

# **Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada**

An Expert Panel Report  
on the Future of Food Biotechnology  
prepared by

**The Royal Society of Canada**

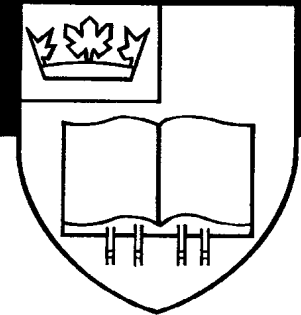
at the request of

Health Canada

Canadian Food Inspection Agency

and

Environment Canada



“studii eodem diversis nitimur”  
“different paths, one vision”

# **ELEMENTS OF PRECAUTION: RECOMMENDATIONS FOR THE REGULATION OF FOOD BIOTECHNOLOGY IN CANADA**

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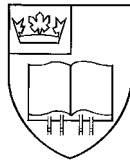
The Royal Society of Canada

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Health Canada

Canadian Food Inspection Agency

and Environment Canada



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## **EXPERT PANEL ON THE FUTURE OF FOOD BIOTECHNOLOGY**

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***The opinions expressed in this report are those of the authors and do not necessarily represent those of the Royal Society of Canada or the opinion or policy of Health Canada, the Canadian Food Inspection Agency and Environment Canada.***

William Leiss, President  
The Royal Society of Canada

January 30, 2001

Dear Dr. Leiss:

We are pleased to enclose a copy of the report *Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada*. The report has been prepared by the Expert Panel on the Future of Food Biotechnology, established by the Committee on Expert Panels of the Royal Society of Canada, in response to a request from Health Canada, the Canadian Food Inspection Agency, and Environment Canada. Our report addresses the questions posed by these agencies in the Terms of Reference negotiated between the government agencies and the Expert Panel, which are outlined in the Executive Summary and the Introduction of the enclosed report. These Terms of Reference asked the Expert Panel to provide advice on the Canadian regulatory system and the scientific capacity the federal government requires into the 21<sup>st</sup> century to ensure the safety of new food products being developed through biotechnology.

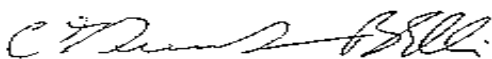
The enclosed report responds to this request by summarizing the scientific developments that have led to the current status of application of the technology and identifying the social and scientific dynamics that foreshadow new applications of biotechnology. It examines in detail the safety implications of these applications for human and animal health and the natural environment. The report also critically examines the current standard principles and practices governing the regulation of food biotechnology both in Canada and internationally, and makes a series of recommendations in three areas: 1) those concerning fundamental policies and principles governing the regulation of biotechnology, 2) those concerning specific Canadian regulations and guidelines, and 3) those concerning the regulatory process itself.

We are happy to report that the enclosed report represents a broad agreement among the members of the Panel. This is not to imply that every member would express all the arguments and conclusions in exactly the same way, or that some members would not favour additional or even stronger recommendations in some areas. Despite the broad agreement among the members, the Expert Panel has agreed that every member should be free to express his or her own individual interpretations and points of difference freely. It is a tribute to the RSC Committee on Expert Panels that a panel of this size and diversity of expertise and opinion was able to work in such a highly collegial and collaborative manner. Many of the issues with which we were charged are complex and controversial. They generated vigorous debate within the Panel. We would like to thank all the members of the Panel for the energy and time they devoted to the completion of this report in such a collaborative spirit.

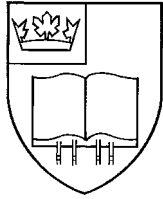
This is a large and complex topic. The Panel had to carry out its task in a relatively short time span given the enormity of the task. We were able to obtain the information we needed and to meet the deadlines we faced largely due to the able support provided to the Panel by Dr. Geoffrey Flynn, Chair of the Committee on Expert Panels, and Ms. Sandy Jackson, the Project Administrator for the Royal Society of Canada. We are deeply indebted to them for their tireless assistance.

We hope that Health Canada, the Canadian Food Inspection Agency, and Environment Canada will find our recommendations useful in the important task they face in the regulation of food biotechnology in Canada.

Yours sincerely,



Conrad Brunk and Brian Ellis  
Co-Chairs, RSC Expert Panel on the Future of Food Biotechnology



# The Royal Society of Canada

The Canadian Academy of the Sciences and Humanities

# La Société royale du Canada

L'Académie canadienne des sciences, des arts et des lettres

## Prefatory Note

In November, 2000 Health Canada's Health Products and Foods Branch approached the Royal Society of Canada with a request to commission an Expert Panel to provide advice to ensure the safety of new food products being developed through biotechnology. The Society agreed to do so, and the Committee on Expert Panels undertook the task of screening and selecting the individuals whose names now appear as the authors of this report for panel service.

The report entitled *Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada* represents a consensus of the views of all of the Panelists whose names appear on the title page. The Committee wishes to thank the Panel Members and Panel Chairs, the Peer Reviewers, and the Panel staff for completing this very important report within a short period of time.

The Society has a formal and published set of procedures, adopted in October 1996, which sets out how Expert Panel processes are conducted, including the process of selecting Panelists. Interested persons may obtain a copy of those procedures from the Society. The Committee on Expert Panels will also respond to specific questions about its procedures and how they were implemented in any particular case.

The Terms of Reference for this Expert Panel are reproduced elsewhere in this report. As set out in our procedures, the terms are first proposed by the study sponsor, in this case Health Canada, the Canadian Food Inspection Agency and Environment Canada, and accepted provisionally by the Committee. After the Panel is appointed, the terms of reference are reviewed jointly by the Panelists and the sponsor; the Panelists must formally indicate their acceptance of a final Terms of Reference before their work can proceed. These are the terms reproduced in this report.

The Panel first submits a draft of its final report in confidence to the Committee, which arranges for another set of experts to do a peer review of the draft. The Peer Reviewer comments are sent to the Panel, and the Committee takes responsibility for ensuring that the Panelists have addressed satisfactorily the Peer Reviewer comments.

The Panel's report is released to the public without any prior review and comment by the study sponsor. This arm's-length relationship with the study sponsor is one of the most important aspects of the Society's Expert Panel process.

Inquiries about the Expert Panel process may be addressed to the Chair, Committee on Expert Panels, Royal Society of Canada.

Dr. Geoffrey Flynn, FRSC  
Chair, Committee on Expert Panels

on behalf of the Committee Members for this Panel:

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Christopher Garrett, FRS, FRSC, University of Victoria  
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David Layzell, Queen's University  
John Meisel, CC, FRSC, Professor Emeritus, Queen's University  
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January 30, 2001

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## EXECUTIVE SUMMARY

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This Report is a response to a request to the Royal Society of Canada from Health Canada, the Canadian Food Inspection Agency and Environment Canada that an Expert Panel be assembled to provide advice on a series of questions related to the safety of new food products being developed through the use of new genetic engineering technologies. The Terms of Reference asked the Panel “to provide Health Canada, the Canadian Food Inspection Agency and Environment Canada with advice on our regulatory system and the scientific capacity that the federal government requires into the 21st century to ensure the safety of new food products being developed through biotechnology”. We were specifically charged to address the following issues:

- *To forecast:*
  - ▶ *the types of food products being developed through biotechnology that could be submitted for regulatory safety reviews by Health Canada and/or the Canadian Food Inspection Agency over the next 10 years;*
  - ▶ *the science likely to be used to develop these products; and*
  - ▶ *any potential short- or long-term risks to human health, animal health and the environment due to the development, production or use of foods derived from biotechnology.*
  
- *To assess approaches and methodologies developed in Canada and internationally to evaluate the safety of foods being developed through biotechnology, including those being developed by the World Health Organization, the Food and Agricultural Organization and the Codex Alimentarius Commission.*
  
- *To identify:*
  - ▶ *the scientific capacity that will be needed to ensure the safety of new foods derived from biotechnology, including human resources for research, laboratory testing, safety evaluation, and monitoring and enforcement; and*
  - ▶ *any new policies, guidelines and regulations related to science that may be required for protecting human health, animal health and environmental health.*

This Report addresses these issues in the following way.

**Chapter 1** clarifies the Panel’s interpretation of its mandate and the Terms of Reference. It attempts to delineate clearly the range of scientific and non-scientific issues that fall within its mandate, those that fall clearly outside it, and those related issues that need to be addressed to

provide comprehensive answers to the questions posed by the mandate. Chapter 1 also summarizes the process by which the Panel produced the Report.

**Chapter 2** responds to the mandate to forecast the future directions in the development of agricultural biotechnology. It does so by summarizing the scientific developments that have led to the current status of application of the technology. It identifies the social and scientific dynamics driving its current development, and points to technological developments that are likely to bring new applications of biotechnology. Many of the themes summarized in Chapter 2 are developed in greater detail in subsequent chapters dealing with specific health and environmental risks.

**Chapter 3** summarizes the system currently in place for the regulation of agricultural biotechnology in Canada. The chapter recommends implementation of an independent process for auditing of the scientific and ethical aspects of regulatory decision making.

**Chapter 4** is the first of three chapters that conduct the scientific identification of the short- and long-term risks the Panel found to be most important for regulatory concern in Canada. It focuses on the direct risks to human health posed by genetically modified (GM) food. Part 1 of Chapter 4 considers the specific problems related to the use of the classical risk assessment methodologies for the assessment of toxicological risks from GM foods, especially the assessment of the safety of whole foods. Part 2 focuses on the critical issues related to the identification of potential allergens in GM foods, and makes recommendations for strengthening the scientific capacity for identifying and assessing the allergenicity of new or unexpected proteins in GM foods. Part 3 points to the need to consider the impacts of genetic engineering modifications on the nutritional value of the resulting food.

**Chapter 5** considers the potential direct impacts of genetic engineering upon the health and welfare of agricultural animals, as well as the indirect impacts upon wild animals. Part 1 identifies the risks associated with the genetic modification of fish and farm animals themselves, while Part 2 focuses upon the risks associated with GM feeds, feed additives and metabolic modifiers administered to food-producing animals. Chapter 5 makes a variety of recommendations for the more rigorous assessment of the impacts upon animal health and welfare, genetic diversity and sustainability, as well as upon human consumers of GM animals and animal products.

**Chapter 6** identifies what the Panel considered to be the most significant potential risks to various aspects of the natural environment posed by agricultural biotechnology. The chapter is divided into four parts, each dealing with the impacts of potential gene flow upon different sectors of the natural environment — microorganisms and soil microflora, wild and non-GM plants, target and non-target insects, and wild fish. Recommendations following each of these

sections identify a series of more refined environmental assessments that need to be added to the Canadian regulatory process to protect more adequately important environmental values.

**Chapter 7** introduces a series of three final chapters that deal with critical methodological approaches and assumptions underlying current and proposed regulatory practices in the area of agricultural biotechnology. Chapter 7 is an in-depth analysis and critique of one of the most controversial concepts invoked in both national and international regulatory contexts — that of “substantial equivalence”. The Panel finds the use of “substantial equivalence” as a decision threshold tool to exempt GM agricultural products from rigorous scientific assessment to be scientifically unjustifiable and inconsistent with precautionary regulation of the technology. The Panel recommends a four-stage diagnostic assessment of transgenic crops and foods that would replace current regulatory reliance upon “substantial equivalence” as a decision threshold.

**Chapter 8** focuses upon the current debate over the validity and relevance of the so-called “precautionary principle” in the regulation of agricultural biotechnologies. Many national and international regulatory bodies (including Canada) have adopted the “precautionary principle” as a regulatory axiom. In this chapter, the Panel lays out an understanding of the principle it considers to have both scientific and regulatory validity, and recommends its use as an axiom of Canadian regulatory policy. The Panel finds the use of “substantial equivalence” as a standard of safety (as opposed to a decision threshold in assessment of risk) to be, in general, a precautionary standard.

**Chapter 9** raises a series of issues the Panel identified during its deliberations that it considered to be of critical importance in maintaining the integrity of science upon which the regulation of agricultural biotechnology should be based, and in maintaining public confidence in the regulatory processes. Part 1 of the chapter raises serious concerns about the undermining of the scientific basis for risk regulation in Canada due to the following factors:

- the conflict of interest created by giving to regulatory agencies the mandates both to promote the development of agricultural biotechnologies and to regulate it;
- the barriers of confidentiality that compromise the transparency and openness to scientific peer review of the science upon which regulatory decisions are based; and
- the extensive and growing conflicts of interest within the scientific community due to entrepreneurial interests in resulting technologies and the increasing domination of the research agenda by private corporate interest.

In Part 2 of Chapter 9, the Panel considers the scientific basis for mandatory labelling of genetically engineered food products, and establishes guidelines for mandatory and voluntary labelling on the basis of health risks. The Panel recognizes that there are broader social, political and ethical considerations in the debate about mandatory labelling of GM foods that lie outside

the Panel’s specific mandate, so this discussion is not intended to provide a comprehensive answer to the issue of mandatory labelling.

## **SUMMARY OF THE EXPERT PANEL’S RECOMMENDATIONS**

In light of its investigations, the Panel made the following recommendations. The rationale and complete text of these recommendations are found at the end of each major section of the Report.

### **Recommendations Concerning Underlying Policies and Principles Guiding the Regulation of Agricultural Biotechnology**

7.1 The Panel recommends that approval of new transgenic organisms for environmental release, and for use as food or feed, should be based on rigorous scientific assessment of their potential for causing harm to the environment or to human health. Such testing should replace the current regulatory reliance on “substantial equivalence” as a decision threshold.

7.2 The Panel recommends that the design and execution of all testing regimes of new transgenic organisms should be conducted in open consultation with the expert scientific community.

7.3 The Panel recommends that analysis of the outcomes of all tests on new transgenic organisms should be monitored by an appropriately configured panel of “arms-length” experts from all sectors, who report their decisions and rationale in a public forum.

8.1 The Panel recommends the precautionary regulatory assumption that, in general, new technologies should not be presumed safe unless there is a reliable scientific basis for considering them safe. The Panel rejects the use of “substantial equivalence” as a decision threshold to exempt new GM products from rigorous safety assessments on the basis of superficial similarities because such a regulatory procedure is not a precautionary assignment of the burden of proof.

8.2 The Panel recommends that the primary burden of proof be upon those who would deploy food biotechnology products to carry out the full range of tests necessary to demonstrate reliably that they do not pose unacceptable risks.

8.3 The Panel recommends that, where there are scientifically reasonable theoretical or empirical grounds establishing a *prima facie* case for the possibility of serious harms to human health, animal health or the environment, the fact that the best available test data are unable to establish with high confidence the existence or level of the risk should not be taken as a reason for withholding regulatory restraint on the product.

8.4 As a precautionary measure, the Panel recommends that the prospect of serious risks to human health, of extensive, irremediable disruptions to the natural ecosystems, or of serious diminution of biodiversity, demand that the best scientific methods be employed to reduce the uncertainties with respect to these risks. Approval of products with these potentially serious risks should await the reduction of scientific uncertainty to minimum levels.

8.5 The Panel recommends a precautionary use of “conservative” safety standards with respect to certain kinds of risks (e.g. potentially catastrophic). When “substantial equivalence” is invoked as an unambiguous safety standard (and not as a decision threshold for risk assessment), it stipulates a reasonably conservative standard of safety consistent with a precautionary approach to the regulation of risks associated with GM foods.

9.1 The Panel recommends that Canadian regulatory agencies and officials exercise great care to maintain an objective and neutral stance with respect to the public debate about the risks and benefits of biotechnology in their public statements and interpretations of the regulatory process.

9.2 The Panel recommends that the Canadian regulatory agencies seek ways to increase the public transparency of the scientific data and the scientific rationales upon which their regulatory decisions are based.

9.3 The Panel recommends that the Canadian regulatory agencies implement a system of regular peer review of the risk assessments upon which the approvals of genetically engineered products are based. This peer review should be conducted by an external (non-governmental) and independent panel of experts. The data and the rationales upon which the risk assessment and the regulatory decision are based should be available to public review.

9.4 The Panel recommends that the Canadian Biotechnology Advisory Commission (CBAC) undertake a review of the problems related to the increasing domination of the public research agenda by private, commercial interests, and make recommendations for public policies that promote and protect fully independent research on the health and environmental risks of agricultural biotechnology.

## **Recommendations Concerning Regulations and Guidelines**

4.1 The Panel recommends that federal regulatory officials in Canada establish clear criteria regarding when and what types of toxicological studies are required to support the safety of novel constituents derived from transgenic plants.

4.3 The Panel recommends that, in view of the availability of suitable alternative markers, antibiotic resistance markers should not be used in transgenic plants intended for human consumption.

4.8 The Panel recommends that approvals should not be given for GM products with human food counterparts that carry restrictions on their use for non-food purposes (e.g. crops approved for animal feed but not for human food). Unless there are reliable ways to guarantee the segregation and recall if necessary of these products, they should be approved only if acceptable for human consumption.

5.1 The Panel recommends that the Canadian Food Inspection Agency (CFIA) develop detailed guidelines describing the approval process for transgenic animals intended for (a) food production or (b) other non-food uses, including appropriate scientific criteria for assessment of behavioural or physiological changes in animals resulting from genetic modification.

6.10 The Panel recommends that companies applying for permission to release a GM organism into the environment should be required to provide experimental data (using ecologically meaningful experimental protocols) on all aspects of potential environmental impact.

6.11 The Panel recommends that an independent committee should evaluate both the experimental protocols and the data sets obtained before approvals of new plants with novel traits are granted.

6.12 The Panel recommends that standard guidelines should be drawn up for the long-term monitoring of development of insect resistance when GM organisms containing “insecticidal” products are used, with particular attention to pest species known to migrate over significant distances.

6.13 The Panel recommends that a moratorium be placed on the rearing of GM fish in aquatic netpens.

6.14 The Panel recommends that approval for commercial production of transgenic fish be conditional on the rearing of fish in land-based facilities only.

## **Recommendations Concerning the Regulatory Process**

4.2 The Panel recommends that regulatory authorities establish a scientific rationale that will allow the safety evaluation of whole foods derived from transgenic plants. In view of the international interest in this area, the Panel further recommends that Canadian regulatory officials collaborate with colleagues internationally to establish such a rationale and/or to sponsor the research necessary to support its development.

4.6 The Panel recommends development of mechanisms for after-market surveillance of GM foods incorporating any novel protein.

4.7 The Panel recommends that the appropriate government regulatory agencies have in place a specific, scientifically sound and comprehensive approach for ensuring that adequate allergenicity assessment will be performed on GM foods.

4.9 The Panel recommends that all assessments of GM foods, which compare the test material with an appropriate control, should meet the standards necessary for publication in a peer-reviewed journal, and all information relative to the assessment should be available for public scrutiny. The data should include the full nutrient composition (Health Canada, 1994), an analysis of any anti-nutrient and, where applicable, a protein evaluation such as that approved by the United Nations Food and Agriculture Organization (FAO).

4.10 The Panel recommends that protocols should be developed for the testing of future genetically engineered foods in experimental diets.

4.11 The Panel recommends that the Canadian Nutrient File should be updated to include the composition of genetically engineered foods and be readily available to the public.

5.2 The Panel recommends that the approval process for transgenic animals include a rigorous assessment of potential impacts on three main areas:

- 1) the impact of the genetic modifications on animal health and welfare;
- 2) an environmental assessment that incorporates impacts on genetic diversity and sustainability; and
- 3) the human health implications of producing disease-resistant animals or those with altered metabolism (e.g. immune function).

5.3 The Panel recommends that the tracking of transgenic animals be done in a manner similar to that already in place for pedigree animals, and that their registration be compulsory.

5.4 The Panel recommends that transgenic animals and products from those animals that have been produced for non-food purposes (e.g. the production of pharmaceuticals) not be allowed to enter the food chain unless it has been demonstrated scientifically that they are safe for human consumption.

5.6 The Panel recommends that the use of biotechnology to select superior animals be balanced with appropriate programs to maintain genetic diversity, which could be threatened as a result of intensive selection pressure.

5.8 The Panel recommends that changes in susceptibility of genetically engineered plants to toxin-producing microbes, and the potential transfer of these to the animal and the food supply, be evaluated as part of the approval process.

5.9 The Panel recommends that a data bank listing nutrient profiles of all GM plants that potentially can be used as animal feeds be established and maintained by the federal government.

5.10 The Panel recommends that university laboratories be involved in the validation of the safety and efficacy of GM plants and animals.

5.11 The Panel recommends that Environment Canada and the Canadian Food Inspection Agency establish an assessment process and monitoring system to ensure safe introductions of

GM organisms into Canada, according to the intent of the Canadian Environmental Protection Act.

6.1 The Panel recommends that all ecological information on the fate and effects of transgenic biotechnology products on ecosystems required under existing regulations should be generated and made available for peer review.

6.2 The Panel recommends the carrying out of exhaustive, long-term testing for ecological effects of biotechnology products that pose environmental risks, especially with respect to persistence of the organism or a product of the organism, persistent effects on biogeochemical cycles, or harmful effects resulting from horizontal gene transfer and selection.

6.3 The Panel recommends that, in evaluating environmental risks, scientific emphasis should be placed on the potential effects of selection operating on an introduced organism or on genes transferred to natural recipients from that organism.

6.5 The Panel recommends that the history of domestication, and particularly the time period and intensity of artificial selection, of GM plants should be taken into account when assessing potential environmental impacts. Species with a short history of domestication should receive particularly close scrutiny because they are more likely to pose environmental risks.

6.6 The Panel recommends that environmental assessments of GM plants should pay particular attention to reproductive biology, including consideration of mating systems, pollen flow distances, fecundity, seed dispersal and dormancy mechanisms. Information on these life-history traits should be obtained from specific experiments on the particular GM cultivar to be assessed, not solely from literature reports for the species in general.

6.7 The Panel recommends that environmental assessments of GM plants should not be restricted to their impacts on agroecosystems but should include an explicit consideration of their potential impacts on natural and disturbed ecosystems in the areas in which they are to be grown.

6.8 The Panel recommends that research data from experiments conducted by industry on the potential environmental impacts of GM plants used in Canadian Environmental Protection Agency assessments should be made available for public scrutiny.

6.16 The Panel recommends that potential risks to the environment posed by transgenic fish be assessed not just case-by-case, but also on a population-by-population basis.

## **Recommendations Concerning Scientific Capacity for the Regulation of Food Biotechnology**

4.4 The Panel recommends that the Canadian government support research initiatives to increase the reliability, accuracy and sensitivity of current methodology to assess allergenicity of a food protein, as well as efforts to develop new technologies to assist in these assessments.

4.5 The Panel recommends the strengthening and development of infrastructures to facilitate evaluation of the allergenicity of GM proteins. This could include development of a central bank of serum from properly screened individuals allergic to proteins which might be used for genetic engineering, a pool of standardized food allergens and the novel GM food proteins or the GM food extracts, maintenance and updating of allergen sequence databases, and a registry of food-allergic volunteers.

5.5 The Panel recommends that federal and provincial governments ensure adequate public investment in university-based genomic research and education so that Canada has the capacity for independent evaluation and development of transgenic technologies.

5.7 The Panel recommends that a national research program be established to monitor the long-term effects of GM organisms on the environment, human health, and animal health and welfare.

6.4 The Panel recommends that a detailed analysis be undertaken of the expertise needed in Canada to evaluate environmental effects of new biotechnology products and, if the appropriate expertise is found to be lacking, resources be allocated to improving this situation.

6.9 The Panel recommends that a federally funded multidisciplinary research initiative be undertaken on the environmental impacts of GM plants. Funds should be made available to scientists from all sectors (industry, government and university) with grant proposals subject to rigorous peer review.

6.15 The Panel recommends the establishment of comprehensive research programs devoted to the study of interactions between wild and cultured fish. Reliable assessment of the potential environmental risks posed by transgenic fish can be undertaken only after extensive research in this area.

6.17 The Panel recommends that identification of pleiotropic, or secondary, effects on the phenotype resulting from the insertion of single gene constructs into GM organisms be a research priority.

7.4 The Panel recommends that Canada develop and maintain comprehensive public baseline data resources that address the biology of both its major agroecosystems and adjacent biosystems.

7.5 The Panel recommends that Canada develop state-of-the-art genomics resources for each of its major crops, farm animals and aquacultured fish, and use these to implement effective methodologies for supporting regulatory decision making.