriculture should be different?*
- *Are you participating in a public/private research collaboration?*

All interviewees indicated that they were participating in public/private research collaborations. Respondents differed in their opinions of whether public and private research goals should be different. Three interviewees felt that public and private research goals

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[4] These varieties had not been approved in Japan as of September 1996.

should be similar. The remaining seven interviewees stated that the goals for public and private research did not necessarily have to be different, referring specifically to applied research. Most agricultural research is, by nature, applied and the point was made that applied research goals could be similar for public and private research organizations but that basic research was more the realm of the public sector. One private sector interviewee stated that his company had actually conducted a lot of basic research. However, one public sector interviewee did make a general distinction between public and private research goals:

> We have very definite goals where we place the general improvement of the crop and its quality at a very high priority- whereas a private company, in general, will look at what will return them the highest dollars. They are not necessarily looking at Canada's position in the international markets, they are more looking at their position in terms of the market share that they have and if it doesn't pay in Canada then they will move their resources to another crop or another country where the payoffs will be greater (3).

The distinction between public and private research goals in biotechnology has diminished in recent years with increasing private investment and collaboration between public research institutions and industry (Krimsky, 1991; Busch et al., 1991). Lacy et al., (1988) points out:

> Traditionally much public sector research has been oriented toward farmers and farm cooperatives. However, with the increasing interest and investments of multi-national pharmaceutical, agrichemical and food processing corporations, the primary clients and goals for public sector research may change.

Although most respondents, both in the public and private sectors, mentioned farmers as the primary target or clients of their research, the emphasis was on returns to investment to the companies conducting the research. This means that although farmers may be the primary clients, the primary goal of the research is to benefit the companies. In universities, Krimsky

(1991, p 59) argues that the 'ethos' of biological science has changed where:

> According to this ethos, the production and dissemination of knowledge is fully realized in an instrumental sense only when the knowledge is transferred to the industrial system.

This statement implies that basic research will have a diminished role in universities in the future. In agreement with this argument, Herbert (1994) writes:

> Universities and government are increasingly unwilling to pay for research that does not produce immediate results, but industry is willing to offer generous contributions in return for the use of university facilities - and a degree of control over the research and its outcome.

AAFC has always concentrated on more applied research than universities (Agriculture Canada, 1993; AAFC, 1995d). However, the influence of industrial involvement can be seen by AAFC's emphasis on involving industry in developing research goals by stating that they will seek industry partners where possible, *to validate the choice of projects* (emphasis added, AAFC, 1993). In 1995, AAFC went further to emphasize industry led research (AAFC, 1995d). Asking industry to validate projects makes the assumption that AAFC actually initiates them whereas focussing on industry led research implies that research projects are initiated by industry. AAFC does also point out that they perform research that industry finds unprofitable (AAFC, 1995d, p 12, p 15):

> When a private firm, however, cannot capture its return on investment through patents or brand name applications, it often leaves that work to the state.
>
> We do not compete with the private sector in areas where they have the interest and capability to do the R & D. Rather, we collaborate to create wealth where our strengths are.

AAFC therefore, sees itself as enabling private sector research. This approach assumes that the private sector will identify and want to pursue all agricultural research of public value. However, it brings up the question of whether the private sector would be interested in participating in research that does not ensure a market for their products in the future, for example, organic farming. As AAFC commits more of its research budget to projects with industry collaboration, research on alternative approaches to conventional agriculture will likely suffer.

Another possible problem with the preponderance of the private sector in agricultural research relates to the communication of information. Basic research conducted by a company may be unavailable for widespread use if the company feels that they are giving away information that could affect their competitiveness. Patenting of genetically engineered organisms has also brought up issues of availability of information. For example, one private sector interviewee commented on patenting issues and how they affect research:

> Private research has put a lot of emphasis on patents and public research(*ers*) as well. Now its developing in a direction where they also need patents in areas that I sometimes find a little surprising. Problem is when you patent everything right away, public researchers have no access to certain parts of the technology anymore (1).
>
> If everything is paved with patents then public research is going to suffer- so I think it is in the interest of research politics to steer these things in a certain direction- not too rigidly- I mean companies should be allowed to go ahead, but not 100% (1).

This position is not generally supported by the biotechnology industry (Belcher, 1992; Roberts, 1993). Industry argues that patents are necessary as incentives to research, and

rewards for disclosure (Belcher, 1992; Burk et al., 1993).

5.3 Expectations of Economic Returns

Whether research projects are expected to generate economic returns, refers back to the goals of public vs private research and whether such research is directed towards meeting needs for sustainable agriculture or generating economic wealth.

Questions:
- *In general, are returns from marketing products expected to cover R and D costs incurred?*
- *What acreage or market share of canola do you think needs to be grown to cover research and development costs?*

In response to the question regarding whether returns from marketing products are expected to cover research and development costs, two public researchers said no, not in public sector research, but the other eight interviewees said yes. All of the researchers were participating, or planning to participate, in public/ private research collaborations.

When asked what acreage of canola would need to be grown in order to cover research and development costs, responses varied and most

50% of the market within the next decade, including other company's products (1).

85% herbicide tolerance, regardless of what else they have in them (2).

All varieties will contain the characteristic *(herbicide tolerance)*- they will be clamouring for that if all the societal objections presently being heard are overcome (4)

The expectation would be that you would treat... 50% of the acreage (*with the herbicide in question*). From the corporate standpoint... they will recover *(money)* from the seed sales too (10).

Figure 5.2: Estimates of market share of herbicide tolerant canola will receive in the future.

respondents did not make an estimate. One interviewee estimated that one to two percent of the market would be sufficient to cover the research and development costs for herbicide tolerant canolas and another interviewee estimated ten to fifteen percent. Several respondents offered estimates of the market share that herbicide tolerant canola will actually represent in the future (Figure 5.2). The estimates for actual market share that the canola will get are much higher than the two estimates for the market share required to cover costs implying that the marketing of these canolas is expected to more than cover research costs.

5.4 Responses to Criticisms about Biotechnology

As mentioned in the introduction to this thesis, concerns have been raised about the environmental impact of biotechnology. In terms of crop plants, the main concerns listed were increased weediness or invasiveness of plants, recombination between transgenes and pathogens, risk of transgene spread into wild relatives and effects on non-target organisms (Regal, 1993; Rissler and Mellon, 1993; Tiedje et al., 1989). Interviewees were asked to comment on several statements related to these risks and to some more general 'risks to sustainability' like the reduction of genetic diversity and reliance on chemical herbicides.

Questions/ Comments:
- *Herbicide tolerant canola will be difficult to eradicate as a volunteer weed.*
- *Introducing herbicide tolerant varieties will encourage more farmers to plant canola.*
- *Canola requires more inputs than cereals.*
- *Introducing genetically engineered crop plants reduces crop biodiversity and increases monoculture.*

All respondents disagreed with the statement "Herbicide tolerant canola will be

difficult to eradicate as a volunteer weed". The fact that there are other herbicides that are currently used to eliminate volunteers was cited as the main reason for disagreeing. Another interviewee stated that there would be no problem even if the herbicide tolerance gene was transferred to weedy relatives:

> The fact is that if the transformed plant becomes weedy or if the gene is transferred to a wild species that is weedy, they will be no more difficult to eradicate or control with the products that you had before the introduction (3).

This individual went on to state that canola is not a weed now, its a crop and that volunteers are easy to control with other classes of herbicides. In contrast, another interviewee mentioned that " ...any canola is difficult to eradicate". Whether canola can be considered a weed or not depends upon your position that crops plants can never be classified as weeds or whether you define a weed as any plant that grows where its not wanted.

One public sector researcher commented that with more sophisticated agricultural practices, a more sophisticated and informed farm population is required and that the introduction of the new varieties (herbicide tolerant varieties) would need to be followed by very "strict" education. This implies that the new varieties are more complex to manage than the varieties currently in use. Interviewees were split on whether the introduction of herbicide tolerant varieties would encourage more farmers to plant canola. Five interviewees said that the area in canola would probably increase, particularly in weedy areas. The other five felt that the introduction of these varieties probably wouldn't have a major effect on farmers decisions to plant more canola. In effect, they felt that it was one of many factors influencing farmers. One public sector interviewee who felt acreages would not be affected much cited

the difficulty of growing canola[5]:

> The growing and farming of canola is not dependant on the spectrum of weeds that are out there- farmers have very good weed control right now. Much bigger limitation is that growing wheat is much simpler- growing canola takes a lot more knowledge and management (8).

In a subsequent question, all respondents agreed that canola requires more inputs than wheat in terms of herbicides and fertilizers as well as knowledge and management. One interviewee mentioned the costs of seeds and the implications of the control of seed companies:

> *(more inputs in terms of)* fertilizers and herbicides and the seed is more expensive *(than pre-existing varieties)*, especially when the seeds become more fully controlled by the seed companies (4).

This comment touches upon the issue of control over agricultural inputs by multinational corporations. The possible consequences for farmers in terms of availability of different varieties and input costs as a result of the concentration of control with a few large companies has been discussed extensively in the literature (Fowler and Mooney, 1991; Herbert, 1993; Hobbelink, 1991).

Interviewees were asked to comment on whether introducing genetically engineered crop plants reduces biodiversity and increases monoculture. None of the interviewees felt that genetically engineered crop plants would increase monoculture. Most pointed out that we already have as much monoculture (and little diversity) as is possible, therefore, genetically engineered crops could not increase that level:

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[5] This quote is interesting in that it supports the idea that herbicide tolerant canola is not really needed by farmers.

> Genetic engineering is one of the tools that we we'll be able to use to address a growing need in this world for more food. The population in this world will grow to 8 billion early in the next century and we will have to feed these people and its very nice to be able to say that we have to be careful that we don't want to influence biodiversity and etc, etc. On the other hand we also have to address this food concern and to me, biotechnology, genetic engineering is one of the many techniques for that and I don't think it will influence biodiversity to a larger extent that classical breeding has done and that has been ongoing for 150 years (7)

Four respondents felt that genetically engineered plants would increase biodiversity:

> If you can move genes from species that normally sexually do not transmit genes, you are not reducing diversity, you are increasing it. I think the technology itself is expanding the genetic base (2).

However, this respondent did add a caveat:

> I suppose that any time you have an extremely successful cultivar, people might want to produce that cultivar more at the expense of diversity (2).

Most of the remaining respondents indicated that genetically engineered crops would not reduce biodiversity any more than classical breeding had already done so. One interviewee stated that biodiversity of crops might be reduced, with negative consequences, but that farmers could learn from the experience, for example:

> ...you will end up with a variety that has all the positive characteristics. But does it matter? Let it fail once or twice- farmers and breeders will learn quickly- its part of the process (4).

The respondent made reference to the Texas cytoplasm case which demonstrates the problems with planting large acreages to one or a few varieties[6].

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[6] The Texas cytoplasm of maize was the source of inherited male sterility which was used extensively in the Southern US in the late 1960's to create commercial F_1 hybrids

Interviewees were also asked to comment on some general statements about the incorporation of environmental externalities into economics and environmental impact assessments.

Statements:
- *The benefits of developing herbicide tolerant canola do not outweigh the costs associated with continued herbicide use.*
- *Current economic evaluations have been criticised on the basis that they fail to take environmental impact into account.*
- *Economic analyses should be expanded to include environmental impact and non-renewable resource use.*

The first statement was chosen to examine the issue that the development of herbicide tolerant crops ensure a use for herbicides into the future with concomitant negative environmental impacts (Goldburg et al., 1990). In the statement, the costs of continued herbicide use was intended to refer to environmental costs. However, many of the respondents did not interpret the statement this way and their answers differed considerably. Some focussed on the actual use of herbicides and direct costs to farmers, whereas others also took environmental impact into account. The responses to this statement and an interpretation are presented in Table 5.2. Interpretation of the responses was based on the context of the rest of the response to the statement and interview. One common theme that came up here, as well as in the response to statements about monoculture and biodiversity, is that the introduction of new varieties will be 'no worse than' current practices. This may be interpreted that the situation in agriculture is far from ideal and that genetically engineered

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(Levings and Siedow, 1992). By 1970, maize carrying the Texas cytoplasm represented 85% of the US maize acreage. This cytoplasm also conferred susceptibility to a race of Southern corn leaf blight to the extent that the Texas cytoplasm was abandoned for seed production (Levings and Siedow, 1992).

crops do not appear poised to make a significant difference. Several interviewees stated that agriculture was not feasible or possible without herbicides.

Table 5.2 : Responses and interpretations of the statement: *Benefits of developing herbicide tolerant canola do not outweigh the costs associated with continued herbicide use.*

Response	Interpretation
(1) There is not more herbicide used now than in the past- on the contrary... potentially need less herbicide.	Isn't addressing the issue of continued herbicide use in general- just stating that the new varieties are better than current varieties.
(2) I don't think they understand agriculture and what it takes to produce food, they are out of touch with the reality of agriculture.	Making the case that agriculture is not possible without the use of herbicides, therefore implying that costs are irrelevant.
(3) The impact of these will be to reduce any environmental deleterious effects that we may be experiencing now with present herbicide use.	Like (1), stressing that less herbicides will be used with new varieties, therefore less costs- not necessarily addressing the costs of continued herbicide use.
(4) Let the market decide that- the farmer will quickly pick that up.	This respondent is focussing on direct economic costs only. Reduced herbicide use translates to reduced cost and the market will deal with anything resulting in excess cost.
(5) I don't think anybody has ever costed that so I don't really know.	Seems to understand what the question was getting at, but comments it hasn't been done.
(6) ...environmental costs are even higher with the existing herbicides than with the environmentally friendly new herbicides.	same as (1).
(7) I think the other thing which is very important to take into consideration... is the actual costs to the environment and the costs of society. Clearly we are dealing with .. herbicides that are much safer and represent a much smaller risk to the environment.	Although this interviewee recognizes other aspects of cost, he is again comparing herbicide treatment of new varieties with old rather than addressing the issue of herbicide use in general.

Response	Interpretation
(8) ..that's going to be determined in the market place.	See (4)
(9) That implies that the alternative is elimination of herbicide use and that is not practical- it will not occur- certainly not in the near future.	Recognizes intended meaning of the statement but like number four, implies that agriculture is not feasible without herbicides.
(10) It is impossible to do without. Agreed, it doesn't cut back on the use of herbicides per se, but it is not going to increase.	Only one who states that herbicide use will not decrease but also states that herbicides are essential for agriculture.

The issue of environmental costs was examined in more detail by asking interviewees to respond to two statements regarding environmental costs. Nine of the respondents disagreed with the first statement regarding economic evaluations and environmental impact and asserted that environmental impact is already taken into account, particularly soil erosion[7]. Two of the respondents argued that pesticides and agriculture had a positive impact on the environment:

> I see most of what we have done in the pesticide industry as positive to the overall ecology of the planet- not negative. There have been some mistakes in agriculture just like there have been mistakes in medicine, but I don't see that as a reason to stop progress (2).

> The impact of agriculture on the environment is even positive in that we create countryside that is beautiful to look at that people can even enjoy to have holidays in. If we would have no farming on the Prairies, it would be a dead empty space with nothing there (6).

[7] This answer made responses to statement two irrelevant.

Of the nine respondents who disagreed with the above statements regarding whether environmental impacts should be incorporated into the calculation of economic costs, three mentioned that although there are some unknowns and possible risks associated with new technologies, it was not a reason to stop progress. Another three respondents indicated that environmental issues had been blown out of proportion and one mentioned that the debate had become emotional rather than scientific or rational. The rationale underlying these responses appears to be that producing as much food as possible is important and this 'need' outweighs the possible environmental costs associated with biotechnology. A single respondent agreed with both statements and commented that environmental impact was not taken into account in areas other than agriculture. This individual also stated:

> Biotechnology, from my perspective, is not going to make any difference as far as the environmental aspect of farming is concerned[8] (10).

5.5 Perceptions about the Present State and Future of Agriculture in Canada

5.5.1 Economic Situation and Free Trade

The advent of free trade agreements has increased the emphasis on competitiveness in all industries, including agriculture (Ritchie, 1993). These agreements may be responsible in part for AAFC's current emphasis on competitiveness in agriculture. As long as food can be imported more cheaply (at least by a neo-classical economic analysis) there is little incentive for a country to invest in its own agricultural

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[8] The interviewee is referring to the overall impacts of biotechnology on the environment here rather than herbicide tolerant plants specifically.

capability and sustainability. The next set of questions referred specifically to the economic situation in farming in Canada and the possible consequences of free trade for specialization (related to the independence of agriculture).

Questions:
• Do you think farm net income in Canada has changed in the past 20 years in constant dollars? In what way? Why?
• The next few questions deal with economics under free trade. Classical economic theory states that specialization increases productivity and efficiency. Free trade systems are designed to facilitate specialization on a global scale. How would you define efficiency in agriculture? How do you think Canada will specialize?

The first question referred to changes in farm net income in Canada and the factors influencing net income (Figure 5.3). Eight interviewees felt that farm income had decreased in Canada since the 1970's[9]. One interviewee felt that he didn't have enough information to answer the question and one would not say whether income had increased or decreased. The reasons given for the decrease in income by eight of the interviewees are paraphrased in Figure 5.3. Five of the interviewees linked decreases in farm net income to increases in production costs, lower prices and increased subsidies in other countries. Two of the interviewees mentioned that the countries that need food imports

- world markets, competition, decreased exports to former Soviet Union, EEC subsidies
- surplus of food, countries who need it can't pay
- price supports, interest rates, farming has become a business not way of life
- input costs, need higher prices
- production not as efficient as elsewhere
- low prices, increased production costs
- world economics, subsidies
- Canada too specialized, no processing, many countries can't afford higher prices

Figure 5.3: Summary of interviewees reasons for decrease in farm net income in Canada.

[9] This is supported by the Statistics Canada data presented in the introduction.

the most cannot afford to pay high prices for them. This point is pursued in more detail in a later question. One interviewee indicated that Canadian producers are not as efficient as other producers.

The second question asked respondents to define efficiency in agriculture and to predict changes in Canadian agriculture as a result of free trade, particularly in terms of specialization. Most interviewees defined efficiency as the ability to produce at high levels with minimum inputs. One interviewee made the distinction between economic and technical efficiency and defined economic efficiency as a relative expression, e.g. output per person, or hectare: "I suppose the farmer becomes more efficient if he can put out more by himself per hectare and earn a living". Two of the interviewees also referred to long term costs or sustainability as an additional factor to consider with output and input:

> ...producing a quantity of crop in an efficient manner with reduced costs. Least economic costs bearing in mind both the short term and the long term, bearing in mind that you don't want to go out there and not use products like fertilizer and mine the soil- so there has to be that consideration- but it has to be done through reduced costs (8).
>
> To me it is producing good, high yielding crops at the most economic level you can. ...and then managing that system from an environmental standpoint to make sure that you are sustaining that land for the future so that you are putting in as much as you are taking out (10).

In terms of specialization of Canadian agriculture, some interviewees interpreted this

as meaning the production of specialty crops (which is diversification)[10]. Four interviewees felt that Canada would or should specialize in niche markets, specialty crops and value added. Six of the interviewees felt that Canadian agriculture was already highly specialized and that free trade was unlikely to increase that level of specialization.

5.5.2 Canadian Agriculture and Food Aid

Questions about food aid reflect the role of agriculture in our society: as a means of providing food and income, or as an industry designed to increase wealth.

Questions/Comments
- *Do you think Canada will produce more food crops in terms of quantity in the future?*
- *Do you think it should produce more or less? (i.e. should we even have agriculture)*
- *Do you believe that Canada has responsibility to try to grow more food to help in feeding increased populations in other countries?*
- *It has been argued that most of the large increases in populations are occurring in countries which cannot become self sufficient in food as a result of political, economic or environmental constraints. As a result these countries will not be able to pay for the food they need.*

Increases in agricultural production and biotechnology are often justified in the literature by the argument that world population is increasing and therefore more food production is required (for example, AAFC, 1995c; OECD, 1992). However, it has also been suggested that much of the increase in population is occurring in countries that are unable to pay for the food require (Berlan, 1991). Respondents were asked to respond to questions regarding whether Canada will/should produce more food in the future; if Canada has a moral responsibility to produce more food to help increasing populations in other countries; and to

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[10] The question was intended to address specialization in terms of Canada specializing in only a few crops that it can produce 'competitively' rather than diversifying into numerous different specialty crops.

comment on the statement regarding the ability of countries to pay for the food they need. Eight of the ten interviewees stated that Canada would likely produce more food in the future, primarily from intensification rather than increasing cropped acres. Two felt it was unlikely, given climate constraints in Canada. It was expected that most interviewees would answer that Canada did have a responsibility to produce food to feed the world since this is used as a justification for current agricultural practices (primarily fertilizers and pesticides) and the introduction of biotechnology (AAFC, 1995c; OECD, 1992). However, eight out of ten said no, Canada does not necessarily have a moral obligation to feed the world, because farmers had to make enough money, and we could not give food away[11]. One interviewee commented that we have to get developing countries to a point (through development) where they can buy our products. Two interviewees agreed that Canada had a moral responsibility to produce more food. One stated that we should produce the food and someone would end up paying, either governments or the United Nations.

5.5.3 Environmental Impact and Sustainable Agriculture

Although the negative environmental impacts of agriculture in Canada have been documented in the State of the Environment Reports from the federal government, not all of those involved in agriculture would agree that Canadian agriculture is unsustainable at present. If researchers feel that agriculture is successful and sustainable at present, they will be unlikely to direct their research towards alternatives to biotechnology or other currently

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[11] However, five interviewees mentioned the requirement for increased food production to address world food needs prior to the question about a moral responsibility and whether these countries could pay for the food.

used technologies.

Questions:
• Do you think agriculture has a significant impact on the environment? Has it been increasing or decreasing?
• How would you define agricultural sustainability? Do you think agriculture in Canada is sustainable?

All ten interviewees stated that agriculture had a significant impact on the environment. However, three interviewees believed that agriculture could have positive as well as negative impacts on the environment. For example:

> It has a positive impact in that creates a landscape, places for people to live, to move out of cities, to farm, to preserve the soil and to produce food. I think that the environmental impact is positive as opposed to negative compared with many industrial operations that produce chemicals and cities which have a much more negative impact than agriculture has (6).

Of those that felt agriculture could have both positive and negative impacts on the environment, one felt that the positive impact was increasing, and the other two felt that negative impacts were decreasing. Of the remaining seven interviewees who felt that agriculture negatively impacted the environment, three thought impact in Canada was decreasing, one thought there was no change and the remaining three felt that negative impacts were increasing.

Interviewees were asked to define agricultural sustainability and to state whether they thought agriculture in Canada is sustainable at present. Six of the ten interviewees defined agricultural sustainability in terms of environment and resource base or maintaining levels of production. For example:

> Means that we do agriculture in such a way that we don't hurt the natural resources- that we don't affect any factor that would cause a problem for producing agricultural products in the future at the same location (1).

> In my view, agricultural sustainability means when you plant a crop on a field that produces a certain yield, you do it in such a way that you can go back to the field for the next 100, 200, 1000 years for the continuous production of food (6).

Given that Agriculture and Agri-Food Canada emphasizes competitiveness and economic sustainability, it is interesting that over half of the respondents (three were public sector and three private sector) expressed sustainability in terms of environment only.

The other four interviewees mentioned economic and social aspects of sustainability in addition to the environmental aspects:

> Agricultural sustainability would require that the farm be managed in such a way that the soil and water and vegetative resources are maintained or enhanced over generations and that this be done in a milieu that provides an adequate living for the operator and his family (3).

> I think its more appropriate to ask whether agriculture as we know it today is sustainable. In the broad sense, agriculture is sustainable but its going to have a different format than what we have had before (8).

The first quote indicates a conservation-oriented position, but this was not reflected in the rest of the interview. The second quote here is referring to the sustainability of the current structure of agriculture (e.g. the family farm).

5.6 Biotechnology and Science Policy

Public involvement in policy development and decision-making with regards to biotechnology is one of the sustainability criteria identified in chapter two. Interviewees were asked whether they thought the public or scientists should participate in such policy making.

Questions:
- *What role should scientists play in making biotechnology or other science policies?*
- *What role should the public play in making biotechnology or other science policies?*

In terms of the role of the scientists, respondents answers varied considerably from the belief that scientists should have a direct role in decision making to limiting their role to communication. Respondents answers to this question are presented in Figure 5.4.

These responses describe different roles for science and also to some extent identify other factors which affect policy decisions. For example, responses 2 and 10 indicate that it is the science itself, or what we are capable of, that should drive policy decisions. Respondent 4 indicates that the market place should set priorities for policy decisions. Six respondents indicate that scientists should play a consultative or educational role only and one interviewee felt that scientists should be involved in decision making.

Responses to the question regarding the public's role in decision making are quoted in Figure 5.5. Nine of ten respondents referred to the public's lack of education or knowledge about biotechnology as a barrier to increased public involvement. This implies that a more educated public would have less objection to biotechnology or other new technologies. This belief is not necessarily true, as evidenced by the existence of well informed opposition

1. They should have a consultative role, they should be heard but not make decisions.
2. Scientists identify what is possible thereby providing direction in conjunction with business and government.
3. They have to be front and centre because there are a lot of people that don't. understand genetics or biotechnology...so they have to be there as part of the decision makers to make sure that its used for the general public good.
4. Less of a role than they do now, especially in the context of the questions asked here.. it is the marketplace that will push development.
5. I think scientists in general should be communicating in a manner that the public- at least a knowledgeable public can understand the ins and outs of the technology- they should not be making the decisions.
6. Scientists have the expertise in these areas and they should be consulted because the politicians who make those decisions without the knowledge of the science behind it.
7. One of the roles that they have is to educate the public at large, regulators and all of the decision makers, policy makers of what can be done with this technology ...and how we can implement it.
8. Well I think they play that role by participating in regulatory committees and providing the technical expertise. I think they have a critical role in enhancing understanding of technology.
9. Probably very little, scientists are very good at understanding technology but they have no other special expertise than anybody in determining policy, that's up to the political bodies.
10. It becomes an individuals preference, some scientists have no interest in that... they don't really want to get involved in the political side of policy making. Science has to be the driving force behind any new direction or focus in policy.

Figure 5.4: Responses to question: *What role should scientists play in making biotechnology or other science policy?*

to some aspects of biotechnology (Union of Concerned Scientists, Canadian Environmental Network, FNACQ, Rural Advancement Fund International, Environmental Defence Fund, British Columbia Biotechnology Circle, etc.). Two interviewees state that the public already has a role through the market place. However, as noted earlier, the lack of labelling requirements for food derived from genetically engineered plants or animals, makes consumer or market decisions impossible.

1. Not a big role because most of what people think is perception and perceptions don't really help. People's opinion of if they think it is dangerous or not dangerous are not really very important- of course for marketing they are very, very important, but for developing the guidelines they are not important.
2. The public represents the market and therefore has the ultimate decision making. The public has a lack of information surrounding biotechnology and therefore companies must educate the public to give them a degree of comfort with the technology.
3. The general public wants to be a part of the decision making process- but its not clear whether they want to take the time and make the effort required to get the knowledge and understanding needed to make those decisions. The tendency today is that you don't trust science but you don't learn enough about the science to make judgements on what is good or bad - so you abdicate your position to groups that have a specific axe to grind- the environmental or pure food groups.
4. The general public wouldn't have a clue. The political process as a whole must certainly have an influence and the main role and the political process comes from the people.
5. The public is going to make the decisions whether its at the ballot box or through pressure groups, or in any other way.
6. I think we have to do a job there to educate the public what biotechnology really is... an educated public, yes, an hysterical public, no because they don't know what they are talking about.
7. I think the public already has a role in making the science policies because it is electing a number of politicians who are putting people in place to regulate. I don't think the public at large is well informed enough to make, in a normal democracy, to make and design a policy itself- I think that is not realistic.
8. Well I think the public has a significant role to play because they are often the end users - they are often that target and they suffer the consequences of it so I think they need to have a role through consumer organizations, or sitting on panels or participating in or even sending letters to the editor or the media.
9. An informed public, part of the problem with biotechnology is that a lot of people are afraid of it - anything that is new has an element of fear in it, biotechnology is new.
10. The public has to be kept aware. Yes I think the public has to get involved- but in the proper way- the public wants transparency...and so on and that's where the public involvement should be- to ensure that transparency- not necessarily setting the policy. The majority of the public don't have the knowledge base to really, fully understand what it means and they don't want to. Today's public don't understand science so there is a fear of science but its been pulled into a fear of biotechnology in a way because its a lack of understanding, knowledge.

Figure 5.5: Responses to question: *What role should the public play in making biotechnology or other science policy?*

In summary, respondents agreed in many instances; in terms of motivations for doing research, primary targets, differences between public and private research goals, the impact of biotechnology on the degree of monoculture, that current economic evaluations do take environmental impact into account and on the role of the public in science policy (or more specifically with the characterization of the public as ill informed about biotechnology). The most striking disagreements were in estimates of the environmental or direct costs of herbicide use, defining sustainability and environmental impact of agriculture, and on the role of scientists in making science policy. In conclusion, the interviewees appeared to agree on the research, economic and agronomic practice issues, but diverged on issues of environmental impact, sustainability and policy.

The fact that most interviewees listed farmers as their primary target was the motivation for the next chapter of the thesis; surveys of farmers.

6. FARMER PERCEPTIONS

Since farmers are the ultimate adopters of biotechnology and thus control the impact of these technologies once the are commercialized, an analysis of the role of biotechnology in agriculture would be incomplete without an attempt to characterize these users. I surveyed farmers in the Peace River region of Alberta and British Columbia to answer the research questions listed in Figure 6.1.

1. Do farmers follow recommended practices for growing canola?

2. What sources of information do farmers base their farming decisions on?

3. What are farmers attitudes towards biotechnology research priorities and herbicide tolerant canola?

4. What do farmers see as priorities or requirements for sustainable agriculture in the future?

Figure 6.1: Research questions framing the mail survey to farmers.

Research question one is important in terms of predicting the environmental and economic impacts (and thus sustainability) of new technologies, such as biotechnology. If farmers are not using recommended agronomic practices, the impact of the technologies will be different than those estimated by environmental assessment protocols. With research question two, I was attempting to identify which sources of information about agronomic practices farmers trust most (this is especially relevant if farmers are not following recommended practices). With questions three and four, I was trying to determine if farmers think biotechnology is essential for their long term sustainability, or if they would suggest alternative means.

The survey was developed, in part, by reviewing other farmer surveys in Alberta and elsewhere to identify types of questions (University of Nebraska: Agricultural Producers Opinions and Production Practices Related to Water Quality Issues, 1989; University of Georgia, Farmer First Project: Participatory Sustainable Agriculture Interviews, 1993; Alberta Agriculture, Field Crops Branch, Canola Production Survey, 1982 and 1993). The first draft of the survey was tested on University researchers and subsequently revised. The survey was then taken to the Peace River region for further review by district agriculturists and farmers. A final, revised version of the survey was sent out to 931 canola producers in the Peace River region of Alberta and British Columbia in November, 1994. The survey is more comprehensive than required to answer the research questions posed in the beginning of this chapter. Some of the additional questions represent requests by the survey reviewers and others are present to set the context for the respondents. A complete copy of the survey and a summary coding analysis of the responses to the questionnaire is presented in Appendices 4 and 6. Appendix 5 contains a copy of a summary sent out to respondents in April, 1995. Responses which related directly to the research questions are discussed in detail in this chapter.

Two weeks after the surveys were sent out, reminder cards were sent, and four weeks later, I participated in a radio broadcast which served as a further reminder. 185 complete responses were received, for a response rate of 19.8%[1]. Responses were analysed using

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[1] Survey response rates vary considerably depending on the length of the survey and the target audience (Guppy, 1995). I consider 19.8% a fairly good response, since Statistics Canada routinely gets a response of 8% in this area (Oliver Code, Statistics Canada, personal communication, January, 1995).

descriptive statistics only.

Agricultural conditions and access to information differs throughout canola producing areas. By limiting the survey to an area that was relatively isolated and consistent in terms of conditions for agriculture and distance from large centres, it was hoped that at least some background variation in answers might be eliminated (i.e. in the event farmers in some areas are more informed or have different information sources than those in other areas). Describing 'worst case scenarios' (i.e. where farmers have little access to information) are useful in terms of prediction possible impacts of new technologies (Brunk et al., 1991).

6.1 Following Recommended Agronomic Practices

The responses from the questionnaire were compared with practices recommended in the Canola Growers Manual (CGM) as an assessment of how closely farmers adhered to recommended practices[2].

The CGM doesn't specifically recommend a number of tillage practices, but does mention the need to maintain a minimum trash cover for erosion protection. (CGM, p 701-717). Respondents performed an average of 1.3 tillage operations in the fall and 1.9 in the spring. Seventy percent of respondents had decreased the number of tillage operations they perform in the last five years.

The CGM recommends a soil test for nitrogen and sulphur annually and phosphorus and potassium every three or four years (CGM, p 903). However, only 36.5% of respondents

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[2] The Canola Growers Manual was written by Phil Thomas, Supervisor of Oilseeds Crops, Alberta Agriculture and published by the Canola Council of Canada. The manual is updated yearly.

had their soil tested yearly, another 18% every second year and 31.5% every three years or more, or occasionally. Fourteen percent said they never had their soil tested. Most farmers who did have their soil tested sent it to fertilizer companies (46.8%), or to government labs (40%). The remainder sent their samples to a private lab (12%) and two respondents said they tested the soil themselves.

Most respondents inspected their fields weekly for pest problems (71.8%) or monthly (22.7%). Checks for pests, especially early in the growing season are recommended in order to enable treatment before the problem becomes too severe.

Forty percent of farmers used at least some common seed, 9.2% used common seed exclusively. The majority of farmers who used common seed indicated that they had their seed cleaned (99%), noticed no yield losses (93%) and always used blackleg tested seed (90%). The CGM recommends that only certified seed be used for commercial canola production in order to maintain quality (genetic purity) and to ensure that the seeds are weed and disease free (p 802).

Recommended rates of seeding for both *Brassica napus* (Argentine) and *B. rapa* (Polish) varieties in the Peace River region are 5-8 lbs/acre (5.6-9 kg/ha)[3].

Table 6.1 shows the rates of seeding for the two canola varieties. The majority of farmers seeded *B. rapa* at 5.6-7.8 kg/ha (41.5%), or 7.8-10.1 kg/ha (39%). 42% of farmers seeded *B. napus* in the 7.8-10.1 kg/ha range and another 35% of farmers seeded *B. napus* at

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[3] However, Jeannie Bisson from the Smoky Agricultural Research and Development Association commented that they recommend 9-11 lbs/acre for Argentine varieties (personal communication, June 9, 1994).

10.1-12.3 kg/ha, which is higher than the 5.6-9 kg/ha range recommended by the CGM.

Table 6.1: Rates of seeding for *B. napus* and *B. rapa.*

kg/ha *B. rapa*	# of farmers	kg/ha *B. napus*	# of farmers
<5.6	16	<5.6	1
5.6-7.8	66	5.6-7.8	17
7.8-10.1	62	7.8-10.1	34
>10.1	15	10.1- 12.3	28
		>12.3	1
Respondents	159	Respondents	81

The CGM (p 1049) recommends that canola be grown only once every four years in order to prevent buildup of diseases in the soil, particularly blackleg *(Leptosphaeria maculans*). Farmers were asked to fill in what they had grown on a canola field in the last four years and what they planned to grow in 1995. Eighty five farmers grew canola more than once every four years and an additional eleven indicated that they intended to grow canola in 1995 (after growing it in 1994). Since canola prices were still high in 1995, it is possible that more farmers would decide to grow canola again in 1995. The Alberta Canola Producers Commission cautions against this possibility (ACPC, 1994, p 1):

> ... and whereas it is inevitable that in many areas of Alberta, canola producers will shorten cropping rotations. Shorter rotations may have a short term economic benefit to farmers, however the long term economic effect of a short rotation could wipe out canola production and annihilate the canola industry in Canada.

Mean values for amount of fertilizer added (for those who did add some fertilizer) were: 79.3 kg/ha nitrogen (n=175), 31.6 kg/ha phosphorus (n=147), 20.1 kg/ha potassium (n=98) and

11.6 kg/ha sulphur (n=134). The CGM comments that a canola crop yielding 1960 kg/ha will contain 118 kg/ha nitrogen in the above ground portion of the plant (average yields in the Peace were 1339 kg/ha). Since farmers in the Peace are only adding an average of 79.3 kg/ha, this may be a yield limiting factor. The CGM also indicates that in field trials, highly economical yield responses have been obtained using up to 134 kg/ha nitrogen. A 1960 kg/ha canola crop would also contain 52 kg/ha phosphorus, 93 kg/ha potassium and 23 kg/ha sulphur. Phosphorus and potassium levels are more stable in the soil, and are fairly accurately reflected in soil tests[4] (CGM, p 933). The Peace River region is identified as an area of sulphur deficiency (CGM, p 935). Maximum responses to sulphur fertilizer occur at 20-25 kg/ha (CGM, P 936). Twenty one percent of respondents indicated that they added no sulphur and the remaining seventy nine percent added an average of 11.6 kg/ha therefore, sulphur may also be a yield limiting factor.

Fifty four percent of 144 respondents (who did soil tests) indicated that they added fertilizer in equal amounts to that recommended by their soil test, twenty six percent added more and twenty percent added less.

The above summary of responses to questions about management practices, indicate that, in several instances, farmers do not follow recommended practices. The most striking instances are in terms of frequency of soil testing, the use of common seed and frequency of canola in a crop rotation. This finding is significant in terms of predicting impacts of new agricultural technologies (since studies are carried out in field trials) and may explain why

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[4] Without knowing the results of individual soil tests, its impossible to determine if farmers are actually adding adequate amounts of phosphorus and potassium.

some field crops behave differently in field trials than they do when being grown on a large scale commercially. For example, Lutman (1993) comments:

> As it is clear from practical experiences that rape seeds do persist in sufficient numbers to cause problems in subsequent crops, my experiments are not, in general, reflecting what happens in practice.

Lutman is admitting that his experiments are not emulating what is known to occur in the field. He goes on to identify three possible reasons why this is so; low survival of seeds is adequate to cause problems, environmental conditions experienced by seeds in the experiments did not replicate those in the field or conditions in the years which the experiments were conducted were different (Lutman, 1993). This experiment represents just one example of a failure of experimental results to match those seen in practice. If this phenomenon is more widespread, it may explain the farmer's mistrust of extension information. Crawley (1995) also comments on the paradox presented by rapeseed growing in undisturbed areas when it is extremely difficult to establish rapeseed in these types of areas experimentally. These experiments indicate that more research needs to be done on conditions in the field. Environmental assessments performed in field trials are not necessarily applicable to practice.

6.2 Basis for Decision Making/ Most Trusted Sources of Information

I attempted to identify some reasons why farmers do not always follow recommended practices in several questions relating to sources of information on agronomic practices.

Respondents were asked to rank reasons for choosing specific agronomic practices.

The order of the responses in Table 6.2 reflects the frequency in which an answer was

Table 6.2: Basis for decision making regarding agronomic practice listed in order of frequency chosen or ranked.

Tillage	**Fertilizer addition**	**Pesticide use**
Economics	History of the field	History of the field
Water management	Anticipate higher net returns	When pests become a problem
Erosion control	Cash flow limitations	Opinion/experience
Experience	Health of the crop	Anticipate higher net returns
Soil temperature	Dealer recommendations	Crop protection guide
Pest management	Don't add any	Based on predictions of pest problems
Extension agent recommendations	Extension agent recommendations	Cash flow limitations
		Pesticide company representatives
		Government Extension agents
		Advertising

chosen. Thus, the response at the top of the column was chosen most frequently, and that on the bottom, chosen least.

Most of the top reasons for making decisions either directly or indirectly refer to the farmer's experience. For example, choices like; history of the field or anticipating higher net returns both reflect experience. Government extension agents are chosen the least in terms of information about tillage and fertilizer addition and only above advertising for pesticide use. A later question asked respondents to indicate their main sources of information about

1. Experience
2. Farm papers
3. Neighbours/ friends/family
4. Canola Production Centres
5. Canola Growers Manual
6. Agribusiness agrologists
7. Government extension agents
8. Agriculture Canada or University researchers

Figure 6.2: Sources of information most frequently ranked in the top four choices.

agronomic practices in general. Figure 6.2 shows the frequency with which sources of information were ranked in the top four choices. The order of the top information sources is consistent with the answers to the questions regarding decision making for tillage, fertilizer and pesticide use. Experience is most frequently chosen as the most important source of information about agronomic practices. Again, provincial government extension agents are not frequently ranked as important sources of information, ranked only above Agriculture Canada or University researchers, who do not have a specific extension mandate (Canadian Agricultural Research Council, 1987, p 2). Canola Production Centres and the Canola Growers Manual are both sponsored by the Canola Council of Canada. These sources of information ranked above both agribusiness and government sources which may indicate that the Canola Council has more influence on management practices than the government or directly by the industry[5].

The poor performance for government extension agents echoes earlier findings in Alberta from a survey of farmers about new biotechnology products (Klein, et al.,1994):

Government extension agents, although rated as an important source of information,

[5] It is impossible to conclude that the Canola Council does in fact have a significant influence on agronomic practice at the farm level from this questionnaire. However, if the CCC does affect agronomic practices, their influence would extend from the national government level, through research and development to what is done on the farm.

were given the lowest of the performance ratings; comments included "not very useful" to "almost useless".

Chemical company representatives were rated slightly higher both as importance as a source of information and in terms of performance. Klein et al., (1994) also found that other farmers were rated as the most important source of information.

These findings make it difficult to predict how farmers will manage new products of biotechnology and thus what impact (ecological and economic) these products will have on agriculture and agricultural ecosystems. Experience and information from other farmers is less likely to be useful in helping to deal with new products.

The importance of getting information to farmers about new products and management practices was brought up by a public sector researcher during the interview. The researcher said that the introduction of the new varieties would need to be followed by very "strict" education, implying that the new varieties are more complex to manage than the varieties currently in use (see chapter five). In addition, in their decision documents regarding the approval of transgenic canolas, AAFC (Directive 94-08, 1994) comments:

> A longer term concern, if there is general adoption of several different crop and specific herbicide weed management systems, is the potential development of crop volunteers with a combination of novel resistances to different herbicides. Therefore, agricultural extension personnel, both in the public and private sectors should promote careful management practices for the growers who use these herbicide tolerant crops, to minimize the development of multiple resistance.

However, neither of these sources comments on how the necessary information would be disseminated to farmers who are clearly not impressed with government extension as a source

of information and who may not use recommended practices. Determining how a product is likely to be handled by growers could be crucial to carrying out an environmental assessment of new products.

6.3 Attitudes Towards Biotechnology Priorities and Herbicide Tolerant Canola

Respondents were asked several questions about what research priorities they would identify for research on new canola varieties and their opinions on herbicide tolerant canola. The choices most often ranked in the top three for developing new canola varieties were disease resistance, yield, plants requiring less inputs and plants with herbicide tolerance. Disease resistance was ranked in the top three almost twice as often as plants requiring less inputs and herbicide tolerance, perhaps reflecting a concern about blackleg[6].

The choices that were ranked the least often in the top three were saline tolerance, increased protein content, plants that produce alternative products, insect resistance and oil content. The low ranking of the insect resistance and saline tolerance probably reflect the fact that these are not major problems in this region (CGM, p 602). The low ranking of protein and oil content is interesting given that these are two of the requirements seen as most important in terms of registering a new canola variety (see chapter four).Also, the Canola Council stresses protein and oil content as one of their primary goals:

> Increasing the sum of oil plus protein produced per acre by increasing oil content in canola seed, increasing protein content in canola seed and increasing yield of canola per acre (CCC,1995).

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[6] The interest expressed in disease resistance belies the finding that many farmers do not use appropriate rotations designed to control blackleg.

In addition, one of the speakers from the Japanese Oil Processors Association at the CCC's annual general meeting in 1995 (Fujiwara, March 6, 1995) indicated that the oil plus protein content of crops over the last few years has been insufficient. The apparent lack of interest by respondents in these quality characteristics may indicate that they feel unconnected to the buyers or consumers who are demanding these characteristics. In terms of producing plants with alternative properties, it may be that since these plants are currently still experimental, farmers have little information about them.

6.4 Requirements for Sustainable Agriculture in the Future

Respondents were asked whether they agreed or disagreed with a series of statements describing requirements for sustainable agriculture (Table 6.3).

Respondents agreed most strongly with higher farm gate prices, improvements in the stability and level of farm income, increased self sufficiency of farms, and fewer government regulations. Respondents were, on average, primarily neutral in terms of

stricter guidelines on environmental protection, economic incentives from the government for environmental protection and more protection of wildlife habitat. The remainder of the choices had an average of between 2 and 2.8, in the agreement range (including genetically engineered crops). From these results, it appears that farmers are defining sustainable agriculture primarily in terms of improving economics rather than environmental aspects which echoes the prevailing government and industry view.

In the last part of the survey, respondents were asked in an optional question, what

Table 6.3: Average responses to requirements for sustainable agriculture in Canada (1 signifies strongly agree and 5, strongly disagree).

Sustainable Agriculture Requires:	**Mean**
1. Increased yields	1.98
2. Increased self sufficiency of farms	1.64
3. Better conservation of the soil and water resources	2.09
4. Reduction in use of agricultural chemicals	2.48
5. Increased energy efficiency	2.12
6. Agricultural systems which resemble natural ecosystems	2.80
7. Increased access to information for farmers	2.10
8. More protection of wildlife habitat	2.92
9. Stricter guidelines on environmental protection	3.12
10. Economic incentives from the government for environmental protection	3.04
11. Improvements in the stability and level of farm income	1.58
12. Higher farm gate prices	1.23
13. Fewer government regulations	1.83
14. Rejuvenation of communities in rural areas	2.11
15. Genetically engineered crops and livestock	2.71

they thought were the most pressing problems in agriculture today. Thirty seven respondents wrote in answers. The responses were categorized into themes (Figure 6.3). A few quotes, which covered several themes are presented below.

Many farmers listed rising input costs and low farm gate prices and the effects these were having on agriculture as major problems:

> Small farms (under 1000 acres) are disappearing in our area along with rural communities. Large corporations are taking over agriculture and are not as efficient as small farms thus taking advantage of any government program available. All companies,

> including cooperatives charge higher prices to smaller producers making it difficult to be efficient.

- Government regulations/ costs of government
- International competition/ Free Trade/ Canadian dollar
- Costs: inputs, machinery and fuel, startup, taxation, transportation
- Farm gate prices too low, low price food policies
- Special interest groups and media influence, uninformed decision making
- Research and development: poorly directed and conceived, controlled by multinationals
- Need more natural systems and less chemical use
- Need a stable and affluent farm community to encourage young people to go into farming
- Poorly conceived and administered crop insurance and other programs, farmer dependance on programs
- Need more local processing, too many middlemen involved
- Urban encroachment
- Climate risks
- Financing problems
- Farmers need to be more flexible in marketing, get rid of Canadian Wheat Board

Figure 6.3: Categories of the most pressing problems in agriculture identified by respondents.

One respondent described in more detail what effect higher farm gate prices would have in terms of sustainability of farms and rural communities:

> Higher farm gate prices would negate the need for insurance, subsidies and would give the farmer room for better conservation practices. An affluent farm family community would take care of the direction of plant breeding, herbicide use and conservation planning needs. Higher farm gate prices would keep most younger farm families together on the farm during the winter and the marketing and courses offered would be attended in full. In a few years you would have a better informed farm group.

As mentioned above in the section on requirements for sustainable agriculture, respondents were primarily neutral in terms of environmental protection measures. The following quote gives some insight into why some farmers may not be very supportive of environmental

initiatives:

> I would like to say that in my opinion, environmentally sound agricultural practices are extremely desirable but also will not contribute to sustainable agriculture in Canada, in fact will be the death of agriculture in Canada unless global agriculture is forced to adopt the same practices.

The preceding quote refers to the negative economic effects of environmentally sound economic practices, practices, particularly when farmers must compete in a global market. Respondents referred to unfair world subsidies as one of the reasons they were having difficulty competing. Several farmers referred to multinational control over Canadian farmers as one of the major problems facing agriculture and referred to their involvement in producing genetically engineered crops. For example:

> Multinational corporations (mainly from the US, i.e. Monsanto, Dupont) controlling genetically engineered crops as well as government regulations to meet their agenda and not the agriculture industry needs.

> Also the impending genetic engineering marvels which will not make any more money for the farmer but will generate windfalls for the companys (sic) developing them as any improvement in yield or other aspects will have a cost attached that will bleed off any economic gains.

The results of this survey indicate that many farmers are not following government or industry recommended agronomic practices, in part because they do not trust industry or government as sources of information. Although most farmers felt that herbicide tolerant canola would reduce their input costs, they were neutral about the necessity of genetically engineered crops and livestock for agricultural sustainability. I suspect this is due, in part to the belief reflected in the last two quotes; that any improvements in income would be

captured by the companies developing the products. Like the researchers interviewed in chapter five, farmers most strongly agreed with improvements in economics (as opposed to environmental measures) as important contributors to sustainability. Farmers would likely respond positively to initiatives to improve sustainability (i.e. related to the sustainable agriculture criteria listed in chapter two) only if they felt that it would not compromise the economics of their farm operation. This viewpoint is consistent with that expressed by the researchers and AAFC in their documents.

In general, farmers do not seem optimistic about their future in farming, or the future of farming in general. Only sixty percent of farmers felt that they netted enough in 1994 to sustain their farm, in a year with good yields and high prices. The farmers responding to this survey seem to feel that genetically engineered crops will maintain the status quo in terms of economics.

7. SUMMARY AND DISCUSSION

This chapter begins with a brief overview of the main findings of the thesis and discussion of the major implications of these findings for the implementation of sustainable agriculture in Canada. In the final section, alternative approaches to assessment, policy and regulation of sustainability and biotechnology are proposed.

7.1 Summary of Findings

In this thesis, I addressed the research question: *Will agricultural biotechnology, as currently promoted and developed in Canada, have a negative impact on our progress towards sustainability?* The specific research objectives were: To assess agricultural sustainability and biotechnology policy in Canada against sustainability criteria developed from a synthesis of the literature; to characterize and assess the process by which new canola varieties are registered in terms of a multi-stakeholder process and incorporating the criteria for sustainability; to examine the impact of the implementation of agricultural and biotechnology policy, through review and analysis of the process of variety registration on research and development in canola; to evaluate the user environment into which biotechnology is being introduced; and to make recommendations that could result in the incorporation of sustainability into agriculture and biotechnology research and development. These objectives resulted in a study involving different levels of analysis including policy, process, research and development, and farm level impact.

The thesis began with a description of agriculture in Canada at present and concluded

that Canadian agriculture has not been successful in terms of addressing environmental, social or economic problems. Productivity has increased at the cost of environmental degradation, financial problems and emigration from rural areas.

Chapter two contained an analysis of alternative views of sustainable agriculture in the literature which resulted in the development of a conceptual framework describing approaches to sustainability (Figure 2.1) and sustainability criteria. Perceptions of sustainability were divided into growth-oriented vs conservation-oriented emphases. The sustainability criteria were organized into four general areas (within a conservation-oriented emphasis); long term maintenance and preservation of the natural resources which support agricultural production, a more independent agriculture, a more socially responsive approach to policy making and a more socially just agriculture. These criteria were used to assess AAFC agricultural policy in terms of contribution to biotechnology.

AAFC documents referred to some or all of the sustainability criteria listed above. However, most documents, particularly the most recent ones, are committed to a growth-oriented economic emphasis, which relegates environmental and social concerns to secondary status. The growth-oriented approach affects research, development, policy making and even their public involvement attempts. For example, a consulting company was hired to produce a business plan for AAFC for the 21st century (KPMG, June 1996). The consultants produced a document, based on prior consultations, for further public comment. Common industry needs are listed under; opportunities for growth, barriers to growth and action planning. The strategy for action includes market development, research and development to meed market needs, competitiveness and effective government. No mention is made of the

environment or sustainability.[1] Thus public involvement in policy making is constrained by the pre-determined pro-growth emphasis on economics (see scope criterion in discussion of public involvement below).

AAFC is actively pursuing biotechnology through policy, research and development and fiscal action. In published documents, AAFC stresses that biotechnology has the potential to produce more benefits for agriculture than possible costs (environmental and economic). AAFC's policy on sustainable agriculture (focussing on competitiveness and economic growth) are compatible on the surface. However, I believe that biotechnology is unlikely to contribute to competitiveness or economic growth. Since most of the companies developing herbicide tolerant canolas (and other crops) are multi-national, any product they develop would likely be commercialised in other countries with the ability to produce the product. Therefore, Canada would not have a competitive edge. Several of the herbicide tolerant canolas have a technology fee associated with them (around $15/acre: Ken King, Alberta Agriculture, personal communication, July 8, 1996), which offsets the economic benefit to farmers from reducing the amounts of herbicide they use. The use of herbicide tolerant canolas is predicted to increase yields only in very heavy weed situations, where farmers also have the option of growing another crop that is able to out-compete the weeds (Ken King, Alberta Agriculture, personal communication, July 8, 1996).

The concurrent promotion, regulation and production of biotechnology by AAFC raises the question of a conflict of interest: *Is a Department that strongly supports a*

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[1] I know that the original consultations contained at least one submission relating to agricultural sustainability, I sent it in myself in December 1995.

particular technology in principle, and financially, and which is actively involved in developing biotechnology products, the most appropriate Department to regulate biotechnology? This question may have been one of the motivating factor behind the recommendation of a national standard for biotechnology regulation (Standing Committee on Environment and Sustainable Development, 1995)[2].

The secrecy surrounding AAFC's environmental assessment process makes it difficult to assess whether the environmental impact of herbicide tolerant canolas has been adequately assessed. The risk of spread of transgenic crops (invasiveness) into other environments is one of the criteria in the environmental assessment of Plants with Novel Traits directive. Most experiments reported in the literature dealing with invasiveness of transgenic canolas are designed to compare new varieties with older canola varieties. Crawley et al. (1993) concluded that transgenic canola was no more invasive of natural or disturbed habitats than its predecessors. However, canola has been reported to cause problems in subsequent grass crops (Kirkland, 1993). Canola can also survive permanently in areas like highway verges. For example, Crawley and Brown (1995) comment:

> Feral populations of oilseed rape represent something of a paradox. Yellow drifts of flowers are a characteristic feature of motorway verges in early spring. However, it is extremely difficult to establish oilseed rape populations by sowing seeds into established vegetation and populations which are experimentally established on disturbed ground tend to go extinct after only a few years.

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[2] This issue has not yet been resolved, even though the government's response was that such a standard was not necessary (Government of Canada, 1995). The Standing Committee has held a further two sets of hearings in June and October, 1996 which dealt the development of a standard or a single set of biotechnology regulations (W. Leiss, personal communication, October, 1996).

Given Crawley and Brown's findings about the persistence of canola in disturbed habitats and the fact that volunteer canola can be a significant problem in subsequent crops, a more appropriate question would be: *Given that canola can be a weed in agricultural and disturbed habitats, what are the consequences, or risks associated with that plant being herbicide tolerant?*

In their Decision Documents approving commercialization of herbicide tolerant canolas, AAFC concedes that there is a risk that transgenic canolas will breed with wild relatives and pass on the transgenes, but applicants for the environmental assessment process were not required to submit information on the consequences of this gene transfer. AAFC has not published any studies which address this issue. Research is needed to address the question: *What are the consequences of transgenes like herbicide tolerance being present in related weeds?*

The fact that these questions have not been asked by AAFC or canola researchers in Canada, may be the result of values or beliefs held by the researchers. If one believes that crop plants are never weeds, or works from the fundamental premise that the chance of canola transferring genes to weeds is negligible, then the above questions will not even be asked.

These gaps in the environmental assessment process for herbicide tolerant plants, coupled with the complete lack of economic impact assessment, lead me to conclude that the impacts of these crops have not been adequately assessed. AAFC's support for biotechnology in general and the preponderance of industry involvement in the evaluations of efficacy of canola varieties may have contributed to the inadequacy of the assessment.

Public involvement criteria were developed in chapter two and applied to the case study of canola variety trials and registration in chapter four. Public involvement is essential for supporting a move towards a more socially responsive approach to policy making. Forms and methods of public involvement were discussed, and criteria for assessing a successful process put forth. The criteria for public involvement related to: The degree of power sharing between elected representatives and the public; determining who is allowed to participate and whether everyone in the process has equal legitimacy; whether access to resources, including time, money, institutional support, and expertise, are comparable for participants; the stage of decision-making that the public is being involved in; and the scope of the process (what kinds of issues are being considered).

The process was evaluated as an example of a multi-stakeholder process for technology assessment. AAFC no longer participates directly in the process of determining criteria for new canola varieties (other than in an observer role), instead, they have effectively ceded authority to industry interests as represented by the Western Canada Canola and Rapeseed Recommending Committee (WCCRRC). As a result, the variety testing and registration process has been structured to select for the development and commercialization of varieties meeting a very narrow set of criteria, which are suited to high chemical input agriculture. The WCCRRC and CCC share AAFC's pro-biotechnology perspective, as evidenced by their decision to give genetically engineered herbicide tolerant plants extra points to ensure that they met the criteria for commercialization. The promotion of biotechnology and herbicide tolerant canola varieties will not improve long term preservation of resources and may result in a reduction of genetic diversity of crops if adoption is high,

Table 7.1: Assessment of the process for variety registration and recommendation trials.

Criteria for assessing a consultative process	**Performance of the process for variety registration and recommendation trials**
Decision-making agencies are obligated to incorporate the results of participation into decisions, but retain ultimate authority.	The process meets this criteria. AAFC rarely rejects the recommendations of the WCCRRC.
For broad policy discussion, all interested members of the public should be allowed to participate. For continuity, ongoing decision-making processes require the identification of appropriate stakeholders which represent those affected by the decisions made and are willing to commit to the process.	The process does not meet this criteria. Membership in the WCCRRC and hence participation in the process, was rigidly defined by AAFC. This process is an ongoing decision-making process. Other stakeholders can attend the meetings, but there is no mechanism to allow for their participation.
The minimum resources required for participation should be provided to all participants by the agency involved.	The process does not meet this criteria in terms of who can bring a new crop through the process due to the implementation of cost recovery by the CCC. Smaller or local developers will be at a disadvantage.
The public should be involved both at the early stage of policy development and later on, at the technology assessment stage.	The process studied is at the Technology Assessment stage. At the policy development stage, the CCC acts in concert with AAFC, effectively excluding alternative viewpoints.
Involving the public at both policy development and technology assessment stages should ensure that the scope of the issues addressed is very broad: including social, environmental and economic considerations.	The process does not meet this criteria. The process concentrates on quality and yield criteria, which are of primary importance to processors and exporters (and farmers to some extent). Net income, social and environmental parameters are not considered.

maintains agriculture's dependance on outside inputs and negatively impact net income. The multi-stakeholder process is one of public involvement in technology assessment. Table 7.1 summarizes the performance of the variety trials and recommendations process against public

involvement criteria.

Some of the public involvement criteria listed in Table 7.1 were met by the process or variety trials and recommendation. Those that weren't included; who is allowed to participate and who has access to the variety trials on an economic basis. The process is biased towards industry interests and discourages research and development of canola varieties, which could meet sustainability criteria.

Research and development of new technologies and management practices is required to support a transition to a more sustainable agriculture in Canada. Chapter five presents the results of interviews conducted with members of the biotechnology research and development community in order to identify their attitudes towards the role of biotechnology in agriculture. For some issues, respondents answers were consistent with findings in chapters three and four regarding government and industry approaches towards biotechnology and agriculture. For example, respondents gave economic justifications rather than environmental (or sustainability concerns) as a motivation for doing their research. Most respondents felt that public and private research goals did not necessarily have to be different. This response is not surprising in light of the government's increasing emphasis on industry/public sector collaboration and industry led research. In some respects, public agricultural research is performing in a consultancy role for industry in Canada.

In terms of the role of biotechnology in agriculture, a surprising number of respondents implied that biotechnology would have little impact on agriculture in Canada. In particular, several respondents indicated that biotechnology would not increase environmental impact or the amount of monoculture (i.e. wouldn't make the situation worse).

Most respondents felt that Canada would produce more food in the future, but not to give away as food aid. Mention was made of helping developing countries get to a level where they could afford to buy products. Opinions on the environmental impact of agriculture at present ranged considerably, from the position that agriculture makes a positive contribution to the environment, to the position that agriculture is devastating. Interestingly, most interviewees defined sustainability in agriculture primarily in terms of environment or the resource base and our ability to maintain levels or production, rather than economically. However, several referred to economic and social aspects also. There is an apparent contradiction between the economic motivations for research and the primarily environmental definitions for sustainability. Researchers may feel that their research is unconnected to sustainability, which may reflect the lack of an integrated approach to research goals.

Respondents differed in their opinions of the role that scientists should play in developing science policy (ranging from consultation only to active participation). However, most felt that the public should not play a direct role in policy making and commented on the public's lack of education and fear of biotechnology.

In general, responses supported a growth-oriented approach to agriculture. A belief in the importance of long term preservation of resources was mentioned in most definitions of sustainable agriculture. Respondents were not supportive of a more independent agriculture in terms of inputs, or a more socially responsive approach to policy making, particularly with regards to public involvement. Several expressed concern about net income of farmers, or financial hardships faced by farmers. Some sustainability criteria were considered important

by researchers, others were not, or were explicitly rejected.

In chapter six, one subgroup of the public, farmers, were surveyed to address four research questions: Do farmers follow recommended practices for growing canola? What sources of information do farmers base their farming decisions on? What are farmers attitudes towards biotechnology research priorities and herbicide tolerant canola? What do farmers see as priorities or requirements for sustainable agriculture in the future?

The main findings of the survey were that farmers often do not follow recommended agronomic practices when growing canola and that their most important, trusted sources of information are their own experience and other farmers. Trust in government sources of information was extremely low.

If AAFC did commit to undertake a study of the possible environmental and economic impacts of herbicide tolerant canolas, they would have to begin by identifying actual, as opposed to recommended practices. As pointed out earlier, field trials and experimental conditions often do not mimic practice (Crawley and Brown, 1995; Lutman, 1993).

Farmers were somewhat ambivalent about the contribution of herbicide tolerant canola or biotechnology to sustainable agriculture. Overall, comments provided by respondents at the end of the survey indicated that farmers are fairly pessimistic about the future of agriculture in Canada.

Herbicide tolerant canola (and canola biotechnology in general by extension) and the process by which these varieties are evaluated contravenes several of the criteria for sustainability and public involvement outlined in chapter two. In particular, high adoption of

a few varieties will reduce crop diversity, dependance on off-farm inputs is maintained, local agricultural research and development is discouraged unless it produces similar varieties, the public is not consulted (only a narrowly defined public) and the impact of these varieties on net income or environment has not been addressed. The process is open to industry interests only and has a very narrow scope.

Thus, at present, the development and introduction of biotechnology in agriculture is incompatible with sustainability. In the final sections of the thesis, I will describe some alternative policy and technology assessment frameworks or models for new technologies in agriculture that have been suggested in the literature.

7.2 Alternative Models for Incorporating Public Involvement into Policy Development and Technology Assessment

The current policy and regulatory system for new technologies in agriculture is failing to address sustainability issues. There are two levels at which sustainability should be addressed; as a broad direction for economic, agricultural and scientific efforts in general and at the technology assessment stage (Busch, et al., 1991). The general policy stage is an *ex ante* stage and therefore important to address in addition to the *ex post* stages of technology assessment and regulation. In support of an *ex ante*, and also an institutional assessment of implementation of sustainability, Busch, et al., (1991) comment:

> ...as we have suggested above, the adequate assessment of any technology also demands the assessment of the institutional structures that have led to its creation, promotion, adoption and development in the first place.

In general, the public has not been included in the process of policy development with respect to sustainability and biotechnology in Canada, beyond the occasional call for public comment. The two levels at which sustainability should be considered in the development of new agricultural technologies (and new technologies in general) and how the public can become involved are discussed below.

7.2.1 Involving the Public in Policy Development Through Consensus Conferences

Busch et al., (1991) outline some if the assumptions underlying US agricultural policy that may work against sustainability (Figure 7.2). These assumptions are also implicit in Agriculture and Agri-Food Canada's position on the future of agriculture. For example, AAFC's support of biotechnology implies that they also operate under assumptions two and three in Figure 7.2[3]. Changes in these fundamental assumptions about the nature of scientific progress and its contribution to agriculture are required to implement sustainability as outlined in this thesis. Some of the fundamental questions surrounding these assumptions that should be addressed by AAFC include: *Is growth in agricultural productivity through the application of*

1. The economic system will progress in beneficial ways according to market processes under the watchful eye of the government.

2. Agricultural productivity and food security will result from the successful introduction of more science into agriculture.

3. Scientific progress mandated by market and governments will generate technologies that contribute to prosperity and abundance.

Figure 7.1: Assumptions underlying United States agriculture policy (from Busch, et al., 1991, p 223).

[3] The use of the word 'science' in the second assumption of Figure 7.2 could also encompass the science of organic agriculture. However, AAFC has equated the use of science in agriculture with biotechnology.

technology in Canada in the public interest? Is this growth compatible with sustainability? and is promoting technology without regard for the possible social and economic effects appropriate for government? For example, Gloede (1995) comments "The uncertainties of a new technology may not be off loaded onto society unless these is a real need for this technology". Identifying social needs and priorities for sustainability require the involvement of the public in setting policy objectives for research and development of new technologies.

1. A well-balanced Steering Committee is chosen by government.

2. The Consensus Conference is advertised in the press.

3. Interested applicants submit a one page letter explaining why they are interested in participating. Applicants are screened in an effort to represent demographics and to ensure that they lack significant prior knowledge or specific interest in the topic, and a lay panel is struck.

4.The government prepares a background paper on issues it wants the lay panel to address.

5. The lay panel reads the report and develops questions based on the issues raised.

6. The government establishes a panel of experts (scientific, social, ethical, informed members of stakeholder groups, etc.) who formulate concise answers to the questions raised by the panel.

7. The panel considers the expert's contribution and develops position statements on issues that it was able to arrive at a consensus on and point out areas of disagreement. In Denmark, this report is publicly released and widely debated in government funded forums.

Figure 7.2: Outline of Consensus Conference process (Sclove, 1995; Seecharan, 1995).

Consensus Conferences (CC) are a model for a more allowing public input into policy development that have been used in Europe. In Denmark, Consensus Conferences have been

used on topics ranging from genetic engineering, to educational technology, food irradiation, sustainable agriculture and the future of automobiles and the output has been used in Parliamentary debate on policy (Dughan, 1994; Sclove, 1995). Consensus Conferences have also been conducted on genetic engineering in the Netherlands, and the UK (Dughan, 1994; Sclove, 1995; Seecharan, 1995). The basic process for the development of a consensus conference is outlined in Figure 7.3. There are several advantages to a Consensus Conference process over other public involvement processes. The involvement of a lay public, rather than those with prior interests serves to make the process more objective, and perhaps more credible. In addition, the educational component of the process serves to educate society at large in addition to the lay panel.

Consensus conferences are useful when the issues are complex. In theory, issues would be addressed by a CC before they became too contentious and polarized. The purpose of involving a lay public rather than interest groups is based in the assumption that engaging a wide range of lay people holds the potential to build a broader constituency of public support (Sclove, 1995). Sclove (1996) comments that issues that are intermediate in scope are most suitable for a CC :

> ...broader than assessing the toxicity of a single chemical, for instance, but narrower than trying to formulate a comprehensive national environmental strategy.

Randolph Seecharan, an employee of the Policy Branch of AAFC presented the UK experience with the Consensus Conference model to employees from AAFC, Industry Canada, Fisheries and Oceans, the National Round Table on Environment, Health Canada, Environment Canada and the Canadian Institute of Biotechnology in February, 1995

(Seecharan, 1995). Participants in the conference organized by Mr. Seecharan were ambivalent to the CC idea and generally felt that it would not work in Canada (R. Seecharan, personal communication, June 1996). The main criticisms raised were;

1. The CC process is only appropriate in countries with a homogenous population.
2. The CC process is costly and time consuming.
3. There are credibility problems, particularly with the selection of the lay panel.
4. Recommendations were not linked to parliamentary debate (in the UK experience).
5. The agri-food industry was suffering from 'consultation fatigue'
6. It is more appropriate to conduct CC when a technology was in its early stages.
7. Putting interest groups around the table may work better.

The CC approach has many attributes that could address issues raised in the thesis, and most of the criticisms listed could be addressed fairly easily by modifications to the CC process to make it more workable in Canada. For example, regional CC's could be conducted to address the concern about the lack of homogeneity in our population, or they could be modified to ensure farmers and farm groups are represented. Also, although some sectors of the agri-food industry may be suffering from consultation fatigue, this probably represents groups that have participated extensively in the past (like the Canola Council for example) rather than the general public. The credibility criticism is interesting since several accounts indicate that the papers arising from CC's are reasonable and well thought out (Dughan, 1994; Sclove, 1995; Seecharan, 1995). For example, Seecharan (1995) states: " The lay panel produced an exceptionally measured and balanced report based upon its interpretations of the issues surrounding the questions raised". Biotechnology is in the early stages in Canada, few products have been commercialized. The opposition of the conference participants is not

surprising in the context of this thesis, since the introduction of consensus conferences could provide a powerful (at least in terms of public perceptions) counterpoint to the pro-industry view promoted by AAFC. Consensus conferences represent one model that could be used in Canada to get public input into policies relevant to sustainability. The CC approach would begin at the initial stages, while new technologies are being developed. In addition to public input at the level of sustainability policy, public input into assessment and regulation of technologies that have already been developed is required.

7.2.2 Involving the Public in Technology Assessment

- Technology assessment as a process of problem oriented consultation; technology assessment serves as an intermediary between science and policy
- Technology assessment as a decision-making process for government on technology; a requirement of democratic politics
- Technology assessments as models of social learning in the medium of the general public; an intermediary between science and the public

Figure 7.3: Possible roles of technology assessment (from Gloede, 1995).

Gloede (1995) points out three different ways in which a technology assessment (TA) can be used in society (Figure 7.4). The first and third roles listed in Figure 7.4 are more appropriate to CC's as I have described them and the second role is more suitable to a technology assessment.

Most technology assessments (TA's) are technology induced: "... starting point is an emerging technological development and the analysis focuses on the possible consequences of this development" (van den Daele, 1995).

The Office of Technology Assessment (OTA) in the United States represented one model of a technology assessment process (OTA, 1991). However, established expert committees answered questions posed by government only, therefore the public did not have the opportunity to participate. The OTA was recently abolished in the US (Sclove, 1995).

van den Daele (1995) reviewed a process of technology assessment (TA) of genetically engineered herbicide tolerant crops, which involved the public in Germany:

> The approach taken in this technology assessment is based on the assumption that TA should not merely be a forum of experts at which the state of knowledge on the possible consequences of a technology is presented and evaluated. TA should, in addition, be an "arena" in which the social conflicts related to the introduction of a new technology can be articulated and discussed in an exemplary manner.

The TA reviewed by van den Daele was organized as a technology induced TA rather than a problem oriented approach. A problem oriented approach also involves examination of alternatives to the technology presented, rather than just an assessment of a particular technology (assessment of alternatives would occur during CC's or broader policy discussions). The TA's reviewed were process rather than result oriented, thus serving as a means of social learning rather than developing workable policy or regulatory recommendations. However, TA's could also serve as decision-making processes. The process involving the WCCRRC studied in this thesis is a decision-oriented process. A final report was produced which was intended to produce information about issues related to genetically engineered herbicide tolerant crop plants but is not clear whether this report had any impact on policy or regulation in Germany.

7.3 Conclusions and Recommendations

Implementing sustainable agriculture in Canada will require major changes in the regulatory and institutional environment, particularly in Agriculture and Agri-Food Canada. The current policy, regulatory and institutional environment in Canadian agriculture makes the consideration of sustainability in the development of new technologies unlikely. AAFC's focus on economics and competitiveness in assessing and promoting sustainability and favours industry interests for input into decision-making processes. As a result, some new technologies, such as biotechnology, are specifically promoted over alternative technologies and approaches. Herbicide tolerant canolas, in particular, represent an extension of the input intensive agricultural system (with associated economic and environmental costs) that currently exists.

Interviews of the scientific community and the farmers questionnaire demonstrated that both groups recognized the significance of agricultural sustainability. However, short term economic considerations were the most important issue. The agricultural research community is supportive of research and adoption of biotechnology, while the farming community is more ambivalent. The general consensus appeared to be that biotechnology would not make things worse. AAFC has not adequately assessed the impact of biotechnology in agriculture environmentally, economically or socially, therefore it is difficult to determine the extent and nature of the impact of the introduction of these technologies.

Since government policies, public and private research, and the variety registration

program for new crops (i.e. canola) favours the perpetuation of the current agricultural system, any new biotechnology products will therefore make little contribution towards environmental, economic or social sustainability.

Sustainability represents a new set of priorities and goals for agriculture, which consider long term impacts. These goals encompass a broad range of issues and therefore affect a large number of government policies and stakeholders. The current process of policy development and technology assessment is open only to industry interests. The present system of implementing plant biotechnology policy, at least in the case of canola, is a process which is closed to the general public.

AAFC must develop an action plan for achieving sustainability in consultation with the public. Consensus Conferences were the model proposed to achieve a broadly based consultation. This action plan must provide the guiding principles to all AAFC departments, including Research Branch and the Regulatory Branches (e.g. Food Products and Inspection Branch). The action plan should address the sustainability goals developed in chapter two explicitly and design ways to achieve them, thus directing government spending and collaborative projects on research in agriculture. The technology assessment stage should also involve a broader range of stakeholders than the current WCCRRC and should consider the impact of new technologies on our progress towards sustainability (i.e. broaden the assessment to encompass environmental, social and economic considerations).

Involving the public in policy making and technology assessment would force change on the government from without, which would be considerably faster than waiting for AAFC to change its philosophy and approach from within.

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Appendix 1: Preliminary Analysis of Government Documents Relating to Sustainability.

Sustainability Criteria	**National Agriculture Strategy 1986**	**Growing Together: A Vision for Canada's Agri-Food Industry 1989**	**Growing Together: Report to the Ministers of Agriculture 1990**
General: preservation of resources	✓	✓	✓
Land (urbanization, climate change, etc.)		✓	✓
Soil and water	✓	✓	✓
Genetic diversity		✓	✓
Biodiversity		✓	✓
Less dependance on purchased inputs.		✓	[1]
Self-reliance		[2]	
Public involvement			✓ [3]
Local research and development			✓
Net income	✓	✓	
Safe food and environmental health		✓	✓
Other issues			
Marketing	✓	✓	
Competitiveness	✓	✓	✓
Growth			✓
Education of farmers to change practices		✓	✓

Sustainability Criteria	The Path to Sustainable Agriculture 1992	Government Response to (PTSA)[4]	Agenda: Jobs and Growth 1995	National Environment Strategy 1995
General: preservation of resources	✓	✓		✓
Land (urbanization, climate change)	✓	✓		✓
Soil and water	✓	✓	✓	
Genetic diversity		✓	[5]	
Biodiversity		✓		✓
Less dependance on inputs		✓		[6]
Self-reliance	✓			
Public involvement	✓	✓	✓	✓[7]
Local research and development			✓	
Net income	✓	✓	✓[8]	
Safe food and environmental health	✓		✓	✓
Other issues				
Marketing			✓	✓
Competitiveness		✓	✓	✓
Growth			✓	✓
Education of farmers to change practices	✓			

Notes:

1. Dependance upon outside inputs is mentioned in the context that there are few other alternatives.

2. Self-reliance is mentioned only in the definition in the Growing Together Report.

3. The terms of reference for the document refer to industry consultation only, however, the document does mention consultation with other stakeholders.

4. PTSA: Path to Sustainable Agriculture

5. Genetic diversity is mentioned only in terms of privatizing the Plant Genetic Resources Lab.

6. Dependance on purchased inputs is mentioned in terms of increased efficiency of use on inputs only.

7. The document specifically mentions producers, business, agriculture and agri-food sector organizations and government.

8. Net income is addressed indirectly through growth in agricultural income in general.

Appendix 2: Recommendations of the Standing Committee on Agriculture (1992)

A NATIONAL AGRI-FOOD POLICY

1. The Committee recommends that sustainable agriculture be recognized as an essential part of Canadian life.
2. The Committee recommends that recognition of sustainability include meeting farming needs for economic, social and environmental sustainability.
3. The Committee recommends that the federal government develop long term national goals for a sustainable agri-food system.
4. The Committee recommends that the federal government involve all segments of Canadian Society in a dialogue that will recognize the intrinsic value of food production and promote the formation of a long-term policy for agriculture.

FOOD SECURITY

5. The Committee recommends that one of the goals of the food strategy should be domestic food security.
6. The Committee recommends that production for export should not compromise agriculture's ability to meet future food production needs on a sustainable basis.

STEWARDSHIP

7. The Committee recommends that, to assist farmers in their stewardship role, the federal government offer significant on-farm incentives to develop effective sustainable practices.

MARKET AND PRODUCTION NEUTRALITY

8. The Committee recommends that the federal agricultural support programs should be market and production neutral.

CONSERVATION FARM PLANS

9. The Committee recommends that producers qualify for federal financial assistance only when they have met environmental practices that are part of an approved conservation farm plan.

EXISTING POLICIES AND PROGRAMS

10. The Committee recommends that the federal government set a time frame to meet the urgent need to convert existing agri-food policies and programs into an environmentally sustainable food system.
11. The Committee recommends that sustainable agriculture criteria be included in the development of all agri-food policies and programs.

INFORMATION FOR ADAPTATION

12. The Committee recommends that the federal government give priority to implementing and integrated approach to agricultural research and development.

13. The Committee recommends that the federal government work in partnership with other governments, the universities, industry and producers to ensure adoption of this integrated approach to agricultural research and development.
14. The Committee recommends that, at all levels of decision making, producers have more involvement in the policies, programs, and technologies that may affect them.
15. The Committee recommends that the Government of Canada increase the Capital Costs Allowance in order to assist farmers to purchase approved conservation technology
16. The Committee recommends long term funding under the NSC be committed to maintain the momentum already achieved by programs such as the PCP.

GREEN PLAN

17. The Committee recommends that Green Plan funding build on practical lessons learned from successful programs that are already delivering technology to the farming community.
18. The Committee recommends that increasing the technical skills of resource personnel and farmers be a research priority for the agricultural sector.

INDEPENDENT AUDITOR

19. The Committee recommends that Parliament establish an independent auditor to monitor Canadian agriculture's progress towards sustainability.

Appendix 3: Complete list of interview questions and interview consent form.

INTERVIEW QUESTIONS FOR RESEARCHERS IN AGRICULTURAL BIOTECHNOLOGY

The interview is divided up into sections; in the first section, I will ask you about your specific research; then ask you to respond to common criticisms levelled against biotechnology and herbicide tolerance specifically; finally, I will ask you questions about how you perceive the current situation in agriculture and what you foresee for the future.

SPECIFIC RESEARCH

- Please briefly describe your research.
- How long have you been interested in this type of research?
- What are your main motivations behind doing this type of research?
- What are the direct applications?
- When do you expect your research to reach the market? or to be applied.
- Who would you say is the primary target of your research?
- In general, are returns from marketing products expected to cover R and D costs incurred?
- What acreage of canola do you think needs to be grown to cover research and development/ or market share of canola/ or amount of sales in $$.
- With herbicide tolerant canola, how are/ will recommended practices for growing the crops be determined?
- How are the research goals of your lab, institution or company arrived at? ie why did you choose to work on herbicide tolerance?

ISSUES ASSOCIATED WITH BIOTECHNOLOGY/ HERBICIDE TOLERANCE

- Herbicide tolerant canola will be difficult to eradicate as a volunteer weed.
- The benefits of developing herbicide tolerant canola do not outweigh the costs associated with continued herbicide use.
- Introducing herbicide tolerant varieties will encourage more farmers to plant canola. .
- Canola requires more inputs than cereals.
- Introducing genetically engineered crop plants reduces crop biodiversity and increases monoculture
- There was a canola production survey in 1992 by Alberta agriculture. In that survey 60% of farmers listed heat and drought stress as a major constraint to crop yields whereas only 4-6% of Alberta farmers listed weeds How would you respond to criticisms that herbicide tolerant canola is not meeting a major need?
- It has been suggested that pursuing improved canola is very risky due to the interchangeability of vegetable oils and biotechnology is being applied to soybeans so that the oil may have some of the important characteristics of canola. In other words, can Canadian canola farmers compete with American soybean farmers?

●Current economic evaluations have been criticised on the basis that they fail to take environmental impact into account.
●Economic analyses should be expanded to include environmental impact and non-renewable resource use.
● Are you participating in a public/private research collaboration?
●Do you think public and private research goals in agriculture should be different?

FUTURE OF AGRICULTURE

●Do you think farm net income in Canada has changed in the past 20 years in constant dollars? In what way? Why?
● Do you think agriculture has a significant impact on the environment?
Has it been increasing or decreasing?
●How do you foresee the future of agriculture in Canada in terms of farm size, ownership, demographics, management, etc.?
●Do you think Canada <u>will</u> produce more food crops in terms of quantity in the future?
●Do you think it <u>should</u> produce more or less? (ie should we even have agriculture)
●Do you believe that Canada has responsibility to try to grow more food to help in feeding increased populations in other countries?
●It has been argued that most of the large increases in populations are occurring in countries which cannot become self sufficient in food as a result of political, economic or environmental constraints. As a result these countries will not be able to pay for the food they need.
Please comment.
●The next few questions deal with economics under free trade. Classical economic theory states that specialization increases productivity and efficiency (Adam Smith). Free trade systems are designed to facilitate specialization on a global scale.
How would you define efficiency in agriculture? How do you think Canada will specialize?

● How would you define agricultural sustainability?
●Do you think agriculture in Canada is sustainable?
●What role should scientists play in making biotechnology or other science policies?
●What role should the public play in making biotechnology or other science policies?

1. Postal Code _____

2. Farm profile: *(please specify acres or hectares)*

Total area of farm: _____
Total cropped/fallow area: _____
Area in canola _____
Livestock (*type and number*): _____

3. Do you own all of the land you farm?

( ) Yes
( ) No —› *if no, how much of the land you farm is rented or leased? (acres/hectares)*_____

4. What crops have you grown in the last 5 years?

( ) Argentine canola
( ) Polish canola
( ) Wheat
( ) Oats
( ) Barley
( ) Flax
( ) Lentils
( ) Peas
( ) Grass forage for hay
( ) Grass forage for seed
( ) Other forages (ie, alfalfa, fescue)
( ) Other _____

5. How long have you been growing canola? _____ years

6. Why did you begin to grow canola? *Please indicate how important these reasons were*

Reason for beginning to grow canola	very important **1**	**2**	**3**	not important **4**
1. Neighbours started growing canola				
2. Soil/ Fertility management				
3. Canola is easier to cultivate than other crops				
4. Weed control				
5. Higher net returns than other crops				
6. Ease of marketing				
7. Government support policies				
8.Other reasons: _____				

MANAGEMENT PRACTICES

A. TILLAGE

1. How do you choose your tillage management practices *(please rank relevant reasons with 1 being the most important)*

( ) Experience: have always done it that way
( ) Erosion control
( ) Water management
( ) Pest management
( ) Soil temperature
( ) Neighbours do it that way
( ) Economics
( ) Extension agent/ Government recommendations
( ) Other _____

2. How many tillage operations do you usually perform? Fall ____ Spring_____

3. Have you changed tillage practices in the last 5 years ?

( )No ( ) Reduced number of operations ( ) Increased number of operations

B. SOIL TESTING AND FERTILIZATION

1. Do you have your soil tested regularly?

( ) Yes —› if yes, how often? _____
( ) No —› *how do you decide how much fertilizer to add? (please check those which apply)*

( ) Don't add any
( ) Health of crop
( ) Always add the same amount
( ) History of the field
( ) Dealer recommendations
( ) Government extension agent recommendations
( ) Economics —› *If linked to economics is fertilizer addition linked to:*
( ) Cash flow limitations at certain times of year
( )Anticipate higher net return with fertilizer
( ) Other economic _____
( ) Other _____

2. Where do you get your soil tested?

( ) Do it myself
( ) Government lab
( ) Send it to a fertilizer company

3. How do you apply fertilizer? *(check all those which apply)*

Banding: ( ) Fall ( ) Spring

Broadcast: ( ) Fall ( ) Spring

With the seed ( ) *how much of the total fertilizer was added with the seed?__%*

4. Has this amount changed significantly since you started farming?

( ) No

( ) Yes —› *if yes, has it* ( ) Increased ( ) Decreased

5. Why have you changed the amount of fertilizer you use? *(please rank relevant reasons with 1 being the most important reason)*

( ) Opinion based upon experience
( ) Soil tests
( ) Yield response
( ) Cash flow limitations at certain times of year
( ) Net returns: anticipate higher net return with fertilize
( ) Other _____

C. AGRICULTURAL PESTICIDES (herbicides, fungicides, insecticides)

1. How do you decide which pesticides to use and how much? *please rank the relevant choices with one being the most important)*

( ) When pests become a problem
( ) Based upon history of the field
( ) Based upon predictions of pest problems
( ) Opinion/ Experience
( ) Advertising
( ) Pesticide company representatives
( ) Crop protection guide
( ) Government extension agent recommendations
( ) Cash flow limitations at certain times of year
( ) Net returns: anticipate higher net return with pesticide application
( ) Other _____

2. What would the five major yield reducing pests (including weeds, insects and diseases) be if you didn't spray?

1. _____
2. _____
3. _____
4. _____
5. _____

3. Which pesticides did you use on your canola last year?

_____
_____
_____

4. Which pesticides have you used on crops that are in rotation with canola?

_____
_____
_____
_____
_____

5. How effective are the pesticides you use?

( ) Excellent (90-100% control)
( ) Good (80-90% control)
( ) Fair (60-80% control)
( ) Poor (<60% control)

6. Do you think the recommended rates for pesticide application are generally:

( ) Excessive
( ) Effective for pest control
( ) Inadequate

7. Do you think pesticides have become more or less effective in the last 10 years?

( ) More effective ( ) Less Effective ( ) No change

8. Do you use more or less pesticides than 10 years ago?

( ) More ( ) Less ( ) No change

9. Do you use herbicides to control volunteer canola in subsequent rotations?

( ) No
( ) Yes —› *If yes, which herbicides?*

_____
_____
_____
_____

10. How often do you inspect your field for pest problems?

( ) Never
( ) Monthly
( ) Weekly
( ) Daily

11 Have you ever used tissue testing to identify:

Nutrient deficiencies ( ) No ( )Yes
Sclerotia ( ) No ( ) Yes

12. How much of your canola seed is :

Certified seed from a dealer _____ %
Common seed from own farm, neighbours, etc _____ %
Other _____ _____ %

if you only use certified seed, please go to question 17

13. If you use common seed, why? *(please rank relevant choices with 1 as most important)*

( ) Economics: common seeds are cheaper
( ) Control: can vary seed treatments, etc.
( ) Convenience
( ) Other_____

14. If you use common seed, do you get it cleaned before planting?

( ) No ( )Yes

15. Do you notice yield losses with common seed?

( ) No ( ) Yes

16. Do you use blackleg tested seed?

( ) Always ( ) Sometimes ( ) Never

17. Rate of seeding:

Polish:( ) <5 lbs/ acre
( ) 5-7 lbs/ acre
( ) 7-9 lbs/ acre
( ) > 9 lbs/acre

Argentine: ( ) <5 lbs/ acre
( ) 5-7 lbs/ acre
( ) 7-9 lbs/ acre
( ) 9-11 lbs/ acre
( ) > 11 lbs/ acre

18 . What varieties of canola have you grown in this field in the last 5 years?

1994_____
1993_____
1992_____
1991_____
1990_____

19. Why did you choose these varieties? *(please rank the top three with one being most important)*

( ) Yield
( ) Maturity
( ) Disease resistance
( ) Stress resistance (frost, drought, etc.)
( ) Better net returns
( ) Harvest management
( ) Other _____

CHARACTERISTICS OF A PARTICULAR CANOLA FIELD

Please use one representative field on your farm that was used for canola production in 1994 to answer the rest of the questions in this section.

1. What crop rotation have you used on this field?

1990 _____
1991 _____
1992 _____
1993 _____
1994 Canola
1995 *(planned)* _____

2. How long have you been cultivating this field?

0-5 years _____ 5-10 years_____10-15 years _____>15 years_____

3. Why did you choose this particular crop rotation?*(please check those which apply)*

( ) Have used the same rotation for a number of years
( ) Economics
( ) Disease control
( ) Weed control
( ) Fertility management
( ) Water management
( ) Erosion control
( ) Tillage/residue management
( ) Other _____

4. How much fertilizer did you add to the field you have chosen in 1994? *(please specify lbs/ac or kg/ha)*

Nitrogen	Potassium	Phosphorus	Sulphur

5. Was the amount of fertilizer you added

( ) above ( ) equal to ( ) below

the recommended rate from your soil test?

6. Soil texture

( ) Clay
( ) Clay loam
( ) Loam
( ) Sandy loam
( ) Sandy
( ) Peaty (organic)

7. Soil problems noticed in this field over the past 5 years. *(please check boxes to indicate the extent of the problem).*

Problem	Severe		Minor		No Problem
	1	**2**	**3**	**4**	**5**
Salinity					
Poor drainage					
Crusting					
Wind Erosion					
Water Erosion					
Pesticide residues					
Other:					

Yields

1. How did the 1994 season rate in terms of canola yields?

( ) Excellent
( ) Good
( ) Average
( ) Poor
( ) Very bad

2. Canola yield on the field obtained in 1994 *(please indicate units)*_____

3. Yield goal for 1994 _____

4. Grade obtained for canola on this field in 1994 _____

5. Average yields 1990-1994 :

1994 _____
1993 _____
1992 _____
1991 _____
1990 _____

6. Have yields of canola increased or decreased since you started farming?

( ) Increased ( ) Decreased ( ) No change

7. What do you think the major limitations to yields in your area are? *(Please rank relevant points - with 1 being the most important limitation)*

( ) Weeds
( ) Disease
( ) Insects
( ) Soil problems
( ) Drought
( ) Frost
( ) Hail
( ) Excess Water
( ) Erosion
( ) Lack of adequate equipment
( ) Lack of appropriate varieties
( ) Fertility
( ) Other

8. What is your main source of information regarding agronomic practices? (*please rank relevant choices with 1 being the most important)*

( ) Government agrologists
( ) Agribusiness agrologists
( ) Canola Production Centres
( ) Applied Research/ Producer Groups
( ) Agriculture Canada/ University Researchers
( ) Farm Papers
( ) Neighbours/ friends/ family
( ) Experience
( ) Canola Growers Manual

9. How did you market your canola in 1994?

( ) Deferred delivery contract
( ) Line elevator or crusher
( ) Producer Cars
( ) Other _____

ECONOMIC INFORMATION

1. Is the farm the main source of income for your family? ( ) No ( ) Yes

2. Net returns for the 1994 canola crop on one field
Gross returns per acre
(for the canola grown in 1994)

A. Yield _____ bu / acre
B. Price _____ $/ bushel

Gross Returns (A X B) _____ $/ acre

3. Costs of production
(estimated, for the canola field)

Seed _____ $/acre
Fertilizer/ Lime _____ $/acre
Pesticides _____ $/acre
Equipment Maintenance _____ $/acre
Fuel _____ $/acre
Rent on land _____ $/acre
Insurance _____ $/acre
Marketing _____ $/acre
Program payments _____ $/acre
Other _____ $/acre

C. Total Costs _____ $/acre

Net Returns
Gross returns/ acre
\- Total costs/ acre
= _____ Net returns

4. If you had the net return identified here for your whole farm over the next 10 years, would it be enough to sustain your farm?

( ) No ( ) Yes

OPINIONS ON AGRICULTURAL RESEARCH GOALS

1. If you were an agricultural researcher trying to improve canola varieties, which characteristics would you concentrate on? *Please rank the top three in order of importance with 1 being the most important.*

( ) Insect resistance
( ) Disease resistance
( ) Plants that require less inputs of fertilizer and pesticides
( ) Drought tolerance
( ) Frost tolerance
( ) Herbicide tolerance
( ) Increased protein content
( ) Increased oil content
( ) Plant that produce alternative products i.e. industrial chemicals, plastics
( ) Saline tolerance
( ) Yield
( ) Other _____

OPINIONS ABOUT HERBICIDE TOLERANT CANOLA

You may be aware that several genetically engineered herbicide tolerant crops will likely be coming on the market in 1995 or 1996. I am interested in finding out how producers feel about genetic engineering in general and specifically about herbicide tolerant canola.

1. Do you believe that genetically engineered crop plants will improve the economic situation in farming?

( ) No ( ) Yes ( ) Don't know

2. Most of the current research on genetically engineered canola in Canada is directed towards herbicide tolerance. If you were going to design a herbicide tolerant plant, which herbicide would you choose?

_____

One of the first genetically engineered canola to reach the market will probably be Roundup tolerant canola produced by Monsanto.

3. Do you think that use of Roundup resistant canola would significantly improve yields in your fields?

( ) No ( ) Yes

4. Do you Use Roundup at present?

( ) No ( ) Yes

5. If you had the opportunity to grow canola that was resistant to Roundup at all life stages, when would you use the herbicide? *(please check all those that apply)*

( ) Previous Fall
( ) Pre-planting burnoff/ Pre- emergence
( ) Seedling stage
( ) Rosette stage
( ) Flowering
( ) Ripening/ Pre-harvest
( ) When water stress (weed competition) became evident
( ) Other _____

6. How would you control volunteer canola in crop rotations following Roundup tolerant canola? *Please list possible herbicides*

_____

_____

_____

7. Do you think that Roundup tolerant canola would reduce your overall herbicide costs?

( ) No ( ) Yes ( ) Don't know

8. Roundup is often used as a spring burn-off herbicide in conservation and zero tillage systems. Would you be more likely to try zero or conservation tillage if you had Roundup tolerant canola?

( ) Already use conservation/ zero tillage
( ) No
( ) Yes
( ) Don't know

VISION OF AGRICULTURE IN THE FUTURE

Free trade in agricultural products will have significant effects on Canadian farmers. In this section, I would like to get an idea about what farmers think Canada needs in order to maintain a sustainable agriculture.

Please indicate whether you strongly agree (SA), agree (A), feel neutral (N), disagree (D), or strongly disagree (SD) with the following statements.

1. Sustainable Agriculture in Canada Requires:

	SA	A	N	D	SD
1. Increased yields.					
2. Increased self sufficiency of farms					
3. Better conservation of the soil and water resources					
4. Reduction in use of agricultural chemicals					
5. Increased energy efficiency					
6. Agricultural systems which resemble natural ecosystems					
7. Increased access to information for farmers					
8. More protection of wildlife habitat					
9. Stricter guidelines on environmental protection					
10. Economic incentives from the government for environmental protection					
11. Improvements in the stability and level of farm income					
12. Higher farm gate prices					
13. Fewer government regulations					
14. Rejuvenation of communities in rural areas					
15. Genetically engineered crops and livestock					

2. In your opinion, what are the most pressing problems facing agriculture in Canada today?(optional)

_____

_____

_____

_____

_____

Follow-up Information

Please fill out your name and address if you are interested in receiving a summary of the survey

Name: *(please print)* Address:

_____ _____

Appendix 5: Summary of results of the survey which sent to farmers, March, 1995.

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March 23 1995

Thank you to all those who participated in the Canola Producers Survey sent out last November. About 1000 surveys were sent out to canola producers in the Peace River Regions of BC and Alberta, and 182 responses were received, for a response rate of approximately 18.2%. This mailing represents a short summary of the main findings of the survey. I will complete a more thorough analysis of the survey for the purposes of my thesis. Please do not hesitate to write to me at the above address if you have any questions or concerns about this summary. Since some respondents did not answer all questions, percentages are calculated as number of respondents with a given answer over the total number of respondents for that particular question.

FARM PROFILE

Total area of farms ranged from 160 acres to over 29,000 acres. The average farm size was 1898.3 acres. 26.4% of farms had some livestock on the farm, with cows being the most common (20.9%). There were also a few bison, goats, llamas, pigs, horses and chickens. 60% of farmers rented at least some of their land- an average of 801.6 acres.

Next to canola, the most common crops grown were wheat, oats, barley and forages. Peas were grown by 42.3% of respondents. Other crops listed included canary seed, bromegrass, clover seed, timothy and potatoes. A few grew lentils and 17 grew flax. Most farmers grew only Polish canola varieties (56.1%) and got an average yield of 23.2 bushels/acre. Those growing only Argentinean varieties (12.6%) got an average yield of 32.5 bushels/acre while those growing both varieties (31.3%) got an average yield of 26.7 bushels/acre.

Number of years growing canola ranged from 1 year to 38, with an average of 18 years. Higher net returns and ease of marketing were the most important reasons indicated for why farmers began to grow canola. Government policies and neighbours beginning to grow canola were least important.

MANAGEMENT PRACTICES

Tillage management practices were based primarily on economics, water management, erosion control and experience and farmers performed an average of 1.3 tillage operations in the Spring and 1.9 in the Fall. Most farmers had reduced the number of tillage operations they performed in the last 5 years (71.5%) compared with only 3.9% who had increased the number of operations. 36.6% of farmers had their soil tested yearly, 18.3% every second year, 20% occasionally and 13.1% never. In response to the question, how do you decide how much fertilizer to add- the most common responses were; history of the field and anticipate

higher net returns with fertilizer application.66.3% of farmers have increased the amount of fertilizer they use, primarily because of yield response, the fact that they anticipate higher net returns and the results of soil tests.

AGRICULTURAL PESTICIDES (INCLUDING HERBICIDES, INSECTICIDES AND FUNGICIDES)

The most common factors influencing decisions on how much and when to use pesticides were; history of the field, when pests became a problem and opinion or experience. The most common pests and pesticides used by respondents are shown in Table 1. Flea beetles were the most common insect pests and Blackleg the most common disease. Note: Wild oats resistant to Group 1 herbicides (ie.Poast) have been detected in Alberta[1]. MCPA, Ally, and 2,4-D were the most common pesticides used in rotation with canola and were also listed as the most common herbicides used to treat volunteer canola. 83.1% of farmers found the pesticides they used to be good or excellent, 60.6% found pesticide application rates effective for pest control, and 37.5% thought they were excessive. Most people use more pesticides than they did 10 years ago (70.5%) but 19.1% had no change. Fields were generally inspected for pests weekly. Only 5.5% of respondents had ever used tissue testing to identify nutrient deficiencies and 8.2% for sclerotia.

Table 1: Most Common Yield Reducing Pests and the Most Common Pesticides used.

Pests	Pesticides
Wild Oats	Lontrel
Thistles (Canada and Sow)	Poast
Stinkweed	Seed Treatments-Vitavax, Premiere, Benolin
Quackgrass	Edge
Wild Buckwheat	Muster

40.1% of farmers used some common seed, primarily for economic reasons, although several farmers stated that they used common seed because they knew what weeds were present and that there was no blackleg on the local seed. Almost

Table 2: Most Common Varieties Grown

Year	Polish Varieties	Argentine Varieties
1994	Horizon, Reward, Colt	Legacy, Bounty
1993	Horizon, Parkland, Tobin	Bounty, Westar

[1]Morrison, I.N., M.D. Devine. **Herbicide Resistance in the Canadian Prairie Provinces: Five Years After the Fact.** 1994. Phytoprotection 75(suppl)5-16.

all farmers using common seed had their seed cleaned, used blackleg tested seed and noticed no yield losses. The most popular varieties of canola grown are presented in Table 2. Respondents seeded Polish varieties at 5-7 or 7-9 lbs/acre and Argentine varieties at 7-9 or 9-11 lbs per acre. These varieties were chosen on the basis of yield, maturity and disease resistance; a few farmers listed availability of seed.

CHARACTERISTICS OF A PARTICULAR CANOLA FIELD

44% of farmers grew canola only once every 4 years. Most fields had been cultivated for over 15 years. Crop rotation choices were based primarily on weed control, economics, and disease control. The average amounts of nutrients added are presented in Table 3. Amount added was generally equal to soil test recommendations, although 26.1% added more than soil test values and 20.4% added less. Most common soil problems listed were crusting, drainage, water erosion and pesticide residues.

Table 3: Fertilizers Added to Fields in 1994

Nutrient	# of farmers using	average amount added (lbs/acre)
Nitrogen	172	70.8
Potassium	95	18.1
Phosphorus	144	28.2
Sulphur	131	10.4

YIELDS

About equal numbers of farmers had a good to excellent year (40.6%) or average year (41.1%) in terms of canola yields and obtained grade 1 for their canola. Average yields over the past 5 years were between 27 and 32 bushels/acre for Argentine varieties and 23-25 bushels/acre for Polish varieties. 62.9% of respondents believe yields have increased in the last 5 years but 25.8% saw no change. Major limitations to yield listed included; drought, weeds, frost, excess water and disease. Experience, farm papers and neighbours, or friends were the most important sources of information followed by

Table 4: Individual Costs of Production

Input	# of Respondents	Average Cost ($)
Seed	150	7.48
Fertilizer/ Lime	150	23.23
Pesticides	137	19.81
Equipment Maintenance	144	9.17
Fuel	145	6.83
Rent on land	68	18.36
Insurance	117	8.75

Canola Production Centres and the Canola Growers Manual. Line elevator or crusher and deferred delivery contracts were the most common means of marketing canola but 9.6% of respondents had some canola unsold (Jan/95).

ECONOMIC INFORMATION

The farm was the main source of income for 83% of respondents. The average price obtained for the grade 1 canola marketed was $7.76/bushel with a range from $7.00 to $15.00 (certified seed grower). Gross returns averaged $190.92 per acre. Average net returns were $101.57/acre. Table 4 (previous page) shows the average individual costs. Note: when individual costs are added together ($120.02/acre), the total is more than the average total cost listed by respondents ($90.27/acre). This occurred because not all respondents filled out the individual costs; therefore, individual costs add up to more than the average total cost listed. The added individual costs of $120.02/acre may be more realistic. 60.5% of respondents felt their farm was sustainable at the level of net returns identified and 39.1% did not. However, several of the farmers who thought their farm was sustainable pointed out that 1994 was an unusually good year in terms of yield and price.

OPINIONS ON AGRICULTURAL RESEARCH GOALS

If respondents were conducting agricultural research, they would be concentrating on disease resistance, yields and designing plant varieties or cultivars that require less inputs of fertilizer and pesticides.

OPINIONS ABOUT HERBICIDE TOLERANT CANOLA

54.5% of respondents believed that genetically engineered crop plants would improve the economic situation in farming and 89.9% believed that Roundup tolerant canola would reduce their overall herbicide costs. Most farmers believe that Roundup would be the best herbicide to design a herbicide tolerant plant to and 68.2% feel that Roundup tolerant canola will significantly improve yields. Producers would add Roundup to these plants at many life stages, primarily the seedling and rosette stages but a few farmers wrote that they would add Roundup when it would kill Canada thistle. 52.5% of farmers already use, or would be more likely to try zero or conservation tillage with Roundup tolerant canola given that Roundup can be used as a Spring burn-off in these systems.

VISION OF AGRICULTURE IN THE FUTURE

In response to the question about the requirements for sustainable agriculture in Canada, respondents agreed most strongly with higher farm gate prices, improvements in the stability farm income and increased self sufficiency of farms. Respondents also felt that increased yields, better conservation of soil and water resources, increased energy efficiency, increased access to information for farmers, fewer government regulations and rejuvenation of communities in rural areas were important. There was less support for reduction in the use of agricultural chemicals. Most farmers felt neutral or disagreed with the concept of agricultural systems which resemble natural systems, more protection of wildlife habitat, stricter guidelines on environmental protection, economic incentives from the government for

environmental protection or genetically engineered crops and livestock as important contributions to sustainable agriculture

Many respondents wrote down their thoughts in the last section on the most pressing problems facing agriculture. These comment are not presented here, but they are appreciated and **will** be incorporated into the final thesis.

Thanks again for participating in the survey and good luck in 1995!

Appendix 6: Summary data for mail survey[1].

Appendix four provides a copy of the questionnaire that was mailed to 931 farmers in the Peace River region of Alberta and British Columbia. The purpose of the questionnaire was to gauge farmer's actions and responses to new technologies, specifically to genetically engineered canola. The results of the questionnaire analysis have been incorporated into the text of the dissertation in appropriate sections in Chapter six. 185 responses were received. The summary data presented here is arranged in the order the questions were presented in the survey.

Characteristics and History of the Farm

Postal code data indicated that forty one respondents were from British Columbia and 134 from Alberta. Ten respondents did not indicate postal codes.

Table 1: Acres farmed and in canola (SD: Standard deviation, SE: Standard error).

Variable	N	Range	Mean	Median	SD	Skewness	SE of skew
Acres farmed	184	155- 29000	2050	1545.5	2479.6	7.5	0
Acres cropped/ fallow	179	137-28000	1659.5	1300	2260.9	9.2	0
Acres in canola	180	25-14000	598.4	400	1093.6	10.5	0

The median acreage farmed was 1545.5 acres, 1300 (median) of which were cropped (Table 1). A median of 400 acres were in canola production on farms in 1994. Forty eight farmers out of 185 had livestock of some sort. Seventy two farmers owned all of their land and 108 rented some of it (n=183). Of those farmers who rented (n=108), the average area rented was 802 acres. The crops grown by farmers in the last five years are listed in Table 2.

Table 2: Different crops grown in the last five years.

Crop	**# who have grown**	**%**	**Crop**	**# who have grown**	**%**
Argentine canola	82	44.3	Lentils	3	1.6
Polish canola	161	87.0	Peas	78	42.2
Wheat	180	97.3	Grass forage for hay	75	40.5
Oats	100	54.1	Grass forage for seed	94	50.8
Barley	143	77.3	Other forages	115	62.2
Flax	17	9.2			

[1] Extreme outliers were kept for the summary analysis

Table 3 : Number of years respondents have been growing canola (n=180, mean=18 years).

Range of years	Number of farmers
1-5	11
6-10	21
11-15	41
16-20	56
21-25	25
26-30	20
>31	6

The most commonly grown crops were canola, wheat, barley and forages (Table 2). Respondents had been farming for an average of eighteen years (Table 3).

Government policies and neighbours growing canola were not seen as important reasons for beginning to grow canola (Table 4). Higher net returns and ease of marketing were more important. Other reasons listed for beginning to grow canola included: crop rotations, earlier maturity, and storage.

Table 4: Reasons for growing canola (1 is very important, 4 is not important).

Reasons for beginning to grow canola	Average response	n
Neighbours started growing canola	3.6	173
Soil/Fertility Management	2.66	176
Canola is easier to cultivate than other crops	2.91	174
Weed control	2.94	171
Higher net returns than other crops	1.2	181
Ease of marketing	1.51	180
Government support policies	3.74	171

Management Practices

Respondents were asked to identify the most important reasons for determining their tillage management practices. 137 respondents correctly ranked reasons, and the remainder either checked off choices, ranked several reasons as most important, or did not respond. For surveys where respondents checked off or incorrectly ranked four or less choices, they were arbitrarily assigned rankings[2]. Therefore, the information in Table 5 has been used only to identify which reasons were found most often in the top four rankings. All ranking questions were treated in this manner.

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[2] For example, if a respondent placed check marks beside four or less choices, these choices were arbitrarily assigned a ranking for coding purposes. If the respondent checked more than four, this was coded as a no response (99) since it was impossible to tell which four were ranked highest.

Economics was listed most frequently in the top four rankings (134), followed by water management (121), erosion control (106) and experience (92). Respondents performed a

Table 5: Reasons for choosing tillage management practices.

Reason	Rank #1	Rank #2	Rank #3	Rank #4	Total
Experience	53	13	17	9	92
Erosion control	31	38	27	10	106
Water management	36	44	25	16	121
Pest management	7	21	20	22	70
Soil temperature	10	20	23	29	82
Neighbours	0	2	2	3	7
Economics	42	27	34	31	134
Extension agent/ government recommendations	0	4	4	7	15
Number responding	179	170	153	128	-

mean of 1.34 (SD= 0.9) tillage operations in the fall and 1.89 (SD=0.81) in the spring. For forty three respondents (n=182), their tillage practices had not changed in the last five years, 128 had reduced the number of tillage operations they performed and seven had increased them.

Table 6: Frequency of soil testing.

Frequency of testing	Number of farmers	% (n=178)
Yearly	65	36.5
Every second year	32	18.0
Occasionally	35	19.7
Every three years or more	21	11.8
Never	25	14.0

Respondents were asked whether they had their soil tested regularly. Table 6 indicates how frequently soil was tested (farmers filled in frequency themselves).

Ninety six farmers also indicated how they decide how much fertilizer to add. Some farmers checked off more than one choice, so the total number of times a choice was checked off is presented in Table 7.

Table 7: Basis for decisions about how much fertilizer to add.

Decision	Number of farmers
Don't add any	8
Health of the crop	25
Always add the same amount	13
History of the field	63
Dealer recommendations	21
Government extension agent recommendations	7
Other	3
Economics: Cash flow limitations Anticipate higher net returns with fertilizer Other	41 26 47 8

Most farmers had their soil tested by a fertilizer company (74/158 respondents), sixty three by government labs, nineteen indicated that they sent their soils to a private lab and two said they tested it themselves.

The results of question 3 on page 3 were not analysed because not all options were provided for farmers and many wrote in their own options. Since it is impossible to determine whether the respondents did feel that what they checked off was appropriate, these results were not analysed.

121 farmers (n=184) indicated that the amount of fertilizer they use had increased significantly since they started farming, fifty seven indicated that there had been no change, and six indicated a decrease.

Respondents were asked why they had changed the amount of fertilizer they use. 133 respondents filled in the forms correctly, and the data was analysed as described for the previous ranking question (Table 8).

Table 8: Reasons for changing the amount of fertilizer used.

Reasons	Rank #1	Rank #2	Rank #3	Total
Opinion based upon experience	22	7	30	60
Soil tests	32	23	18	73
Yield response	49	40	22	111
Cash flow limitations	0	4	10	14
Anticipated higher net returns	22	40	21	83
Other	1	0	0	1
Number responding	125	114	101	-

Yield response, anticipated higher net returns and soil test results were most often ranked in the top three. Reasons for choosing pesticides are presented in Table 9.

Table 9: How decisions regarding pesticide use are reached.

Choice	Rank #1	Rank #2	Rank #3	Total
When pests become a problem	56	18	16	90
Based upon the history of the field	38	47	20	105
Based upon predictions of pest problems	8	9	13	30
Opinion/experience	20	35	22	77
Advertising	0	0	1	1
Pesticide company representatives	3	4	2	9
Crop Protection Guide	14	15	28	57
Government extension agent recommendations	2	1	5	8
Cash flow limitations	2	6	7	15
Anticipate higher net returns	25	22	23	70
Other	2	0	0	2
Number responding	170	157	137	-

The history of the field, when pests become a problem and opinion or experience were the most often chosen for what pesticide decisions are based on. The least chosen options were advertising, government extension agents and pesticide company representatives.

Table 10 shows the frequency with which the top five pests were chosen as the major yield reducing pests.

Table 10: Major yield reducing pests identified.

Pests	#1	#2	#3	#4	#5	Total
Wild oats	116	20	13	0	1	150
Thistles (Canada and Sow)	35	42	17	18	16	128
Stinkweed	4	23	10	15	12	64
Quackgrass	9	12	12	14	10	47
Buckwheat	2	12	18	12	4	38
Insect: Flea beetles	7	3	10	9	10	39

Wild oats and thistles (Canada and Sow) were the most common weeds and flea beetles the most common insect pests. The most commonly used pesticides on canola are listed in Table 11.

Table 11: Most commonly used pesticides on canola

Pesticides	#1	#2	#3	#4	Total
Poast	31	25	1	1	58
Lontrel	12	32	27	7	78
Edge	25	9	3	5	42
Vitavax	22	1	5	3	31

The most commonly used pesticides on crops in rotation with canola were: MCPA (total=48), Assert (total=34) and Ally (total=36). Thirty farmers (n=160) felt that the effectiveness of the pesticides they used were excellent, 103 thought they were good, twenty four, fair and three, poor. Sixty one farmers found recommended rates for pesticides excessive (n=161), ninety seven felt they were effective and three, inadequate. 115 farmers use more pesticides than they did ten years ago (n=164), eighteen use less and thirty one use the same amount. Most farmers used herbicides to treat volunteer canola in subsequent rotations (165/183 responses). The most common herbicides used to control canola were MCPA (total=82), Ally (total=60) and 2,4-D (total=57).

Most farmers inspected their fields for pests weekly (130/181) or monthly (41/181). One respondent never checked for pest problems and eight said they checked daily. One farmer added in that he/she checks the fields during the previous year's harvest. Most farmers did not get their crops tissue tested to identify nutrient deficiencies (175/185) or sclerotia (170/185).

111 farmers used certified seed exclusively and seventeen farmers used common seed exclusively (n=185). The remaining 57 farmers used a mix of common and certified seed. Farmers who did use some common seed were directed to answer several questions about why they chose to use common seed and whether they noticed any differences between common and certified seed. Table 12 shows the most common reasons for using common seeds. The last reason, that growers know what's in their own seed was written in by respondents.

Table 12: Reasons for using common canola seeds.

Reasons	#1	#2	#3	Total
Economics: Common seeds are cheaper	54	8	2	64
Control: Can vary seed treatments, etc	4	13	14	31
Convenience	2	21	13	36
Know what's in the seeds (diseases, weeds, etc)	9	4	5	18
Number of Respondents	69	46	34	-

Economics and convenience were chosen most often as important reasons for using common

seed. However, since eighteen farmers added in the response that they know what is in their own seeds, this response may have been more popular had it been offered as an option. Of the seventy one growers who responded to the question regarding cleaning of common seed, seventy had their seed cleaned and one did not. Sixty six of seventy one respondents indicated that they notice no yield losses with common seed, the remaining five respondents did. Sixty three of seventy respondents always used blackleg tested seed, five sometimes did and two never did.

Table 13 shows rates of seeding for Polish and Argentinean varieties of canola[3]. Polish canolas were seeded primarily at 5-7 or 7-9 lbs/acre and Argentine varieties at primarily 7-9 or 9-11 lbs/acre.

Table 13: Seeding rates for Argentine and Polish canola.

lbs/acre Polish	# of farmers	lbs/acre Argentine	# of farmers
<5	16	<5	1
5-7	66	5-7	17
7-9	62	7-9	34
>9	15	9-11	28
		>11	1
Respondents	159	Respondents	81

Table 14: Most common canola varieties grown.

Year	Varieties grown	# of responses
1994: Polish	Horizon	46
	Reward	30
	Colt	20
1994: Argentine	Bounty	17
	Legacy	12
1993: Polish	Horizon	31
	Parkland	25
	Tobin	12
1993: Argentine	Bounty	10
	Westar	8
1992: Polish	Tobin	30
	Parkland	27
	Horizon	22
1992: Argentine	Westar	12
	Alto	7

[3] Polish canola is *Brassica rapa* (formerly *campestris*) and Argentine canola is *Brassica napus*.

Table 14 shows the most commonly grown canola varieties from 1990-1994. Varieties grown in 1990 and 1991 were the same as in 1992. Table 15 shows the reasons farmers chose certain canola varieties. Respondents wrote in the last four answers; whichever is cheapest, does well in a particular area, availability of seed and green seed content. The two most common reasons for picking a particular variety were yield and maturity followed by disease resistance and better net returns. In this case there is quite a pronounced difference between rankings. Yield is predominantly ranked as the most important choice and maturity as second. Disease resistance and net returns are more often ranked third. 138 respondents ranked this question correctly but answers were coded as mentioned previously.

Table 15: Reasons for choosing certain canola varieties.

Reason	Rank #1	Rank #2	Rank #3	Total
Yield	120	35	5	160
Maturity	32	76	38	146
Disease resistance	7	27	42	76
Stress resistance	1	4	13	18
Better net returns	7	18	41	66
Harvest management	6	9	20	35
Whichever is cheapest	0	1	0	1
Does well in a particular area	0	0	1	1
Availability of seed	6	0	0	6
Green seed content	0	1	0	1
Number of respondents	179	171	160	-

Characteristics of a Particular Canola Field

Table 16: Number of farmers growing canola 1990-1994 and predicted for 1995.

Year	Number growing canola	Number of respondents
1990	54	172
1991	44	176
1992	30	179
1993	13	182
1994	185	185
1995 (predicted)	11	158

The number of farmers growing canola each year on a particular field is presented in Table 16. Canola should be grown only once every four years to control diseases, (particularly blackleg; *Leptosphaeria maculans* (Canola Growers Manual, p 1045), so responses were analysed to determine how many farmers grew canola more than once every four years. Eighty five farmers grew canola in a shorter rotation than the recommended four years. Many farmers did not indicate what they would grow in 1995, so there is the potential for a higher number with short rotations. Since canola prices were still high in 1995, it is possible that at least some farmers would have grown canola again in 1995 after growing it in 1994. 121 of 183 respondents had been cultivating that particular field for more than fifteen years, twenty eight for ten to fifteen years, twenty for five to ten years and fourteen for less than five years.

Table 17: Reasons for choosing a particular crop rotation.

Reason	Number checked
Have used the same rotation for a number of years	67
Economics	146
Disease control	106
Weed control	135
Fertility management	75
Water management	40
Erosion control	48
Tillage/residue management	69
Other	8

Respondents were asked to check off reasons why they chose the crop rotations they used. Table 17 shows how many respondents checked off each reason.

Economics, weed control and disease control were checked most often as reasons for choosing a particular crop rotation.

Median values for amount of fertilizer added were: 70 lbs/ac Nitrogen, 25 lbs/acre Phosphorous, 8 lbs/acre Potassium and 9 lbs/acre sulfur. Seventy eight of 144 respondents added fertilizer equal to the amount indicated by their soil tests, thirty seven added more and twenty nine added less. Fields had clay loam (105/181), clay (40/181), sandy loam (21/181), loam (9/181), sandy (5/181) and peaty (1/181) soils.

Table 18: Soil problems experienced.

Problem	Average response	SD
Salinity	4.72	1.19
Drainage	3.9	1.16
Crusting	3.46	1.13
Wind erosion	4.35	1.08
Water erosion	3.72	0.92
Pesticide residues	4.35	0.81

Table 18 shows average responses for soil problems experienced. None of the problems listed appeared very important to growers, since the averages were all higher than three. Three was listed as a minor problem and five no problem.

Yields

Nineteen of 183 farmers answered that 1994 rated as an excellent year for canola yields, fifty four said it was good, seventy seven said average, twenty four poor and nine very bad. The mean of responses was 2.73 (SD=0.98), between good and average. For the next question, farmers were asked about the yields they obtained for canola in 1994. The overall mean was 24.12 bushels/acre (n=182, SD=8.64). However, Argentine and Polish canolas yield differently, with Argentine canolas usually yielding about 15% higher (Canola Growers Manual). Table 19 shows the mean yields for farmers who grew only Argentine canola, or Polish canola.

Table 19: Mean canola yields for 1994 (n=182).

Canola type	Number	Mean yield	SD
Argentine	24	32.25	8.13
Polish	101	21.62	7.43

Overall average yield goal was 29.3 bushels/acre (n=174, SD=6.25). However, farmers growing only Argentine canola had an average yield goal of 36.22 bu/acre (SD=6.32) and those growing Polish only had an average goal of 27.04 bu/acre (SD =5.29). Almost all farmers obtained a grade of one for their canola in 1994 (179/181), one had grade two and one, grade three.

Average yields over the last four years are presented in Table 20. 114 of 181 respondents felt that canola yields had increased since they started farming, twenty felt that they had decreased and forty seven had seen no change in yields.

Table 20: Average canola yields from 1990-1994 (bushels/acre).

Year	Yield for both varieties			Yield for Argentine			Yield for Polish		
	n	Mean	SD	n	Mean	SD	n	Mean	SD
1994	175	23.63	7.88	24	31.5	6.85	94	21.01	7.02
1993	136	25.18	8.17	20	29.15	9.57	71	24.62	7.84
1992	142	23.61	7.98	21	30.24	6.88	74	21.61	6.84
1990	133	24.53	6.98	21	30.71	5.74	66	22.55	6.06
1991	126	23.68	6.57	20	27.05	8.39	63	22.54	6.12

Major limitations to yield identified drought, weeds, excess water and frost as the most important problems (Table 21). 138 responses were correctly ranked.

Table 21: Major limitations to yield.

Limitation	Rank #1	Rank #2	Rank #3	Total
Drought	63	41	23	127
Weeds	42	33	36	111
Excess water	23	30	12	65
Frost	13	17	22	4
Number of respondents	184	177	161	-

Table 22: Sources of information for agronomic practices.

Source	Rank #1	Rank #2	Rank #3	Rank #4	Total
Government agrologists	15	4	9	10	38
Agribusiness agrologists	16	12	13	16	57
Canola Production Centres	20	20	17	16	73
Applied research/ producer groups	13	12	21	16	62
Agriculture Canada/ University researchers	8	10	2	11	31
Farm papers	24	34	24	16	98
Neighbours/ friends/ family	13	34	24	16	87
Experience	59	23	29	13	124
Canola Growers Manual	10	22	14	20	66
Number of respondents	178	170	154	134	-

Experience, farm papers and neighbours, friends and family were the most often ranked in the top four choices for sources of information for agronomic practices (Table 22). 141 responses were correctly ranked. The sources of information picked the least were government agrologists and Agriculture Canada or University researchers.

108 of 182 respondents used deferred delivery contracts to market their canola, 120 marketed through a line elevator or crusher, twenty nine through producer cars and another nineteen had unsold canola. Eighty three respondents checked off more than one choice, indicating that they used more than one form of marketing.

Economic Information

The farm was the main source of income for the family for 152 of 182 respondents. The average price obtained for canola was $7.77/bushel (SD=0.77) with a range from $5.00 (for a grade three crop) and $15.00 for a certified seed crop.

Average gross returns were $191.04/acre (n= 174, SD=79.16), the minimum gross return was $22.95/acre and the maximum was $705.00 (this maximum was for a certified seed grower). Average costs are presented in Table 23.

Table 23: Average costs of production for a canola field.

Input	n	Average cost	SD
Seed	154	7.55	4.69
Fertilizer/Lime	153	23.34	6.98
Pesticides	140	79.51	8.51
Equipment maintenance	147	9.17	7.39
Fuel	148	6.85	4.16
Rent on land	70	18.12	10.57
Insurance	120	8.63	5.64
Marketing	58	3.44	3.92
Program payments	52	6.88	5.50
other	67	15.75	4.58

Some farmers filled in a total cost, which averaged $90.13/acre. However, when the averages of all the costs are added up, the total is $119.24/acre. I believe the latter is more representative of the true costs, since farmers that listed a total cost did not always fill in a value for each cost. Average net returns were $101.81 (n=159, SD= 78.82). One hundred of 165 respondents indicated that the net returns they made in 1994 would been enough to sustain their farm, and sixty five said it would not.

Opinions on Agricultural Research Goals

Respondents would concentrate primarily on disease resistance, yield, developing crops that required less inputs and herbicide tolerance if they were doing research on canola (Table 24).

Table 24: Characteristics of canola respondents would focus on for research.

Characteristic	Rank #1	Rank #2	Rank #3	Total
Insect resistance	4	6	7	17
Disease resistance	66	39	25	130
Plants requiring less inputs	23	25	21	69
Drought tolerance	9	21	23	53
Frost tolerance	4	16	14	34
Herbicide tolerance	17	21	24	62
Increased protein content	0	4	3	7
Increased oil content	2	9	20	31
Plants that produce alternative products, eg. Plastics	2	5	7	14
Saline tolerance	0	0	0	0
Yield	41	23	21	85
Other	3	0	1	4
Number of respondents	171	169	166	-

Opinions about Herbicide Tolerant Canola

Most respondents felt that genetically engineered crop plants would improve the economic situation in farming (98/181), however, twenty eight of 181 did not believe the situation would be improved and fifty five didn't know. 135 of 150 respondents said they would design herbicide tolerant plants that were tolerant to Roundup. 124 of 182 respondents felt that Roundup tolerant canola would significantly improve yields in their fields and 172 of 183 respondents currently use Roundup.

Table 25 shows which stages of cultivation or growth stages of canola that respondents would most likely use Roundup. The rosette and seedling stages of canola were chosen the most often as when respondents would spray with Roundup.

Table 25: Stages at which Roundup would be used (n=184).

Stage	Number	Stage	Number
Previous Fall	60	Flowering	12
Pre-Planting burnoff/ Pre-emergence	48	Ripening/Pre-harvest	63
Seedling stage	87	When water stress/ weed competition became apparent	33
Rosette stage	109	Other	6

For control of Roundup tolerant canola in subsequent crops, respondents chose MCPA (total=69), 2,4-D (68) and Ally (60) most frequently. 135 of 184 respondents felt that Roundup tolerant canola would reduce overall herbicide costs, nineteen felt that it wouldn't and 30 said they didn't know.

Respondents were asked whether they would be more likely to try zero or conservation tillage with Roundup tolerant canola. Forty three (n=184) said they already use conservation tillage, fifty seven said they would not be more likely to use conservation tillage, forty nine said yes and thirty five said they didn't know.

Vision of Agriculture in the Future

Respondents were asked whether they agreed or disagreed with statements regarding requirements for sustainable agriculture in the future in Canada (Table 26)

Table 26: Responses to requirements for sustainable agriculture in Canada.

Sustainable Agriculture in Canada requires:	**n**	**Mean Response**	**SD**
1. Increased yields	180	1.98	0.9
2. Increased self sufficiency of farms	181	1.64	0.8
3. Better conservation of the soil and water resources	180	2.09	0.74
4. Reduction in use of agricultural chemicals	183	2.48	1.07
5. Increased energy efficiency	179	2.12	0.72
6. Agricultural systems which resemble natural ecosystems	171	2.80	0.9
7. Increased access to information for farmers	179	2.10	0.78
8. More protection of wildlife habitat	181	2.92	0.98
9. Stricter guidelines on environmental protection	182	3.12	1.08
10. Economic incentives from the government for environmental protection	182	3.04	1.15
11. Improvements in the stability and level of farm income	183	1.58	0.81
12. Higher farm gate prices	183	1.23	0.47
13. Fewer government regulations	183	1.83	0.96
14. Rejuvenation of communities in rural areas	179	2.11	0.91
15. Genetically engineered crops and livestock	179	2.71	1.03

Respondents most strongly agreed with; higher farm gate prices, improvements in the stability and level of farm income and increased sufficiency of farms. Respondents disagreed most strongly with; stricter guidelines on environmental protection, economic incentives from the government for environmental protection and more protection of wildlife habitat

For the last part of the questionnaire, respondents were asked to fill in what they though were the most pressing problems in agriculture today. Table 27 paraphrases responses to this part of the questionnaire.

Table 27: Paraphrased responses to question regarding the most pressing problems in agriculture.

PRESSING PROBLEMS IN AGRICULTURE
1.Farm gate prices are too low
2. Input costs are too high
3. High machinery and fuel costs
4. Canada's food policy-low food prices and lack of coordination between federal and provincial governments
5. Competing on the world market/ unfair world trade arena- subsidies in other countries- cut all subsides
6. Costs of government bureaucracy
7. Price stability
8. Need an affluent farm family community
9. Too many middle men- benefitting more- processors and value added sectors getting most of the profits
10. Aging farmers
11. Inefficient and expensive transportation/ Crow rate changes/ union rail worker strikes
12. Government regulations and interference
13. Threat of special interest groups
14. Startup costs for young farmers prohibitive
15. Free trade deal- favours US
16. Poorly conceived crop insurance program- and other programs
17. Farmers not involved in decision making/ wrong people involved in decision making re programs- poorly informed
18. Need more natural systems
19. Less chemical use
20. Larger farms causing communities to be less stable- decline of family farm
21. Not enough local processing/ local supply and demand
22. Misinformed media influencing public/ urban perceptions of farmers and farming- need more education about agriculture- consumer ignorance and apathy
23. Need genetically engineered products
24. Too much taxation on farmers
25. Poor R and D- not properly directed or conceived- need more directed towards farmers

26. R and D controlled by multinationals to meet their own needs
27. Too many new varieties of seeds with questionable advantages
28.Investment in land and machinery not offset by returns
29. Agribusiness focussed in too few companies/ multinationals- are taking advantage of government programs and price-setting
30. Urban encroachment on class 1 land (Vancouver and Toronto)
31. Farmers dependance on government programs
32. Value of Canadian dollar
33. Canadian Wheat Board Control and Marketing strategies
34. Farmers must be more flexible and adapt to new market conditions/ new marketing alternatives- being able to access new market niches
35. Financial partners (ie banks) who do not understand or are not required to share risk
36. Climate risks