FOOD FOR THOUGHT:

SCIENCE COMMUNICATION AND THE PUBLIC UNDERSTANDING OF SCIENCE

A CASE STUDY

By

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Abstract

The objective of this research was to investigate and explain how the conversation (or lack there of) of the scientific community and the general public has shaped the course of the genetically modified (GM) food debate in Britain and Canada. In addition to providing an explanation as to how science communication has already influenced this discussion, this thesis attempts to provide insight into how to improve this discourse and by doing so, positively influence the ultimate implications of GM technology in Canada's future. A case study approach was chosen to demonstrate the effect of science communication on public understanding in the GM food debate in Britain, as compared to Canada. The research design involved a collection and analysis of reported data in the form of a series of published opinion surveys and reports. This approach has demonstrated that science communication is the link between scientists and the public understanding of science, as it determines which scientific information is successfully communicated and which is not. It further addresses the fact that the GM food debate is not only an issue of science, but also one of social, cultural, ethical, and economic concern. The results from the case study show that the British public has tended to be more skeptical, while the Canadian public has tended to be more accepting of its government's GM policy. Both publics expressed considerable interest in becoming involved with the biotechnology debate. There are also collateral issues, such as the underlying motives driving GM technology, which have to be considered in ultimately drawing conclusions regarding the support of biotechnology. To improve the future, scientists, governments, and the public have to acknowledge each others' viewpoints and be able to collaborate to make viable, sustainable choices.

Chapter 1: Introduction

The relationship between science, science communication, and the public understanding of science is becoming increasingly important given today's pressing scientific issues and the greater public interest in science. This is of particular relevance to Environmental Science, because as environmental scientists we are knowledgeable in a variety of disciplines. These disciplines largely encompass the basic sciences of Biology, Geology, Chemistry, Physics, and Mathematics, although there is also some focus on the humanities such as English, History, and Sociology. Therefore, it is important that environmental scientists are able to facilitate communication between the experts in these disciplines and the public at large.

Issues such as Mad Cow Disease, drug approvals, and GM food have all been covered by the British and the Canadian media as of late, and have raised substantial questions about science in the minds of the public. In the context of this thesis the public are defined as citizens with not specialized scientific knowledge, and with limited knowledge of the GM food debate specifically. This thesis will examine and discuss the relationship between science, science communication, and the public understanding of science in the context of the GM food debate. Through a critical examination of evidence in literature, it will investigate how the role of science communication in the GM food debate has affected the public understanding of science, and specifically of biotechnology, in Britain as compared to Canada. The objectives included:

- to explore the practice of science communication, and through available evidence in literature, to determine the role it has in the public understanding of science;

- to complete a comparative analysis of science communication practices and the public understanding of science in Britain and Canada; and
- to present a summary of the GM food debate and the role of science communication and public understanding.

A more in-depth investigation of the studies of science communication and the public understanding of science, and the definition of science in these contexts, will be presented in Chapter 2. A full discussion of the case study approach and context will be presented in Chapter 3.

Broadly defined, science attempts to interpret natural phenomena, discover new problems, and provide solutions to already existing problems (Alm, 1999; Enger & Smith, 2004). The study of science is based on the compilation of unbiased evidence gathered via employment of the scientific method, including: the formation and testing of a hypothesis, making consequent observations, and providing conclusions based on the results obtained (Enger & Smith, 2004).

From a historical perspective science moved into the public eye during World War II and it is only over the past century or so that science has become regarded as truly relevant to daily life (Frodeman et al., 2003). The Second World War required considerable financial investments with respect to technological developments, since these would increase the chances of successful outcome (Frodeman et al., 2003). Scientists were relied upon heavily to develop technologies such as the atomic bomb and radar; and many historians believe that Hitler's inability to quickly make full use of his researchers resulted in Germany's defeat and demonstrated the potential power of using scientific technology to its fullest (Rotella et al., 2002; Shachtman, 2002). The critical

role that science and technology played in World War II inspired among the public and within governments the need and desire for ongoing scientific research.

The advances in science made during the Second World War supported the view that scientific research was a fundamental part of society (Rotella et al., 2002). Two examples of technological advances that arose post World War II were computers and the internet. These have both positively influenced the public, communication, and general understanding. The internet was developed as a means of communication for political and military leaders should there be a nuclear war (B. Sterling, 1993). Although the threat of nuclear war eventually lessened, the internet continued to develop and improve. Millions of people around the world presently use the internet for communication and information retrieval (B. Sterling, 1993). In fact, the internet is now used by many as a resource for scientific information. As a result, interested citizens can easily acquire peer-reviewed and factual journal articles on any desired topic. Comprehensive search engines allow for easy cross-referencing of abstracts. Searches can be completed quickly as opposed to dewy decimal systems and filling cards, which are long, involved processes. However, along with the credible, peer-reviewed material that can be found on the internet there is as much, if not more, unreliable information. It is therefore extremely important to ensure that citizens have the knowledge necessary to determine that the scientific material they access is credible. The public can be taught how to determine what is credible science and what is not. Using sources such as university materials and peer reviewed journals largely insures credible science and the public has access to these.

Although science is a vital component of our lives and society it is poorly understood. Science communication has the potential to considerably influence our future, since, if practiced effectively, countries around the world will become increasingly competitive and dynamic due to increased scientific knowledge and public understanding of science (European Science Foundation 2003). Science communication will increase the competitive ability of countries by opening avenues of trade, negotiation, and their ability to be informed on an international level. What is now termed 'the public understanding of science movement' originated in Britain in 1985, when a committee of the Royal Society made several recommendations concerning the public's understanding of science and why it should be of particular concern to scientists of the present (Gregory & Miller, 1998; Gregory, 2003). Their study drew the following observations:

- science and technology play major roles in most aspects of the daily lives of the British public;
- Britain's national affluence depends on science and technology;
- British industry would be more competitive if those in noteworthy positions had a better understanding of the potential achievements of science and technology;
- there is room for more science in British media, including a strong case for more science in general public programs and improved contact between scientists and journalists; and
- scientists must learn to effectively communicate with the public (Gregory & Miller, 1998; Gregory, 2003).

Similarly, effective science communication is also crucial to Canada's future since, as has already been the case in Europe, increased scientific knowledge can create a more dynamic and competitive country. The conclusions drawn from the British Royal Society study in 1985 can be applied directly to Canada, since:

- science and technology also play major roles in the daily lives of Canadians;
- Canada's national prosperity depends, to a large degree, on science and technology;
- Canadian industry could be more competitive if those holding authoritative positions, such as CEO's and policy makers, had a better understanding of the potential achievements of science and technology;
- contact between scientists and journalists could be improved, as could the incorporation of scientific knowledge by the media and public programs; and
- communication between scientists and the Canadian public could also be considerably enhanced (The Government of Canada, 2003).

Since scientific and technological developments result in major changes in the public's daily lives, and many important decisions are based on scientific data, a concrete understanding, and an ongoing public dialogue, of the implications of scientific progress are crucial (European Science Foundation, 2003). Thus, it becomes essential to increase the general public's interest in and understanding of science. This is critical in both developed and developing countries. In developing countries openness to new approaches is essential, as traditional jobs and skills are becoming obsolete due to technological developments (Duvick, 1999; European Science Foundation, 2003). This is also the case in developed countries, but to a less extreme degree, since our

technological advancements may not separate life and death. Technological developments in developing countries may improve the basic necessities of life (for example, through providing larger crop yields, which would decrease starvation), while technological developments in developed countries may tend to focus more on improving convenience, such as easy access to computers or wireless internet.

Two consequences central to the development of science communication as a distinct area of study and practice resulted from the report published by The British Royal Society in 1985 (Gregory & Miller, 1998; Gregory, 2003). Specifically they were:

- the establishment of COPUS (The Committee on the Public Understanding of Science), a committee consisting of members drawn from a wide range of professions and disciplines, which encourages scientists and journalists to communicate with the public; and
- funding by the Economic and Social Research Council for a nationwide research program allowing researchers from a variety of fields in the social sciences to bring their expertise on issues that currently fall under what is termed 'the public understanding of science and technology' (Gregory & Miller, 1998).

This latter report addressed the following question: "how does the public understanding of science and technology affect science itself?" (Gregory & Miller, 1998, pp. 3). One hypothesis put forward was that the more the public knows about science and technology, the more they will value and respect the ideas and the practitioners (Gregory & Miller, 1998). Subsequently, the report was criticized for the fact that it simply called for increased public understanding of science and technology, but failed to consider what types of information the public might require, or how they might interpret or use this

scientific information once acquired. As a result, follow up research investigated the relationship between science and the public from the point of view of both scientists and the public. This follow up research concluded that increased public understanding of science and technology was often geared towards greater public appreciation of science, although it does not guarantee this (Gregory, 2003). Nevertheless, the study concluded that the public should have the resources to make informed decisions regarding science, and to do this citizens require a general understanding of science and the scientific process. This understanding might be achieved though education of the public.

As taxpayers and consumers, the public pay for the products produced by science and technology, and according to science writer Isaac Asimov, 'without an informed public, scientists will not only no longer be supported financially, they will be actively persecuted' (Gregory & Miller, 1998). Wider scientific knowledge might aid in decreasing the considerable costs of treating avoidable diseases, cleaning up after unaware polluters, and providing emergency public education programs during times of crisis. Thus, nations such as Britain and Canada, which rely on scientific and technologically based industry for their prosperity and security, require not only an abundant supply of scientists, but also a public who understand and are willing to support their activities (Gregory & Miller, 1998).

The literature gathered in preparing this thesis suggests that prior to 1997/98, achieving successful science communication was much more of a priority in Britain than it was in Canada (Moses, 2002; Gregory, 2003). This can be at least partially attributed to early actions of the British Government with respect to disasters like sheep farming after Chernobyl and more recently, BSE (Bovine Spongiform Encephalopathy) or Mad

Cow Disease and Foot and Mouth Disease (FMD). The Advisory Council on Science and Technology has, however, made some recent and noteworthy progress in Canada (The Government of Canada, 2004) (please see Appendix A for a description of and the mandate of this advisory body). Canadian public opinion surveys regarding research into biotechnology issues have also been conducted from 1999 through 2003 and the Government of Canada has published a report on biotechnology covering the period from 1998 until 2003 (Pollara & Earnscliffe, 2000-2003; The Government of Canada, 2003). Broadly speaking, the term biotechnology has been quite ambiguous, although there are high hopes regarding overall developments in this field (Bud, 1991). Furthermore, although there were no early public opinion surveys conducted in Canada, citizens have always expressed interest in the scientific process (The American Association for the Advancement of Science, 1883).

The very first survey of public knowledge, regarding science and technology, was conducted in the United States in 1957 by the National Association of Science Writers, who, as a result of their findings, sought to determine trends concerning the nature of their potential audience. Such surveys are currently conducted regularly in the United States by The National Science Foundation (Gregory & Miller, 1998).

The first British survey on the public understanding of science, funded by The Economic and Social Research Council, was conducted in 1988, and the results were published in *Nature* in 1989 (Gregory & Miller, 1998; Palmer, 2004). The impetus for this survey may well have been a result of the financial pressure felt by many British scientists in the early 1980s (Gregory, 2003). Many left for jobs abroad and the British scientific community felt threatened as a result (Gregory, 2003). The 1986 Chernobyl

accident could well have been another factor. The main cloud of radioactive contamination from Chernobyl passed over Britain on May 2nd and 3rd 1986, severely affecting the hill sheep farmers of Cumbria in the Lake District of northern England (Wynne, 1989). The attempts by scientists to explain to the local sheep farmers the repercussions (i.e. that their sheep were contaminated with radioactive material and therefore unmarketable) of Chernobyl, is an example of a case where scientists failed to realize the pre-existing scientific literacy of this sector of the British public. The Chernobyl accident and its propagating effects "dramatically underlined a problem already gaining more general recognition: the difficulty of communicating technical knowledge about risks or lack of risks" (Wynne, 1989, pp. 11).

The 1988 British survey designed to be comparable to the surveys conducted in the United States, included a number of questions now referred to as 'The Oxford Knowledge Quiz,' and subsequently used in many other countries (Gregory & Miller, 1998). Surveys like this produce important information that is both relevant and intriguing. However, they have also attracted a great deal of criticism, as critics claim they reinforce a 'deficit model' of the public understanding of science, ergo the public is lacking in scientific knowledge it should have (Davison, 1997; Gregory, 2003). This in turn presents a picture of a scientific community that has all the facts and a public that does not, hence raising questions including:

- Who decides which facts we are supposed to know?
- How many of them do we really need to make informed choices?
- What use are these facts to us anyway?

If the public are to understand scientific information and successfully distinguish between what is genuinely (credible), versus what is apparently scientific (non-credible), they need to understand both the methods of science as well as the scientific community (Gregory & Miller, 1998).

Thus, aside from having a good understanding of key facts and the scientific method, it is also imperative that scientists themselves explain the nature of their work to the public in an understandable manner, as this can offer crucial insight into the nature and value of scientific knowledge to the average citizen. Hence, successful science communication, which results in greater scientific literacy, includes an understanding and knowledge of scientific and technological facts, the way such knowledge is produced, and how the scientific community decides what is, and what is not, considered science (Gregory & Miller, 1998). When debate arises within the scientific community concerning the credibility of science, replication of experiments, testing of hypotheses, and peer-review can aid in achieving consensus.

Today, governments are faced with increasingly complex issues that require decisions which could have considerable and lasting impacts on societies and their economies. Improved access to information via the internet, as mentioned above, as well as via other media sources, has increased public interest in science based issues and placed greater emphasis on public participation in decision making (Pollara & Earnscliffe, 2000-2003; Devereux, 2003). Recent government decisions in areas such as natural resource management and public health and safety have eroded public confidence and contributed to public concern regarding the ability of the Federal Government to successfully address science based issues (Hepworth, 2002). Examples include BSE and

outbreaks of FMD in Britain and laws and regulations concerning the safety of products (i.e. herbicides, pesticides, GM, etc.) in Canada (Hepworth, 2002; Moses, 2002). The public expects its government to accurately describe the full benefits and drawbacks of new scientific discoveries and technologies (Huffman et al., 2004; Pollara, 2004; Savadori et al., 2004). Thus, governments must effectively use the scientific advice they receive to depict the strengths, and the weaknesses offered by advancements in science and technology.

Scientific advice is clearly one key aspect of government decision making, although, the roles of economics, political polarity, traditional, ethical, and cultural knowledge should also be considered. Hence, decision makers must weigh these aspects and consult advisors competent in areas of public policy such as law, public administration, and international relations (Devereux, 2003; The Government of Canada, 2004). Public knowledge concerning science and technology should also be of interest to decision makers, since the public is ultimately the consumer of such advancements.

Science advice plays an important role by contributing to government decisions regarding Canada's strategic interests and concerns in areas such as public health and safety, food safety, environmental protection, sustainable development, innovation, and national security (Beringer, 2000; The Government of Canada, 2004). The effective use of science advice may also contribute to Canada's ability to influence international solutions to global problems. Canada requires a science advisory procedure that leads to sound government decisions, minimizes crises, and takes advantage of opportunities (The Government of Canada, 2004). Therefore, an effective advisory procedure combines sound science and the best scientific advice, ensuring that a thorough and impartial

assessment of all available science is undertaken in providing recommendations. Credible science advice should be considered by decision makers to ensure that the public and Parliament are confident that the government is using science in the best interests of all Canadians (The Government of Canada, 2004).

This overly positivist set of goals begs the question: what about science for science's own sake? There are and always will be scientists who practice science for the sake of simply doing science. Curiosity is, after all, how scientific endeavors first began and it remains the driving force behind science today. Scientists do science to solve existing problems, but also for the pure pleasure of doing science for its own sake. Figure 1.1 illustrates the different spheres of influence science may be asked to take in today's society. This thesis focuses almost entirely on the role of science in informing the public, but both the curiosity driven science of research and the regulatory driven science of governments must not be forgotten.

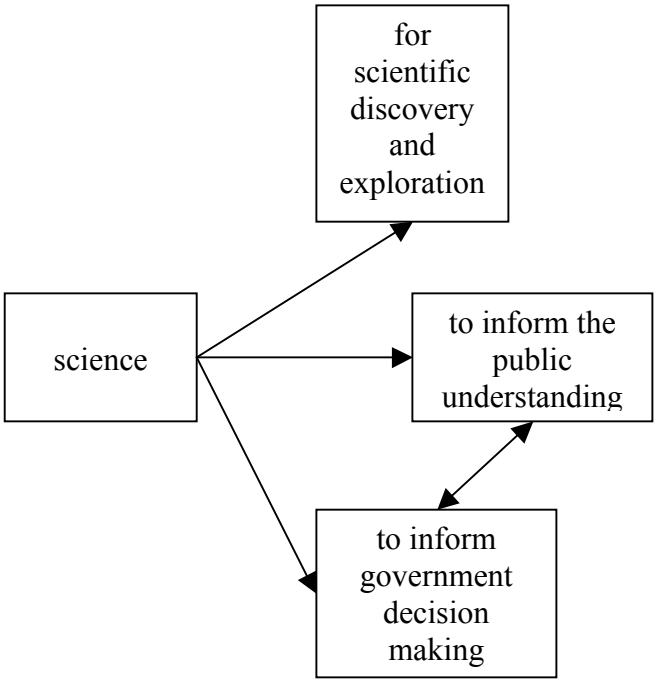

Figure 1.1 The different spheres of influence science may be asked to take in today's society.

The GM food debate was selected for this research as it presents an effective illustration of the critical role for science communication. As a case study, it demonstrates that science communication is the link between scientists and the public understanding of science, as it determines which scientific facts are clearly communicated and which are not. The results of this debate discussed in Chapters 5 and 6 reveal the general necessity of communication in the field of science (Shadden, 1996). Numerous issues surrounding genetically modified (GM) food have caused heated public debate, scientific discussion, and media coverage (SCOPE Research Group, 2000-2005; Devereux, 2003; Heller, 2003; Canadian Biotech News, 2004). The techniques of modern genetics have made the direct manipulation of the genetic makeup of organisms possible. In agriculture, genetic engineering allows simple genetic traits to be transferred to crop plants from wild relatives, other distantly related plants, or virtually any other organism (Kessler et al., 1992; Raybould & Gray, 1993; SCOPE Research Group, 2000-2005; Moulton, 2001). Hence, recombinant DNA technologies have brought a new precision to the natural progression of crop development, which traditionally selects desired traits through crosses between crops and their wild relatives and is a lengthy, relatively imprecise process (Raybould & Gray, 1993; SCOPE Research Group, 2000-2005; Moulton, 2001). GM can be utilized in numerous ways to control a variety of plant traits, and the consequences of one manipulation may be completely different from those of another, based on the traits being modified (SCOPE Research Group, 2000-2005; Moulton, 2001).

A variety of ecological and human health concerns have been associated with the possibilities created by GM, although to date, no conclusive evidence of this has been produced (Pollara & Earnscliffe, 2000-2004). Benefits associated with GM food offer the potential to quickly improve crop yield, pest resistance, and herbicide tolerance to a degree not possible via traditional methods (SCOPE Research Group, 2000-2005; Moses, 2002). Further, GM crops can be manipulated to produce completely artificial substances, from the precursors to plastics to consumable vaccines (SCOPE Research Group, 2000-2005; Moses, 2002). Risks linked to GM food involve the possibility of human health, environmental, and economic problems including:

- unanticipated allergic responses to unusual substances in foods;
- the spread of pest resistance and herbicide tolerance to wild plants;
- unintentional toxicity to benign species; and
- increasing control of agriculture by large, multinational corporations (SCOPE Research Group, 2000-2005).

GM food poses both similar and dissimilar questions for the British and the Canadian publics alike. One major difference is that while GM products must be labeled in Britain, they can make their way to Canadian shelves largely, or even entirely, unnoticed (Pollara & Earnscliffe, 2000-2003). This raises fundamental questions, including how the Canadian public can know what they are actually buying or be allowed to exercise informed choice (Pollara & Earnscliffe, 2000). It also raises questions concerning the level of public debate on GM in Canada. Labeling is effective in Britain, because the British public is informed regarding GM by comparison to the Canadian public. The British public is therefore able to make decisions concerning GM based on

an understanding of the label. In Canada however, scientists and GM advocates have expressed concern regarding labeling, since they fear that labels would cause Canadians to reject GM products based on the label rather than their knowledge of GM. The labeling debate is therefore related to this thesis, because it demonstrates that without an understanding the public might choose to reject GM products simply due to the label, as opposed to facts that are derived from understanding.

One similarity within the populations under study is that the British and the Canadian publics have a relatively similar exposure to literature concerning the potential benefits and drawbacks posed by GM food; although Canadians presently appear to be considerably more trusting of their government. Evidence of this claim is presented in the 2004 Pollara report discussed in Chapter 3 and in numerous reports concerning public opinion regarding biotechnology presented in Chapter 5.

Chapter 2: A Review of the Literature

The literature reviewed in conducting this research was chosen from an enormous body of literature on both GM food and science communication. It was necessary to be very selective concerning what was presented in this study to ensure that all sources used were from governmental and non-governmental organizations, were informative, and were credible.

2.1-Science Communication

Science communication can be broadly defined as the communication of scientific knowledge between scientists and the public. As such it addresses theoretical and practical questions central to current scientific, political, and social debates; crossing national, cultural, and economic boundaries on issues including health care policies, educational improvements, international development, and environmental risk (Rogers, 2004). Such questions are of importance to scientists and the public, since scientists will need to answer them, and the public will be directly affected by them. In the past, issues regarding the public understanding of science have informed some activity concerning science communication (Miles, 1951). Science communication was first strongly encouraged in Britain as a result of numerous reports which depicted science to be a great cultural achievement that could be enjoyed and valued by all citizens for pleasure, democratic, and practical purposes (Gregory, 2003).

Within the context of science communication, science can be broadly defined to encompass social science, engineering, medical knowledge, the physical, and natural sciences. The evolution of science communication has been fueled by increased public interest in expert knowledge, which has set new standards for communication between scientists and the public; linking public policy and understanding to the parameters in which scientific knowledge is created (Pollara & Earnscliffe, 2000-2004; Devereux, 2003; Rogers, 2004).

Achieving successful science communication should be seen as a priority since emerging knowledge based societies will accentuate the importance of sound scientific advice as a key factor in policy formation, both nationally and internationally. Science and technology affect most principal government functions, and the importance of

sustainable scientific advice will grow as the appearance of new science based issues increases. Effective science communication combines broad, yet interrelated topics, including:

- communication within research communities;
- communication of scientific and technical information to the public; and
- science and technology communications policies.

Science communication is critical to the general public's understanding of science and the scientific process because it is the link between what scientists do and how this activity is understood and accepted by the public (Hargreaves et al., 2002; Shanahan, 2002; Pollara, 2004). In modern society, the media is a primary source whereby knowledge is communicated to the public, and has become essential in communicating scientific knowledge and attempting to generate a public understanding of science. However, for science communication to actually be effective in aiding the public in making informed decisions, the material presented by the media has to be factual and accurate (credible). It is important that scientific knowledge not be tailored to public opinion because public opinion can be very illogical and irrational in nature (Shanahan, 2002). The rather common belief in the existence of unidentified Flying Objects (UFOs) is a prime example. Many people (in fact, a majority of the population in the United States) believe that UFOs exist, even though there appears to be no factual evidence for this belief (Duke, 2005). Furthermore, irrationality poses threats not only to proper decision-making, but also to civilization itself (Shanahan, 2002; Gregory, 2003).

Recently, the amount of coverage devoted to science by all forms of the media in Britain and Canada has increased, raising the question of whether additional coverage

actually advances public awareness and understanding of science (Hargreaves et al., 2002; Pollara, 2004). In Britain, recent interactions between the media and science have been the subject of much discussion and controversy. Scientists have been accused of paying insufficient attention to communicating what they do and the media have been accused of being scandalous, irresponsible, or simply misinformed with respect to their coverage of science (Hargreaves et al., 2002).

As a result, a key question is in fact whether public knowledge of science allows citizens to make informed decisions and judgments when scientific policy enters public jurisdiction and where there is specific public interest involved. Regardless of one's perspective on how successful attempts at increasing the public understanding of science have been with respect to informing the public, a convincing argument can be made for the fact that the public should not be asked to make decisions without somewhat of an understanding. Furthermore, a sound democracy requires a public that is well informed on issues related to public policy. Since public policy and science are intimately connected, if a sound democracy requires a public that is well informed regarding public policy issues, it also requires a public that is well informed concerning scientific issues. Thus, communication of scientific development, investigation, and analysis is an essential component of democracy. The media plays a central role with respect to informing the public about science, since the public largely relies on the media to do this (Pollara & Earnscliffe, 2000-2004; Hargreaves et al., 2002).

2.2-The Public Understanding of Science

Relationships between science and the public have been investigated for many years, most recently under the title "the public understanding of science" (Gregory, 2003, pp. 131). Initiatives in the public understanding of science have also been initiatives in science communication, since they include developing methods to deliver scientific information to the public, thereby teaching scientists how to adequately express their messages (Gregory, 2003).

Evaluating the way the public understands science has changed from the deficit model mentioned previously (see a brief discussion in the introduction to this work and below), to recognizing a broader public understanding and engagement and the development of additional ways in which the public can gain an understanding of scientific knowledge (Dickson, 2000; Hargreaves et al., 2002). Until recently, much of the research on the public understanding of science accepted the deficit model of science communication, a model based on a hypothetical failure of the public to comprehend science sufficiently, which relied on the theory that the more the public learned about science, the more supportive they would be of it (Gregory, 2003). However, given that this is not always the case, what needs to be questioned is *why* the public needs to understand science. The straightforward answer is that it is generally advisable for the public to be well informed whether about History, Geography, Art, Politics, Music, Physics, Biology, or a contemporary, specialized scientific issue like GM food. There has been some criticism in the past since some are concerned that improving public knowledge levels may not have any advantages (Gregory, 2003). Such criticism has been primarily expressed by those who believe that scientific knowledge should be reserved for scientists, since it is not the public's role to be scientifically knowledgeable.

Therefore, the argument is that informing the public is of little importance, since it is scientists' role to be scientifically literate. However, research suggests that while a public with low levels of factual knowledge appears to become more positive about science once better informed, gaining still further knowledge encourages thinking that is more critical (Gregory, 2003). This illustrates the advantages of improving public knowledge levels.

A study conducted in Britain in 2002, examined the ways in which three specific issues were reported on television news, radio news, and in the printed press over a seven and one half month period. Those issues – climate change, developments in cloning and genetic medical research, and dangers associated with the MMR (measles, mumps, and rubella) vaccine – were chosen because of their sensitivity and widespread public awareness. Two nation-wide surveys were conducted, tracking the public's, knowledge, opinion, and understanding of such issues (Hargreaves et al., 2002). The results established that there is a distinct relationship between media content and public knowledge, since there is little advantage to the news media covering scientific issues that do not generate notable public interest. Thus, tracking media content and public understanding simultaneously is conducive to gaining an understanding of what the public knows, as well as why they know what they do. Science covered by the news often appears to be geared towards providing entertainment (such as using provocative headlines to attract public attention) rather than increasing public understanding. In addition, science issues are often geared towards providing information that is either directly related to the health of the viewers or is pitched that way, even though it may be irrelevant. Using a specific example, this affects the tenor of public opinion, producing

stories along the headlines of "GM Crops: Dangerous to YOUR Health?" (Duke, 2005). Again, this might considerably affect the terms of the debate and create an alarmed public when such alarm may, in fact, be unnecessary and indeed misleading. Generally, news papers and television are the forms of media most likely to employ science correspondents (Hargreaves et al., 2002). If science magazines do indeed play an important role in communicating science, the report issued by Hargreaves et al. (2002) indicated that they did not play a considerable role in communicating science to a non-specialized audience.

The use of the public as a source in scientific reports would appear to be of particular importance in efforts to engage people in scientific issues (Devereux, 2003; Pollara & Earnscliffe, 2000-2004). Hence, to effectively increase public understanding, it is necessary that scientific reports be presented as interesting, accessible, and informative. Although television is the most popular source of information pertaining to scientific issues, the amount of television watched by the British public has little effect on levels of knowledge (Hargreaves et al., 2002). The public tends to consume news rather indiscriminately, retaining only certain aspects of a given story. It is also necessary to bear in mind that the media is as equally able to inform as they are to misinform (Hepworth, 2002). What appears to get retained by viewers is merely that there are two groups of evidence. These two groups are often dualistic – one side saying yes and the other side saying no. This misrepresents the true nature of the scientific debate, since it tends to produce a negative impact on the larger public understanding of science, thereby implying the importance of description in accurately communicating information (Hargreaves et al., 2002). What is noticeable is how influential the main themes of the

media coverage were in building the foundation for public understanding in Britain; however, a high degree of public uncertainty remains (Williams, 1998; Hargreaves et al., 2002).

Public understanding of science becomes essential when research effectively questions the safety of recent scientific developments that involve a large portion of the citizenry (Hargreaves et al., 2002; Hepworth, 2002). It becomes critical that such research be carefully reviewed with this in mind by both the scientists publishing it and the journalists reporting it alike. Therefore, steps should be taken to ensure that the public understands enough about recent scientific developments to connect this understanding to both reassurance and concern. There is little evidence to support the claim that additional science, scientists, and science specialists in the media will advance the public understanding of science, since historically speaking, scientists tend to share their science with the public only during times when they feel their own enterprise is in danger (Shanahan, 2002; Gregory, 2003).

The "science for the sake of science" approach, or in other words doing science for the pursuit of knowledge rather than purpose, appears least likely to generate public engagement, thereby advancing public understanding (Hargreaves et al., 2002). Thus, it may not be solely the science itself that is essential, but rather the establishment of clear associations between science, policy, and the greater public interest (Shanahan, 2002). It is essential that media coverage enables the British public to make informed decisions about contemporary scientific issues, whether it be as citizens on issues of public policy, as parents, or as children (Hargreaves et al., 2002). It also appears that a great deal of reiteration is needed given the current status of public understanding (Gregory, 2003).

Furthermore, broadcasters need to understand issues like the science of cloning, genetic medical research, and GM food if they are to make reliable statements when they place such issues in the public arena.

The British public often differentiates between types of scientists with respect to trusting the information it receives (Hargreaves et al., 2002). Generally, the public places a great deal of trust in university research scientists, and a majority claim to mistrust scientists who work for private businesses, with government scientists falling somewhere in between (Hargreaves et al., 2002). This suggests that scientific information is partly judged with respect to the perceived independence of the scientists reporting it and that public trust of the motives behind private business is decreasing (Hargreaves et al., 2002; Devereux, 2003). Policymakers in the public understanding of science movement, tend to argue that the greater the public's level of scientific knowledge, the more supportive it will be (Gregory, 2003). However, since a majority of citizens have such low confidence about their scientific expertise, attitudes are clearly far from being well-established. Nevertheless, it does indeed appear that the more knowledge people have, the more optimistic they tend to be about scientific developments (Pollara & Earnscliffe, 2000-2004; Hargreaves et al., 2002). Hence, the present challenge for scientists, policy makers, and journalists, is to employ a more integrated approach, whereby the public can decide what kind of scientific research it should support and what it would rather not support (Einsiedel et al., 2000; Hargreaves et al., 2002; Devereux, 2003; Heller, 2003). As discussed further in Chapter 6, post-normal science is, to a certain degree, a new type of science which can be broadly defined as science that is able to cope adequately with uncertainty.

Chapter 3: Case Study Introduction

3.1-The GM Food Debate: Why and a Background

The GM food debate was chosen as the case study for this research, since it is not only an issue of science, but also one of environmental, social, cultural, ethical, and economic concern (Devereux, 2003). Furthermore, GM is a contemporary issue and public opinion in Britain and Canada, although concerning the same debate, is very different. These were important criteria as this research sought to examine and discuss the relationship between science, science communication, and the public understanding of science. This relationship is clearly a complex one, involving more than rigidly defined science (Silverstone, 1991). As such it involves ethical and economical questions and must distinguish between credible and non-credible science, as previously discussed. The GM debate is also of direct relevance to Environmental Science as it is a complex, interdisciplinary, and contemporary issue that transcends the specific attention of one discipline and moves frequently into the public sphere. Science communication specifically, might be beneficial to the biotechnology industry given the increasing public interests regarding its products (Pollara & Earnscliffe, 2000-2003; Gregory, 2003).

3.2-The GM Food Debate: Britain

GM tomato puree was first introduced in Britain during 1996/97 and was quickly accepted by consumers due to careful preparation (efforts to inform citizens and promote

the product) of the public (Moses, 2002). However, despite this initial success, roughly one year later a backlash against all GM crops and products occurred (Williams, 1998; Moses, 2002; Devereux, 2003). This backlash may well have been influenced by any or all of the following:

- a very uncertain government that in the public's perception had failed to deal adequately with the BSE crisis or the more recent FMD disaster;
- campaigning by lobbyists against the further expansion of GM in the marketplace for various political purposes;
- instilment of fear for the purpose of publicity and sales by large sections of the press, giving prominence to bad as opposed to good news;
- a public predominantly ignorant of present agricultural practices and also poorly equipped to understand new technology, making people easily alarmed as a result; and
- an ever growing fear of uncertainty as well as increasing demands for absolute safety and an apparent developing need to be able to place blame and seek monetary compensation for anything, anywhere that is going or may go wrong: in short, the growth of a risk-averse and litigious public consciousness (Moses, 2002).

In Britain the cultivation of GM crops and the sale of foods derived from them depended on a variety of considerations including the associated benefits and concerns. Benefits included:

- oilseed rape with a lower saturated oil content;
- the production of pharmaceutical products in plants;

- the cultivation of industrial oils;
- wheat modified for better bread making qualities;
- potatoes resistant to imperfections with better storage properties;
- improved shelf life for fruits and vegetables;
- minimal waste production before and after sale;
- improved flavours;
- the removal of allergens from peanuts, strawberries, etc.; and
- overall healthier foods due to higher contents of vitamins etc. (Moses, 2002).

Concerns were related to the overall safety of these benefits.

GM agriculture in Britain has at least partially responded to what has happened in other parts of the world where biotechnology has offered the opportunity of increased yields without the unaffordable costs of pesticides (Palmer, 2004). Developments in biotechnology have also appeared able to reduce input costs while maintaining yields, improve the shelf life of fruits and vegetables, and offer the potential of saving entire industries through the delivery of virus-resistant potatoes, sweet potatoes, and papayas. Furthermore, some heavily mineralized and arid land could become useable and generate crops that are better adapted to cope with climate change as well as the increasing global shortage of irrigation water (Moses, 2002; Parlmer, 2004). Already well developed advantages include inexpensive and edible vaccines that do not require refrigeration and 'Golden Rice,' designed to ameliorate dietary deficiencies involving specific amino acids and vitamins (Moses, 2002; Palmer, 2004). Therefore, by refusing to open its markets to products including those mentioned above, Britain might run the risk of becoming a market closed to struggling farmers in poor nations. Nevertheless, even after BSE and

FMD, GM animals like cattle bred to be genetically resistant to BSE or FMD, remain unlikely in Britain (Moses, 2002).

The commonly perceived risks appear to be of great importance with respect to British public opinion surrounding GM issues. Although there have been numerous potential risks regarding various health hazards and environmental damage associated with GM crops and foods, there have been no such effects anywhere that anyone has been able to determine for certain (Moses, 2002; Palmer, 2004). Furthermore, it should be possible to quickly screen modified plants for potential risks, after which detailed tests could be conducted on these plants to eliminate the associated risks (Moses, 2002). In fact, there may be a strong case for environmental benefits, since the use of GM crops could allow for reduced pesticides and spraying (therefore, less tractor fuel, reduced exhaust, lower labour costs, less damage to the land due to soil compaction, etc.) and could create higher yields and lower costs as a result of retail prices that would be lower than normal, meaning a higher income for farmers (Moses, 2002; Palmer, 2004). Another important factor with respect to public opinion and consumer choice is the anti-GM advertising that attempts to market GM-free products by claiming that they are "natural" as opposed to GM products which are "unnatural" (Moses, 2002). However, this is deemed misleading by those like Moses who believe that all nature, including humans and their actions, is natural. Moses claims that there are "many more examples of the way in which evocative words [can be] used to divert attention away from reality" (Moses, 2002, pp. 403).

3.3-The GM Food Debate: Canada

Overall, health and medical applications are the most positively received forms of biotechnology by Canadians, while GM food is regarded most negatively (Pollara & Earnscliffe, 2000-2004). While Canadians' assessment of the role of the Federal Government concerning performance is weak, their confidence in the biotechnology regulatory system is quite high. The potential health and environmental impacts associated with biotechnology are the primary concerns of Canadians (Pollara & Earnscliffe, 2000-2004). Canadians strongly believe that science should be used as the main guidance tool regarding the decision-making process, although they do think that biotechnology also has moral and ethical components (Pollara & Earnscliffe, 2000-2004). Canadians consider "informed choice" to be the most appropriate approach with respect to GM food (Pollara & Earnscliffe, 2000-2004). Canadians (and others around the world) view advancements in biotechnology to be inseparably linked to societal progress (Rabino, 1994; The Government of Canada, 1998-2003). Therefore, as is also the case in Britain, developments in biotechnology are inevitable if Canada wishes to expand and be recognized universally as a country that is becoming increasingly modern and remaining cutting-edge in technological terms (Pollara & Earnscliffe, 2000-2004).

Canadian views on biotechnology have been tracked over a four year period through eight public opinion surveys (December 2000 through March 2003). The first survey indicated a growing level of discomfort regarding GM food on a personal consumption level (Pollara & Earnscliffe, 2000). The following survey indicated that most Canadians were very surprised to learn how pervasive GM ingredients are in processed food, and they wondered how this happened without their knowledge or

consent (Pollara & Earnscliffe, 2000). The next survey indicated that few Canadians were willing to state categorically that they would not consume food that contained GM ingredients (Pollara & Earncliffe, 2001). Furthermore, despite their knowledge of the long-term uncertainty pertaining to GM food and regulatory systems, few Canadians believe that there are current safety concerns, since they have not heard anything about sickness or negative impacts (Pollara & Earncliffe, 2001). The following survey indicated that Canadians believe that what appears on shelves is safe and that most Canadians are now aware that there are likely GM ingredients in much of the food they purchase and that they have probably consumed GM food at some point as a result (Pollara & Earnscliffe, 2001). The next survey indicated that GM food remains the least acceptable of all applications concerning biotechnology, since many Canadians feel "uncomfortable with GM," some feel "very uncomfortable," and slightly fewer claim they "would never again buy [food products they] knew [to be] GM" (Pollara & Earncliffe, 2002, pp. 10). The last and most recent survey indicated the lowest percentage of Canadians strongly opposed to biotechnology since 1999, although there is still a considerable group who express "some level of discontent [regarding] GM food" (Pollara & Earnscliffe, 2003, pp. 4).

Chapter 4: Methodology

A case study approach was chosen to investigate how the role of science communication in the GM food debate has affected the public understanding of it and hence, the acceptance or rejection of GM foods. The case study approach involved a comparison of the GM related communication initiatives in Britain and Canada and analyzed the resultant trends in public opinion.

Selecting the GM food debate was the first step of the case study procedure. A multidimensional matter, the GM food debate was chosen since it is a contemporary topic and a polarizing scientific issue, which also affects human beings environmentally, socially, culturally, ethically, economically, and politically worldwide. As such, much literature has been written and published with respect to studying this complex debate and environmental issue. The multitude of literature on the GM food debate makes it feasible to examine reports published by governmental and non-governmental organizations.

In designing the scope of the case study, the decision was made to limit the data review to a comparison between Britain and Canada. On the basis of a preliminary study concerning the GM food debate in preparing the initial proposal for this thesis, it was decided that Britain and Canada would allow for a range of opinions, while keeping the data collection to a manageable amount for analysis. Both similarities and differences exist between the two countries, but in both GM food has been the topic of considerable public debate in recent years. The Vaughan Memorial Library at Acadia University was the primary source for information from which many key documents analyzed in the

study were retrieved. As a result, the investigation was begun with a search of published literature on the GM debate and employment of the comprehensive search mechanisms Science Direct, Web of Science, ProQuest, and Jstor. Policy Analysts at the Canadian Biotechnology Secretariat were also contacted.

Science Direct is an index to over 1600 full text Elsevier science journals, which are mainly scientific, technical and medical (Science Direct, 2005). Full text indices are available from 1998 to the present and some journals have full text back to 1994 (Science Direct, 2005). Web of Science indexes articles in the sciences, social sciences, arts, and humanities (Web of Science, 2005). Web of Science consists of the Arts & Humanities Citation Index, the Science Citation Index, and the Social Sciences Citation Index and it can be searched as an index as per usual, or via the searching of citations to articles (Web of Science, 2005). It allows researches to save a search query ("research profile") which can be returned to later (Web of Science, 2005). Web of Science provides searches of journals, conference proceedings, and the World Wide Web (The Thomson Corporation, 2004). ProQuest is a collection of databases, each with a different subject focus, featuring a substantial amount of full text indices from scholarly journals, periodicals, magazines, newspapers, and dissertations (ProQuest, 2005). This extensive search mechanism scans these information sources, searching databases together or individually (ProQuest Information and Learning Company, 2004; ProQuest, 2005). ProQuest is run by the ProQuest Information and Learning Company, with a sole focus on "collecting, organizing, and distributing value-added information" (ProQuest Information and Learning Company, 2004, pp. 1). Using Jstor, the fulltext backfiles of 322 major scholarly journals from the very first issue can be searched (Jstor, 2000-2005).

The literature survey results were examined to determine the considerations (i.e. concerns, benefits, etc.) involved in the GM food debate and the extent of their importance with respect to science communication and the public understanding of science in Britain as compared to Canada. From this research the principal views involved in the debate were identified. Further research regarding the background of these considerations was completed to ensure that a diverse selection of opinions, including governmental and non-governmental views, was accounted for and included. Based on the initial readings and discussions with Professor Linda Lusby and Dr. David Duke, it was decided that the views to be compared would be those of the British and the Canadian publics and their respective governments.

The initial literature surveys on the GM food debate led me to conclude that the British and the Canadian publics, as well as their respective governments, all held opinions with respect to the GM food debate and that these opinions were also quite different in some respects. Therefore, it was this literature that was chosen for collection, comparison, and analysis in this study.

In an attempt to minimize researcher bias to the largest degree possible, a very specific research procedure was designed and meticulously followed to ensure that literature and data were collected in an organized, regular fashion. The basic procedure involved the following steps:

1. Site search for 'biotechnology + debate'
2. Site search for 'biotechnology + science communication'
3. Site search for 'biotechnology + public understanding of science'
4. Site search for 'biotechnology + debate + Britain'

5. Site search for ‘biotechnology + science communication + Britain’
6. Site search for ‘biotechnology + public understanding of science + Britain’
7. Site search for ‘GM food + debate’
8. Site search for ‘GM food + science communication’
9. Site search for ‘GM food + public understanding of science’
10. Site search for ‘GM food + debate + Britain’
11. Site search for ‘GM food + science communication + Britain’
12. Site search for ‘GM food + public understanding of science + Britain’
13. Site search for ‘biotechnology + debate + Canada’
14. Site search for ‘biotechnology + science communication + Canada’
15. Site search for ‘biotechnology + public understanding of science + Canada’
16. Site search for ‘GM food + debate + Canada’
17. Site search for ‘GM food + science communication + Canada’
18. Site search for ‘GM food + public understanding of science + Canada’

The steps as outlined above were executed using the comprehensive search mechanisms Science Direct, Web of Science, ProQuest, and Jstor. The results were recorded and compiled after each consecutive step and only credible sources were included and analyzed. Credibility was assessed through an examination of each source for obvious bias, missing information, or information not attributable to specific research methods or sources. By using this method surveys were selected for use in the study. Surveys used had to be conducted by credible research firms or researchers and within

the specific time frame covered in the study. Each search proved productive for the British and the Canadian publics as well as their respective governments, meaning that there were many examples of relevant surveys. To obtain additional information for analysis, Policy Analysts at the Canadian Biotechnology Secretariat were contacted concerning news releases, speeches, and official statements from British and Canadian Government officials as well as public opinion polls.

Once the data from the surveys identified had been collected, they were compared and analyzed for trends, such as public understanding and trust for both Britain and Canada. The studies included were nation wide surveys geared towards the public in general. The majority of citizens polled had no specialized scientific knowledge, however, there were also a number of citizens included who were informed (i.e. had some scientific background like a science degree). Studies published by governmental as well as credible, non-governmental organizations were included to gain as complete an understanding as possible. The results and the questions posed to the public (where applicable) were summarized. The summaries of the results were then evaluated and analyzed to determine how trends differed in Britain as compared to Canada, with respect to the role of science communication in the GM food debate and how it affected the public understanding of science as exemplified by the survey results. An analysis of trends was chosen as the method of reporting, as the results reviewed were from different publics, were reported by different individuals in different countries, and involved different governments. Hence, comparing studies using exact numbers and percentages would be misleading given these variables. Furthermore, considering that these variables are qualitative it is important not to attempt to analyze them quantitatively.

The complete results are presented in Chapter 5.

Chapter 5: Results

5.1-Report and Public Opinion Survey Results

The results obtained from the literature surveyed will be presented in this chapter. The British results are based on the following documents:

- "Towards a better map: science, the public, and the media" (Hargreaves et al., 2002);
- "GM nation? the findings of the public debate" (Heller, 2003);
- "GM Nation? the public decides" (Devereux, 2003);
- "The GM dialogue: government response" (Department for Environment, Food and Rural Affairs, 2004);
- "Nanotechnology: views of the general public" (BMRB Social Research, 2004);
- "Agricultural biotechnology and the UK public" (Moses, 2002);
- "Understanding 'science and the public'" (Gregory, 2003);
- "The public understanding of science" (The Royal Society, 1985); and
- "Seeds, food and trade wars: public opinion and policy responses in the USA and Europe" (Ten Eyck et al., 2004).

The Canadian results are based on the following documents:

- "Public opinion research findings on biotechnology" (Pollara, 2004);
- "Meeting the public's need for information on biotechnology" (Einsiedel et al., 2000);

- “Mistrust of science, industry and govt. yields bad biotech policies” (Hepworth, 2002);
- “The effect of trust on public support for biotechnology: evidence from the U.S. biotechnology study, 1997-1998” (Harvey, 2003);
- “Summary of public opinion research into biotechnology issues in Canada” (The Government of Canada, 2004);
- “Public opinion research on biotechnology: Canada-U.S. tracking survey” (Decima Research Inc., 2004);
- “Public opinion research into genetic privacy issues” (Pollara & Earnscliffe, 2003);
- “Public opinion research into biotechnology issues in the United States and Canada: eighth wave summary report” (Pollara & Earnscliffe, 2003);
- “Public opinion research into biotechnology issues: seventh wave executive report” (Pollara & Earnscliffe, 2002);
- “Public opinion research into biotechnology issues: sixth wave executive summary” (Pollara & Earnscliffe, 2002);
- “Public opinion research into biotechnology issues: fifth wave executive summary” (Pollara & Earnscliffe, 2001);
- “Public opinion research into biotechnology issues: fourth wave executive summary” (Pollara & Earnscliffe, 2001);
- “Public opinion research into biotechnology issues: third wave executive summary” (Pollara & Earnscliffe, 2000);

- "Public opinion research into biotechnology issues: second wave executive summary" (Pollara & Earnscliffe, 2000);
- "Public opinion research into biotechnology issues" (Pollara & Earnscliffe, 2000);
- "Biotechnology transforming society creating an innovative economy and a higher quality of life: report on biotechnology 1998-2003" (The Government of Canada, 2003); and
- "Seeds, food and trade wars: public opinion and policy responses in the USA and Europe" (Ten Eyck et al., 2004).

The British studies were conducted in 1985, 2002, 2003, and 2004. The Canadian studies were conducted in 1997-1998, 2000, 2001, 2002, 2003, and 2004. The coverage of all the studies selected was nation wide and geared towards consumers in general. The public surveyed included involved (informed) citizens, but primarily focused on the general public.

5.1.1-The British Results

The study conducted by Hargreaves et al. (2002) focused on climate change, the measles, mumps, and rubella (MMR) vaccine and controversy, and cloning and genetic medical research. Citizens of a deliberative democracy should have some knowledge of these issues since they are all contemporary, have serious implications with respect to public policy, and have all been regularly covered by the media. The study focused on television news [(weekday BBC 6:00pm news and the weekday ITV 6:30pm news), radio news (the *Today* program), and reputable and tabloid press news (5 daily newspapers

including: *The Guardian*, *The Daily Telegraph*, *Daily Mail*, *The Sun*, and *The Daily Mirror* and 4 Sunday newspapers including: *The Mail on Sunday*, *The Sunday Times*, *News of the World*, and *The Observer*)]. It was conducted over 197 days (January 28th to September 15th, 2002) and initially analyzed 2,214 stories that contained 'climate change,' 'global warming,' 'MMR,' 'cloning and genetic medical research,' 'cloning,' 'clone,' 'gene,' 'genetic,' and 'stem cells.' The researchers decided that stories which also contained 'scientific' and/or 'scientist' should be included, increasing the final number of stories to 3,093. Two nationally representative surveys (April and October of 2002) were conducted. Each of these consisted of over 1,000 adults (interviewed in person) from 10 different locations all over Britain. The questions were designed by the research team as well as scientists and science correspondents to decipher what people knew with respect to issues that considered public interest and were regularly covered in the news. Both surveys contained a public understanding index of the same 13 multiple choice questions. The key findings relevant to this study are presented in Figure 5.1.

- average number of correct answers in both surveys was <50%
- with science degree number of correct answers was >50%
- no science background number of correct answers was lower than both of the above
- under 25 and over 65 scored lowest, between 45 and 54 scored highest
- reputable paper readers averaged higher than tabloid readers
- television was the most popular source, but the amount of news people watched had little effect on their levels of knowledge except for those who never watched the news at all who scored lower
- generally, knowledge did not increase between April and October, suggesting that patterns of media coverage and learning were relatively consistent and long term
- the knowledge people did have, usually corresponded to the aspects of the science stories that received the most constant coverage
- the climate change results suggested that the public have misunderstood thematic connections made by the media to be causal scientific connections
- MMR was most likely to be the main focus, was granted lengthier coverage, generated the most opinion/editorial pieces, and letters from readers, suggested the highest level of public engagement, and was the most likely to be covered by news reporters as opposed to specialist correspondents, including members of the public
- the most prominent MMR theme concerned the suspected connection (made by Dr. Andrew Wakefield as well as some anti-vaccination groups) between it and autism as well as the proposal to give parents the choice of 3 separate vaccines
- cloning and genetic medical research had the lowest levels of public engagement, generated fewer opinion/editorial articles, fewer readers' letters, made less reference to the public, and was the most likely to be treated as a science rather than a news story
- while most people felt partially or well informed with respect to climate change and MMR (contrary to what their knowledge actually suggested), the majority admitted they were not very well informed concerning genetic medical research, although a succession of low profile media reports of the medical benefits associated with this research appeared to have led to a marginal increase in the knowledge of its potential medical benefits

Figure 5.1 Key findings from "Towards a better map: the public and the media" extracted from Hargreaves et al. (2002).

Figure 5.1 depicts a British public that has been exposed to a great amount of media coverage pertaining to contemporary scientific issues. This media coverage includes television and printed press. The knowledge the public has tends to correspond to the

scientific issues that are of primary concern to the government and receive the most constant coverage.

The studies conduced by Heller (2003) and Devereux (2003) are based on reports by the Steering Board of the public debate on GM and GM crops. They were conducted on the premise that there should be a means by which the public is able to guide the way GM is debated, as opposed to responding to an agenda set by others. A promise was made by The Secretary of State that the British Government would listen to the results of the debate and respond to them in public. This was intended to promote an innovative, effective, and deliberative discussion on GM issues to be framed against the background of the possible commercial production of GM crops in Britain. Therefore, there were hopes that through such debate meaningful information about the nature and spectrum of the public's views, particularly at a grass roots level, would be used by the government to inform decision-making. The key findings relevant to this study are presented in Figure 5.2.

- 7 key messages about GM:
    1. people are generally uneasy about GM and there are many more who are cautious, suspicious, or hostile than there are who are supportive
    2. the more the public engages in GM issues, the harder the attitudes and the more intense the concerns
    3. there is little support regarding early commercialization
    4. there is widespread mistrust concerning government and multinational corporations' motives
    5. there is a considerable desire to learn more and for further research to be conducted
    6. developing countries have special interests
    7. the debate was welcomed and valued by the public
- the public do not regard GM as simply a scientific, environmental, economic, political, or ethical issue and do not consider science and the scientific method, economic and economic analysis, academics, or politicians as single reliable sources of evidence or guidance
- precaution is a major case against GM, since the feeling that no major technological changes should be introduced until their environmental and societal impacts (including long-term impacts) are known and measurable is prominent
- another common claim was that reliable, independent scientific evidence to remove doubts about GM crops and GM food seemed to be lacking

Figure 5.2 Key findings from "GM nation? the findings of the public debate" extracted from Heller (2003) and "GM nation? the public decides" extracted from Devereux (2003).

Figure 5.2 depicts a British public that is generally skeptical concerning GM. There also appears to be widespread mistrust concerning the government and multinational corporations. Although public engagement has increased concern, the public has expressed a desire to learn more and actively seek out information independently. The public appears to regard GM as a complex issue in which precaution and independent scientific evidence are crucial.

The report published by The Department for the Environment, Food and Rural Affairs in 2004 summarized and responded to three simultaneous studies conducted in Britain during 2002 to 2004: the GM public debate, the science review, and the costs and benefits study. It aimed to create a dialogue between all aspects of opinion regarding GM

issues, thereby providing Britain with exceptionally diverse and detailed evidence to make informed decisions. The report suggested that since the EU's regulatory principles are strictly based on the precautionary principle, all GM organisms (GMOs) must be subject to assessment of their potential risks to human health and the environment on the basis of scientific evidence. The key findings relevant to this study are presented in Figure 5.3.

- conclusions concerning the GM public debate:
    1. public attitudes towards GM crops are influenced by a complex range of issues and concerns, making GM crops the focus of much wider concerns to a large degree
- overall conclusions:
    1. protecting human health and the environment via the strict regulation of GM crops must be done on a case specific basis consistent with the precautionary principle
    2. ensuring consumers can choose between GM and GM-free products because of labeling
    3. protecting farmers' interests by implementing measures to encourage the co-existence of GM and GM-free crops; giving farmers who wish to establish GM-free zones guidance and choice
    4. considering the best ways to provide the public with the information it requires in an open fashion is the way of the future
- information must also be provided concerning gaps in scientific knowledge, developing countries, and ethical issues since a precautionary based approach provides the necessary balance between managing the risks and employing the potential benefits of GM food and crops
- Britain is the only country that has implemented a thorough and comprehensive process to inform its decision-making in GM food and crops
- it is impossible to completely eliminate risk and scientific uncertainty
- the appropriate response is not to ban the technology, but rather to implement a regulatory system that is effectively able to manage risks, as this is consistent with the precautionary principle

Figure 5.3 Key findings from "The GM dialogue: government response" extracted from the Department for Environment, Food and Rural Affairs (2004).

Figure 5.3 depicts a British public that view GM as a complex issue, thereby associating GM crops with widespread concern. To ensure the protection of human health, the public believes that GM products should be assessed on a case specific basis that is consistent with the precautionary principle. Furthermore, the British public wants choice for citizens and farmers alike and it believes that informing the public, as opposed to attempted cover-up, is essential in the future. The British public realizes that risk and uncertainty are components of science, but wants both sides of the GM debate. Although the public is skeptical, it believes that the proper response to GM is not a ban, but rather the implementation of a regulatory system effectively able to appropriately mandate the risks.

The report published by BMRB Social Research (2004) presents the findings of research undertaken by BMRB Social Research on behalf of the Royal Society and the Royal Academy of Engineering's Nanotechnology Working Group. In selecting the studies for this thesis, it was decided that this study on nanotechnology was relevant to this research since, like GM and biotechnology, nanotechnology is a relatively new science that has been covered widely in the media as of late. There were two elements to the study: a qualitative component (two evening workshops) and a quantitative component [BMRB's person-to-person survey questions (January 8th to 14th, 2004)]. The qualitative workshops aimed to examine the public awareness of and attitudes towards:

- nanotechnology;
- public views on potential environmental, health and safety, social, and ethical implications;
- areas of concern and general questions; and

- regulations.

The quantitative research aimed to gain awareness about nanotechnology and whether it would have a positive or a negative effect on the quality of life. The key findings relevant to this study are presented in Figure 5.4.

- concerns included:
    1. the financial implications
    2. the impacts on society
    3. uncertainty as to whether or not nanotechnology applications would be successful in the human body
    4. the long-term and side effects
    5. whether or not it could be controlled
- benefits included:
    1. the exciting nature of nanotechnology
    2. the possible applications of it
    3. the possible creation of new materials
    4. the sense that it was a natural technological progression
    5. the hope that it would improve the quality of life
- there appeared to be limited awareness regarding nanotechnology although it was highest among men, younger respondents, and citizens of a higher social grade
- the majority of those who could provide a definition felt that nanotechnology would improve the quality of life in the future, but whether they felt overwhelmingly good or bad about it depended on its uses
- although major concerns accompanied nanotechnology, there were also positive associations and respondents felt that the benefits and the drawbacks would become increasingly clear over time

Figure 5.4 Key findings from "Nanotechnology: views of the general public" extracted from BMRB Social Research (2004).

Figure 5.4 depicts a British public that associates both feelings of concern and acceptance with nanotechnology. Somewhat uncertain as to its potential implications at the moment, the British public feels that the benefits and the drawbacks of nanotechnology will become increasingly clear over time.

The work by Moses (2002) claims that the future of GM crops and food in Britain should not be dismissed as an unimportant matter, since it is an ongoing debate. Moses also suggests that decisions regarding GM crops and food will have extreme effects on the British economy, employment, and trading positions rurally and overall. This work suggests that regardless of one's opinion, it remains difficult to predict how long the GM debate will continue and the degree of damage that will occur as a result of the decision that is made in the end. Of relevance to this study is Moses' claim that although a considerable level of uncertainty remains among the British public, GM technology will eventually be accepted, as was the case with technologies like vaccination and pasteurization, which were initially also resisted (Moses, 2002).

The research presented by Gregory (2003) was a response to the report published in 1985 by the British Royal Society. The report issued by the Royal Society was a response to threats felt by the British scientific community since many British scientists were leaving for jobs abroad. Many scientists believed that a major factor in this situation was the British public, who, without much knowledge of science, did not value it. The formation of COPUS followed the publication of this report and led to projects like the science book prize, grants for activities which fostered public understanding of science, and media training for scientists. The key findings relevant to this study are presented in Figure 5.5.

- the report concluded that everyone should have some understanding of science, ideally provided at school, emphasizing the need for more science in the media, arguing that scientists would have to learn to communicate to the public and should consider it their job to do so
- a survey conducted in 1988 designed to measure the scientific knowledge and attitudes of lay people included a "knowledge quiz" on matters like: whether the sun goes around the earth or vice versa; whether insects have 8 legs; and whether radioactive milk can be made drinkable via boiling
- the public did not score well, confirming the view that most people had very little scientific knowledge
- therefore, the public was said to be suffering from a deficit of scientific information, which supported the Royal Society's recommendation that the solution to the lack of public understanding regarding science was a result of a lack of communication of science to non-scientists
- however there was also a great deal of criticism, since some scientists were not convinced that the public understanding of science required improvement, since they were not certain this would benefit anyone
- other criticism was linked to the fact that understanding had clearly been equated with factual knowledge of the content of science and furthermore with an appreciation of the scientific enterprise

Figure 5.5 Key findings from "The public understanding of science" extracted from the British Royal Society (1985) and "Understanding 'science and the public' extracted from Gregory (2003).

Figure 5.5 depicts a British public that is said to be suffering from a deficit model of understanding concerning science. Figure 5.5 also suggests that there needs to be increased communication between scientists and the public to inform decision making. However, it is important to remain conscious of the fact that public understanding is often equated with factual knowledge of the content of science and furthermore with an appreciation of the scientific enterprise.

5.1.2-The Canadian Results

The report published by Pollara (2004) comprised a telephone survey of a random sample of 1,430 Canadians, including 794 general public respondents and 636 involved respondents. The objectives for the Pollara research included:

- to obtain insight into the awareness levels of Canadians with respect to biotechnology;
- to explore knowledge levels concerning Health Canada's activities and achievements regarding biotechnology;
- to explore areas of communications; and
- to understand which methods Canadians employ to gather their information about biotechnology.

The data were collected between March 20th and 31st, 2004. The key findings relevant to this study are presented in Figure 5.6.

- more positive reactions to 'biotechnology' and more negative reactions to 'genetic modification'
- although mostly unaware of Health Canada's roles and activities regarding biotechnology, Canadians seem to be quite confident with respect to Health Canada's abilities to adequately regulate such technology
- with regards to information seeking on biotechnology, Canadians have been only modestly engaged, with the internet being the most popular source of information
- Canadians expressed an interest in several issues associated with biotechnology, including:
    1. genetic tests for cancer
    2. summaries of GM food
    3. how biotechnology contributed to the health of Canadians
    4. summaries of health treatments derived from biotechnology
- fewer Canadians expressed interest in hearing about:
    1. the elements of Health Canada's regulatory process
    2. seeing a summary of biotechnology initiatives Health Canada was previously involved in
    3. the ethical guidelines and legal standard in-place for carrying out research in Canada
    4. issues such as international collaboration on safety and regulation
- some level of concern regarding biotechnology was associated with the long term risks concerning GM food and human health
- there was also concern with respect to the severity of the government's safety approval processes for such products
- there were also ethical concerns, including the concern that there may be something unnatural about these products
- there were also concerns about the environment

Figure 5.6 Key findings from "Public opinion research findings on biotechnology" extracted from Pollara (2004).

Figure 5.6 depicts a Canadian public that, although mostly unaware of the roles of its government and Health Canada concerning GM, has a great deal of confidence regarding these organizations. The Canadian public also believes that the Canadian Government will adequately research and assess the science involved regarding GM. Concerning independently seeking out information, the Canadian public has been only moderately engaged. The Canadian public expressed a great deal of interest concerning GM as well

as some concerns primarily related to the long term risks associated with human health, regulation, and the environment.

The report published by Einsiedel (2000) was prepared for the Canadian Biotechnology Advisory Committee Project Steering Committee on the Regulation of Genetically Modified Foods. It aimed to address the following 5 questions:

1. What is the present context for understanding the information needs of Canadians on biotechnology?
2. What do we know about how consumers seek and use information? (i.e. what strategies are employed? and what information strategies have resulted in what outcomes?)
3. Considering labeling, what is known about the use of labels and what is the efficiency of this policy approach for GM food?
4. What other approaches are presently employed to address Canadian consumers regarding biotechnology? (i.e. are there identifiable "best practices?" and what costs and challenges exist?)
5. How do we evaluate the current information we have and what can we recommend to address the needs of the Canadian public?

The key findings relevant to this study are presented in Figure 5.7.

- earlier cautious support expressed by Canadians has changed over the last 3 years to decreased levels of support and increased levels of uncertainty
- public awareness has increased at the same time that uncertainty has developed due to NGOs expressing potential safety and environmental risks and increased media coverage
- at the Federal and the Provincial levels (with the exception of the Council for Biotechnology Information website) efforts are minimal concerning central sites for consumers to obtain information, by comparison to Europe where the European Commission has launched a program called "Educating the European Pubic for Biotechnology"
- the importance of building consumer trust is imperative, particularly given the existing environment of increasing uncertainty
- there is precedent for labeling
- an ethical framework should be employed to communicate with Canadians about biotechnology
- it is necessary to communicate with the public to raise awareness and understanding of biotechnology as well as public involvement and participation

Figure 5.7 Key findings from "Meeting the public's need for information on biotechnology" extracted from Einsiedel et al. (2000).

Figure 5.7 depicts a Canadian public that was somewhat more uncertain concerning GM in 2000 than it was in 1998. Figure 5.7 demonstrates that with the exception of the Council for Biotechnology Information website, efforts in Canada have been minimal compared to Europe concerning central sites from which consumers can attain information. The importance of building consumer trust is becoming increasingly important especially given the fact that labeling GM products in not required by law in Canada. Furthermore, it is necessary to communicate with the public to raise awareness and understanding and encourage public involvement and participation regarding GM

Hepworth (2002) investigated his theory that the hesitant attitudes and mistrust of science, industry, and government have yielded bad policy and regulation concerning pesticides and plant biotechnology. Industry has relied almost entirely on science as the

basis for new and innovative solutions for farmers and consumers and as a means to assess and manage risks. However, there have been indications that the public may not enjoy the same degree of trust and confidence. The key findings relevant to this study are presented in Figure 5.8.

- although Canadians still agree that science should remain the basis for public policy making, they appear to lack confidence in industry
- industry must clearly articulate that it stands for "international, peer-reviewed, evidence-based science"
- industry must be increasingly open and transparent and improve risk communication
- food safety is very important world-wide and Canada and its farmers appear well positioned to build on the Canada name for quality and safety
- stewardship regarding communication between industry and the public has to be about doing the right thing and not just the minimum as is required by the law

Figure 5.8 Key findings from "Mistrust of science, industry, and govt. yields bad biotech policies" extracted from Hepworth (2002).

Figure 5.8 depicts a Canadian public that is somewhat lacking concerning its confidence with respect to industry specifically. Therefore, it is necessary that industry clearly articulate that it supports international science that is peer-reviewed and evidence-based. Recently, and especially with developments in GM technology, a great deal of attention has been geared towards food safety and Canada appears well positioned to build the Canada name for quality and safety. Communication between industry and the public should be broad in its context as opposed to the bare minimum.

The public opinion surveys conducted by the Government of Canada (2004), Decima Research Inc. (2004), and Pollara and Earnscliffe (2000-2003) were designed to gain an understanding of public opinion regarding biotechnology issues in Canada. Since 1999, the Government of Canada's Canadian Biotechnology Secretariat and its partners

have maintained a large-scale tracking program concerning public opinion research. These reports were "designed to produce two waves of research each year with a large tracking component and chapters of more intensive inquiry into specific issues like genetic privacy, GM food and stem cell research" (Pollara & Earnscliffe, 2000-2003, pp. 3). In the eight wave surveys, Canadians were randomly sampled in each telephone survey to probe issues concerning all aspects of biotechnology. The key findings relevant to this study are presented in Figure 5.9.

- most Canadians believe biotechnology to be a leading-edge technology, critical to the country's future economic success
- most Canadians also exhibit high awareness combined with low levels of engagement and knowledge about biotechnology, although increased awareness and extensive media coverage is escalating knowledge somewhat
- the most prominent concern is about the long-term potential risks, specifically related to human health and the environment; however, Canadians are confident that someone somewhere is in charge of mitigating these risks
- most Canadians believe that products on store shelves have been tested and are safe
- Canadian public opinion regarding biotechnology, largely mirrors public attitudes in the US with the biggest differences in the following areas:
    1. GM food(Americans are more comfortable than Canadians)
    2. perceived risks (Canadians are more concerned)
    3. confidence with respect to regulatory authorities (Americans believe their government to be more strict)
- there appear to be 2 main beliefs that are more prominent in the US and may explain the differences mentioned above:
    1. an unwavering certainty in the ability of science and technology to provide an improved quality of life and standard of living
    2. much stronger faith in the power of entrepreneurship, based on the guiding principle that biotechnology represents a new wave of entrepreneurial achievement in the US
- regarding privacy, Canadians support a regime that achieves a balance between the strict protection of personal genetic information and facilitating access to such information, thereby gaining important benefits

GM Food Specifically:

- GM food remains an area of some reservation among many Canadians
- most Canadians believe a new labeling system is needed and many believe one should be required by law
- the levels of trust were high concerning the role of the Canadian government in 2004 with respect to GM food

Figure 5.9. Key findings from public opinion surveys conducted in Canada (1997-2004).

Figure 5.9 depicts a Canadian public that is highly aware, but only slightly engaged and knowledgeable concerning GM. Although Canadians have not actively sought out information, they are confident that someone is in charge of adequately mitigating the potential long term risks they associate with the implications GM technology might have

on human health and the environment. Most Canadians believe that store products are safe and public opinion largely mirrors that of Americans, although there are some differences that are presented in Figure 5.9. Although GM food remains an area of some reservation, a high level of trust concerning the role of the government was still prevalent in 2004.

The research published by Ten Eyck et al. (2004) compares public opinion and policy responses concerning food and agricultural biotechnology in the United States and Europe. They argue that in some countries, including France, food is in a different category from other commodities. Of relevance to this research is firstly that it is not only governments which are divided over the safety, feasibility, and need for food and agricultural biotechnology, since public opinion polls highlight a gap between the public views as well; and secondly, that GM crops and food are considerably more supported by the US than they are by the EU (Eyck et al., 2004).

5.2-General Summary

These results demonstrate that science communication (or the lack there of) has influenced the public understanding of science, thereby contributing to the different attitudes in Britain as compared to Canada. It is clear that public attitudes towards GM crops and food differ considerably between Britain and Canada in many respects. Generally speaking, the British seem to be rather suspicious of their government (Wynne, 1989; Devereux, 2003), while Canadians appear to be quite trusting (Pollara & Earncliffe, 2000-2004). Furthermore, there are strict regulations with respect to

regulatory systems and labeling in Britain, while although Canadians claim they want "informed choice," many foods on their shelves contain GM ingredients even though they are not labeled as such (Pollara & Earncliffe, 2000-2004; Department for the Environment, Food and Rural Affairs, 2004). This demonstrates the complexity of labeling GM food (Miller, 1999). There is a feeling of mistrust and unease among the British (Devereux, 2003), but one of confidence among Canadians, although they lack sound assessment of biotechnology issues and the performance of the Federal Government (Pollara, 2004).

These results suggest that the GM food debate specifically has received extensive media coverage in Britain and Canada. Both British and Canadian citizens have access to informed information regarding the GM food debate and other related topics. However, fear and mistrust have been instilled in the British public due to the government's treatment and attempted cover-up regarding BSE and FMD. This has led the British public to be uneasy concerning government reports and press releases pertaining to other potentially risky issues like GM food, causing it to actively seek out information independently.

Coverage in Canada concerning BSE and FMD has focused on preventative measures and the negative economic impacts along with international relations pertaining to the United States specifically. Since this coverage has focused on economic concerns, the Canadian public, although confident concerning the role of the government, has not sought scientific reassurance on its own. Canadians trust that the government will adequately research and assess the science involved.

However, there also appear to be some similarities. There has always been greater public support for biotechnology for medical purposes as opposed to agricultural purposes in Britain (Devereux, 2003). This also appears to be the case in Canada (The Government of Canada, 1998-2003; Pollara & Earnscliffe, 2000-2003). Another commonality is the desire of the British and the Canadian publics to be involved in the decisions that will affect them and their future. This is apparent from the substantial involvement by the British in the GM nation debate (Devereux, 2003; Heller, 2003; The Department for Environment, Food and Rural Affairs, 2004) and the results concerning the Canadian public opinion surveys and reports (Einsiedel, 2000; Pollara & Earnscliffe, 2000-2004).

5.3-Trends

The trends in the data collected from Britain and Canada were summarized and analyzed for the years 2002, 2003, and 2004. These years were chosen because there were numerous reports to compare for each of them. Data were also collected previous to 2002; however, it was not possible to summarize trends in these data since there were only single reports available for 1985, 1999, 2000, and 2001. From these trends it appears that the attitude of the British public has become increasingly more opposed to GM food since 2002, while the attitude of the Canadian public has become increasingly supportive since 2002. The results from the included reports and studies also demonstrate that the British Government is attempting to increase public understanding and involvement (i.e. the GM nation debate in 2003) in the hope that an informed public

will be more trusting of decisions and claims made by its government. Regarding Canada, levels of support for GM food and trust concerning the roles of the government and Health Canada, were the highest in 2003 that they had been since 1999 (Pollara & Earnscliffe, 2003). There is however, little evidence from these trends that the Government of Canada is taking an active interest in increasing public understanding to further inform the public.

Chapter 6, the following chapter, will examine the results from the GM food debate case study in reference to the objectives posed for this work.

Chapter 6: Discussion

6.1-The GM Food Debate in Britain

Britain was one of the first nations in the world to begin experiments with biotechnology for agricultural applications (Flavell, 1989). Nevertheless, before the relatively recent war in Iraq, the GM food debate may have given the British Government one of the most serious public policy tests it has ever faced (Devereux, 2003). This debate has been divisive from the beginning: on the one hand a largely unconvinced, risk-averse public, finding its voice in environmental organizations and , to a large degree, the media, and the biotechnology industry, members of the scientific community, and the British Government on the other (Gavaghan, 1999; Devereux, 2003; Heller, 2003). The predominant public perception appears to be that the government's bias towards the interests of the profit-driven multinational corporations has negatively affected its responsibility to protect public and environmental safety (Ten Eyck, 2004). However, the public has always been more supportive of GM for medical purposes as opposed to agricultural ones (Devereux, 2003; Heller, 2003).

It is evident that the government failed to accurately anticipate the extent of the controversy (Wynne, 1989; Wynne, 1991; Heller, 2003). However, these incompatible perspectives are not new for the British public, as parallels can be drawn between the Sellafield nuclear accident in 1957, an incident where technical ability seemed to develop more rapidly than the public institutions that were apparently controlling it (Wynne, 1989). Like the nuclear industry, the biotechnology industry has "failed to take its values

from its customers and its discipline from the market" (Devereux, 2003, pp. 220). There seems to be urgent need for the government to investigate how to deal with new technologies and their unavoidable uncertainties, and for the public to be part of developing policies from the start (Devereux, 2003).

The lack of trust in public institutions and the government is what appears to be the basis for public concern. This has been magnified by the GM food debate, but is not limited to it, since the BSE crisis left the public feeling deceived by scientists and the government who failed to disclose the possible consequences of uncertainty and ignorance (Devereux, 2003; Heller, 2003). As a result, claims of safety and no scientific evidence of harm with respect to GM food and crops tend to be met with uncertainty and hesitation by the British public (Williams, 1998). Therefore what is regarded as misconduct in science, which often leads to a lack of trust, also tends to be influenced by perspective (Schachman, 1993).

Regardless of what appears to be a predominant feeling of uncertainty, two scenarios remain with respect to the future of agricultural biotechnology in Britain: acceptance and rejection (Moses, 2002; Gregory, 2003). The acceptance scenario predicts that:

- Britain will strive for market-driven expansion and application of biotechnology on the basis of existing regulatory policies;
- that British agriculture will be able to sustain its international position and use its potential skills for developing new crop varieties to become a leader in producing specific products; and

- that Britain will successfully make an important contribution to the long-term improvement of global agriculture practices, an essential requirement for feeding the predicted increase (three to four billion) in the total population over the next half century (Hoy, 1991; Moses, 2002).

The rejection scenario predicts that:

- Britain (or at least some of its regions) will reject biotechnology and effectively remove itself from the forefront of future agricultural development;
- that, as a result of rejecting GM practices, Britain will be left behind by the world's dominant food producing regions; and
- that Britain will refuse to import GM crops and foods, potentially making food imports from the rest of Europe and elsewhere impossible, thereby creating large problems, since more than 60% of soybeans worldwide are likely GM already, and Brazil, the last major source of supposedly GM-free soybeans for British cattle feed is now at least 20% GM due to seed smuggled from Argentina (Moses, 2002).

6.2-The GM Food Debate in Canada

As is demonstrated by the results in Chapter 5, the situation regarding the government's attitude towards informing its public is very different in Canada and Britain. Pollara Inc. has played a major role concerning public opinion research in Canada. The largest Canadian public marketing research company, Pollara Inc., helps its clients improve their performance through strategic research that is specifically designed

and analyzed by consultants who are true experts in their fields of study (The Government of Canada, 2003; Pollara, 2004). As such, they have been utilized by the Government of Canada to conduct a series of public opinion surveys tracking reactions to biotechnology in Canada.

A study recently conducted by Pollara (2004) in Canada revealed some interesting information pertaining to Canadians and their views on GM, biotechnology, and the role of Health Canada. The research included the results of a telephone survey of a random sample of Canadians comprised of a combination of the general public as well as involved Canadians (Pollara, 2004). The data were collected between March 20th and 31st, 2004 and the objectives of the study included:

- gaining insight as to the awareness levels of biotechnology among Canadians;
- exploring the knowledge-level of Canadians with respect to Health Canada's activities and achievements in biotechnology;
- exploring areas of communication; and
- obtaining an understanding of how Canadians inform themselves about biotechnology (Pollara, 2004).

The first issue investigated was nomenclature, pertaining specifically to the terms "biotechnology" and "genetic modification," (GM) which appeared to have different implications for Canadians. The general public tended to associate biotechnology with relatively positive connotations, while GM tended to be associated with more negative connotations (Pollara, 2004). Scientifically literate Canadians appeared to have a somewhat more favourable reaction to both terms (Pollara, 2004). There appeared to be strong support for many biotechnology applications, particularly with respect to health

and the environment, although those related to agriculture reflected greater uncertainty (Pollara, 2004). Nevertheless, concerns remain about the long-term impacts on human health and the environment, with ethical concerns being the least worrisome (Krimsky, 1995; Canadian Biotech News, 2004; Pollara, 2004).

It appeared that Canadians were largely unaware of the roles and activities of Health Canada with respect to biotechnology, although Canadians appeared confident in the ability of Health Canada to regulate such technologies (Pollara & Earnscliffe, 2000-2004; Pollara, 2004). Canadians would be in favour of Health Canada placing higher priority on a more stringent approval process; long-term research into potential impacts of new practices and technologies; and increased funding for health research (Pollara & Earnscliffe, 2000-2004; Pollara, 2004). It appeared that Canadians had only been moderately engaged in finding information on biotechnology and those who expressed the strongest concerns were more likely to have sought out information generally and from Health Canada specifically (Pollara, 2004). Those who had not sought out information either claimed they never needed to, or that they did not have the time (Pollara, 2004). The internet appeared to be the most popular means of acquiring information, although the media, including television, the news paper, and magazines was also used (Pollara & Earnscliffe, 2000-2004; Pollara, 2004). Radio advertising and pamphlets appeared to be the least effective means of information acquisition (Pollara & Earnscliffe, 2000-2004; Pollara, 2004).

The top issues related to biotechnology that interested Canadians included genetic tests for cancer, summaries of GM food, how biotechnology contributes to the health of Canadians, and summaries of health treatments derived from biotechnology (Pollara,

2004). Canadians also expressed considerable interest in receiving balanced information, namely the risks and the benefits associated with biotechnology (Pollara & Earscliffe, 2000-2004; Pollara, 2004). Although issues related to health and food applications were of primary concern to Canadians, also of concern were topics like the elements and structure of the regulatory system regarding GM food (Turner, 2001; Pollara, 2004).

Therefore, although most Canadians have not been avid seekers of information related to biotechnology to date, findings suggest that this may change in the future (Pollara, 2004; Pollara & Earnscliffe, 2000-2004). Although Health Canada is not the major source of information currently, there were indications that there is potential for Health Canada to play a much more substantial role in this area and that Canadians expressed confidence that this would in fact happen, suggesting that Health Canada was generally well regarded in the field of biotechnology (Pollara, 2004). Canadians expected balanced information and were mainly concerned with health, specifically in terms of application and stewardship (Hepworth, 2002). Therefore, there appeared to be a natural link between Health Canada's mandate and the information of particular interest to Canadians with respect to biotechnology (Pollara, 2004).

6.3-The GM Food Debate and Post-Normal Science

The BSE epidemic and the licensing of GM maize demonstrate a progression from hazards that are conventional and manageable mainly by applied science, to those that are entirely post-normal (De Marchi & Ravetz, 1999). As defined in Chapter 2, post-normal science is, to a certain degree, a new type of science that is able to cope

adequately with uncertainty. Post-normal science developed in response to the new conditions of science in its social context, typically associated with increasing confusion and uncertainty (Ravetz, 1999; Department for Environment, Food and Rural Affairs, 2004). Being a relatively new science, GM is commonly associated with uncertainty, thereby linking it to post-normal science directly. Initially, the reaction of the British Government after the BSE crisis was to insist that everything was under control and safe (De Marchi & Ravetz, 1999; Gregory, 2003). The British therefore acted in a closed and consensual manner (Ten Eyck, 2004). Hence, confidentiality appeared to be a key aspect of the British system (De Marchi & Ravetz, 1999). However, it is by no means certain that the British closed and consensual approach will retain its previous effectiveness, as demonstrated by GM maize and the present decrease in public trust.

The GM maize controversy started with the development, by Ciba-Geigy (later merged with Sandoz into Novartis) of Knockout, a strain of GM maize that included two bacterial genes for providing desirable traits, plus a marker gene (De Marchi & Ravetz, 1999). GM maize raised two major reservations: firstly, the possibility that it would create resistant pests and/or harm beneficial insects such as lacewings, a major predator of agricultural insect pests; and secondly, the sloppy incorporation of the marker gene was viewed as a considerable potential hazard, possibly leading to increased antibiotic resistance among widespread animal and human microorganisms (De Marchi & Ravetz, 1999). The feelings of uncertainty were heightened when Greenpeace UK published a pamphlet alluding to the strong similarities between the official reassurances about GM maize and the earlier ones about BSE (De Marchi & Ravetz, 1999). Other varieties of

GM maize whose proponents claim they have a less sloppy design have since been approved as well as GM soya beans (De Marchi & Ravetz, 1999).

The decisive factor in approving GM technology should be the safety of a new food product, and although a precautionary principle is employed, its articulation is not fully developed, so some crucial details still need to be decided (De Marchi & Ravetz, 1999; Levidow, 2001). The acknowledged risks are those arising immediately from the product or the procedure used to create it; the risks of its application on a large spatial scale, or those associated with an accumulation of it, are not taken into account (De Marchi & Ravetz, 1999; Savadory et al., 2004). Furthermore, the prospect of profit is accepted as a sufficient benefit for the innovation, while the possible concerns of the public about the manipulation of their food are not necessarily regarded as relevant (De Marchi & Ravetz, 1999; Devereux, 2003).

In one sense, the risks associated with GM maize are post-normal, since there is no blatant, demonstrable evidence of damage (De Marchi & Ravetz, 1999; Moses, 2002). It is not simply a question of different ways of considering a potential risk, since some perceive no risk at all. Therefore, this debate is as much on the practical level as it is on the scientific, since it considers:

- how acutely possible future hazards should be weighted;
- the consequences of faulty procedures; and
- to what degree it is justifiable for policy and commercial concerns to influence the assessments of potential risks (De Marchi & Ravetz, 1999; Devereux, 2003; Gregory, 2003).

The BSE case raised the question of whether the closed and consensual British approach would be adequate for new potential risks like GM food, where, conflicting commercial and political pressures at local and international levels become factors. New potential risks like GM food combine extreme uncertainty with the possibility of extensive and irreversible damage (De Marchi & Ravetz, 1999; Devereux, 2003). Without reliable scientific evidence (credible), governance becomes more dependent on the reliability of authorities, achieved to a degree by additional public participation (De Marchi & Ravetz, 1999; Devereux, 2003).

In the past, concerned citizens have shown that they can handle uncertainty and disagreement among scientific experts quite well (De Marchi & Ravetz, 1999). What causes resentment is when the public feel that problems are being concealed from them (De Marchi & Ravetz, 1999; Devereux, 2003). Also, there appears to be a general awareness that building trust is not an issue of unrealistic, complete sharing, but of being honest given the limitations of one's role in a negotiation; and acknowledgement and appreciation of this can facilitate an honest discussion (De Marchi & Ravetz, 1999). Fair commitments result from such discourse, since each side comes to appreciate the integrity of the other and the legitimacy of another point of view. There are signs that this may slowly be occurring with respect to the GM food debate, although there has been a surge of anger in many parts of the world, against the apparent arrogance of multinational corporations and the complicity of governments (De Marchi & Ravetz, 1999). Therefore, it is becoming evident through issues like GM food that although science is necessary for solving many of today's problems, in its old form, it will probably not be sufficient on its own given the questions we wish to answer. Therefore,

the modern world will likely have to resort to post-normal science as a means to solving current issues.

Ravetz claims that "any science that assumes certainty and relegates the most urgent problems to "externalities" will be seen as increasingly irrelevant and bizarre" (Tognetti, 1999, pp. 690). This implies urgency for adaptive approaches, such as that of post-normal science, since decision making concerning issues like the GM food debate, will need to be informed under uncertainty (Devereux, 2003). This uncertainty has developed largely as a result of science and society becoming increasingly disconnected due to conflicts resulting from the divergence of scientists, social scientists, and the public towards different, contradictory directions (Tognetti, 1999; Devereux, 2003).

Nevertheless, the post-normal science approach should not be construed as an attack on recognized experts, but rather as a form of support, since normal science still has its place in any scientific study pertaining to the environment; however, it needs to be enhanced by a consciousness of the post-normal character of today's problems. The management of multifaceted natural and social issues as if they were simple, scientific systems has created the present combination of achievement and risk (Ravetz, 1999). Currently, the emergence of a new problem-solving strategy is being observed, in which, the role of science, although fundamental, is now valued to include the uncertainties of natural systems and the relevance of human morals (Ravetz, 1999).

6.4-The GM Food Debate and the Role of Trust

Mistrust and fear are nothing new concerning science as they have been associated with it since the very first centuries of modern science (Cohen, 1981). Public trust is an important factor contributing to the commercial success of biotechnology specifically (Harvey, 2003). The role of trust in encouraging public support is especially important with respect to risk communication. This is the case because consumers seem to believe that biotechnology corporations have a "reporting bias" (overstate benefits and understate risks) and a "knowledge bias" (inability to adequately anticipate all the possibilities) concerning how the risks and the benefits associated with biotechnology are communicated to the public (Devereux, 2003; Harvey, 2003). This often causes information considering the risks of biotechnology reported by biotechnology corporations, to be disregarded by the public. Therefore trust, or the lack thereof, clearly influences the public support of biotechnology (Harvey, 2003).

Knowledge and trust tend to be linked very closely. As a result, when knowledge is lacking trust is essential, and when trust is lacking knowledge is essential (Gregory, 2003). The issue of trust in public institutions and the government still appears to be the core of public concern in Britain, although this appears to be less of an issue in Canada presently (Devereux, 2003; Pollara, 2004). This may be a result of deceit felt by the British public following crises like BSE and FMD. Trust can be seen "as a 'counterbalance' or an 'inoculation' against uncertainty; it provides the basis of confidence in those who regulate the risk" (Ten Eyck, 2004, pp. 262). Therefore, as a risk regulator, it is essential that the government act responsibly, basing its decisions on well-researched information, and the safety and cultural values of the public.

6.5-Summary

The findings of this research have shown that science communication must be employed to foster communication between scientists and the public to enhance the public understanding of science. When the public understanding of science is improved through better communication between scientists and the public, it ensures, as much as possible, that public opinion is based on logic rather than irrationality. It should also be noted that even within the scientific community itself, there is often large disagreement on fundamental issues. This disagreement however, is what has shaped and advanced science rather than limited it.

As is apparent from the questions raised by the British public in response to the debate over GM technology, there appears to be a considerable interest not only in the science of GM crops, but also concerning their political and social consequences (Gregory, 2003). These questions concerned responsibility, accountability, regulation, trust, and how the results of this debate would be used with respect to decision-making in the future. Although there is widespread unease about GM technology and little support regarding the overall commercial uses for it in Britain, this is accompanied by an overriding consensus in favor of further GM research, as well as enthusiasm and appreciation for the opportunity to engage with GM experts and other members of the public and thus be able to influence the course of the debate (Gregory, 2003).

The British Government has been advised not to ignore the findings of the GM nation debate, since this would only propagate feelings of suspicion and lack of trust in the government, making it increasingly difficult to engage the public in similar exercises

in the future (Devereux, 2003). It is also critical that the government examine the lessons to be learned from this debate. It is important that the government consider the lessons concerning the implications of policy regarding GM food, as well as how to more effectively engage a largely disheartened public in the decision-making process (Devereux, 2003).

Canadians exhibited a great deal of interest concerning biotechnology (Pollara & Earnscliffe, 2000-2004). They seemed to be most concerned about potential risks regarding human health and the environment (Pollara & Earnscliffe, 2000-2004). Although Canadians have always been the least accepting of applications of biotechnology involving GM food, their support appears to have increased recently (Pollara & Earnscliffe, 2000-2003; Pollara, 2004). Canadians also expressed a great deal of confidence regarding Health Canada's role in investigating any future health-related issues (Pollara, 2004). Overall, Canadians appear to have a generally positive attitude towards biotechnology, which has remained quite consistent since 1998/99 (Pollara & Earnscliffe, 2000-2004; The Government of Canada, 2003). Their attitude regarding GM food specifically appears to be an increasingly positive one (Pollara & Earncliffe, 2000-2004).

Canadians' current level of trust in their government and regulatory departments such as Health Canada, as well as the differences between the British and the Canadian publics, may be partially explained through the following observations. The BSE and FMD disasters in Britain have left the government in a position of attempting to re-build trust, through the provision of reliable information. Due to limited natural resources in Europe, the public tends to be more protective of the environment because these natural

resources (available land, fresh water, etc.) are so expensive and limited (European Science Foundation, 2003). Governments have realized the necessity to conserve these limited natural resources and have influenced (through education, taxing gas, adopting more environmentally friendly technologies, etc.) the perception of the European public as a result (European Science Foundation, 2003; Duke, 2005).

The following examples illustrate the complexity of the GM debate when considered in its complete context. These are of importance to the relationship between science communication and the public understanding of science, since they are major factors in how public opinion concerning this debate is formed. Biotechnology is a relatively new science and the public largely expects it to be approached with caution. The ulterior motives behind the GM debate are also evident and inform public opinion in general and with respect to opinion concerning government decisions. Therefore, they must also be considered in an analysis of the roles of science communication and the public understanding of science regarding the GM debate in Britain and Canada.

There is no scientific evidence as of yet establishing for certain that GM food is in fact harmful to human health (European Science Foundation, 2003; Pollara, 2004). However, the entire basis of scientific reasoning rests largely on rejecting null hypotheses in order to accept a single hypothesis. This process of elimination keeps science healthy through continual challenge and scrutiny rather than rash acceptance before conclusive evidence is found. The nature of science rests largely on how scientists decide to apply their understanding of natural phenomena.

While discoveries in science expand our consciousness of already existent trends and qualities, the direction in which these achievements guide science is a factor of how

we choose to apply them. For example, Alexander Fleming's discovery of antibiotics represented a monumental step forward in modern medicine (Duke, 2005). But our continual over usage and eventual reliance on this breakthrough has indeed altered (negatively) its potential. The way in which antibodies react with pathogens was there for us to find, but how we have used this discovery has altered its importance. In the case of biotechnology, while we have no way of knowing necessarily if such unforeseeable consequences may emerge as a result of its application, to fail to entertain this possibility would be to disregard what science has taught us.

As mentioned in Chapters 2 and 3, one of the principal arguments in favor of crop biotechnology is the prospect of increased agricultural efficiency: higher crop yields, less pesticide use, and reduced emissions from agricultural energy consumption, to name a few. We must however, be aware of other factors influencing the course of the biotechnology debate. Most crop biotechnologies have been developed in the private sector for profit rather than in the interest of agricultural development in the third world. In practice the opposite has occurred. Developing countries were largely ignored by large multinationals because they were not seen as being of much value as consumers of GM technology. It appears that just as drug companies (often the same companies as those developing biotechnology such as Monsanto/Novartis) have more or less ignored the needs of impoverished areas of the world as neither the people nor their governments of these regions can afford modern drugs, so have they shown no interest in these countries with respect to GM until now.

What has changed is what has happened outside of the developing world, notably the differences in policy between the EU and the US Governments (Cohen & Paarlberg,

2004). Public opinion in countries such as the EU and Japan (both large importers of American agricultural products) is tending to shift away from unequivocal support for GM and the market for GM is therefore stagnating somewhat (Cohen & Paarberg, 2004). Developing countries such as Africa are now the new market for crop biotechnology not necessarily because of its attributes but because of its potential market value.

The example of how the famine and subsequent food crisis of 2002 in southern Africa was dealt with by the US highlights this. By insisting on shipping GM maize as food aid to African nations despite the widespread opposition to this by African Governments, the US disregarded many legitimate concerns about GM. Because of the US insistence of not milling the grain before shipment to African nations, the fear was that GM seeds would unintentionally be planted by African farmers and thus make their exports tainted with GM or altered genes (Zerbe, 2004).

The course of GM's effect in future years will depend as much on the dialogue between the public, governments, and scientists. Regardless of the new advances in biotechnology that will hold great potential in a variety of areas, the way in which such discoveries are directed by this discourse will determine their ultimate influence. Clearly, governments must play an increasingly important role in this process as a link between scientists and the general public. Public opinion has always, and will always be of immense value in tempering the outcomes of scientific breakthrough, and this should be fostered rather than disregarded. The ultimate outcomes of science are felt most in the public domain, and so as the recipient of science, the public must be formally allowed into the discussion. Public opinion is not always right, or even well informed, but it cannot be simply ignored and disregarded on this basis.

Chapter 7: Conclusions and Recommendations

7.1-Conclusions

This thesis attempted, through a critical examination of evidence in literature, to investigate how the role of science communication in the GM food debate has affected the public understanding of science, and specifically of biotechnology, in Britain as compared to Canada. The following objectives were used:

- to explore the practice of science communication, and through available evidence in literature, to determine the role it has in the public understanding of science;
- to complete a comparative analysis of science communication practices and the public understanding of science in Britain and Canada; and
- to present a summary of the GM food debate and the role of science communication and public understanding.

The trends suggest that the currently skeptical British public may be explained by attempts made by the British Government to increase public understanding and involvement (i.e. the GM nation debate in 2003). These attempts were made by the British Government in hopes that an informed public would be more trusting of decisions and claims made by its government in the future. However, it appears that due to the mistrust of the British public concerning its government, the public is also skeptical of government provided information regarding GM.

With respect to Canada, the trends suggest that levels of support for GM food and trust concerning the roles of the government and Health Canada have increased since

1999. There is however, little evidence from these results that the Government of Canada is taking an active interest in increasing public understanding to further inform the public. These results demonstrate that more research needs to be done to determine the absolute and directional affects of science communication on public understanding. However, based on the trends identified, it does appear that the role of science communication in the GM food debate has affected the public understanding of science, and specifically of biotechnology, in Britain as compared to Canada. The attempts by the British Government to inform its public demonstrate that a more informed public does not guarantee an increased level of trust. Conversely, the lack of attempt by the Canadian Government to inform its public about GM, illustrates that a less informed public does not guarantee higher levels of mistrust.

The overall success of the commercial biotechnology industry depends largely on the public's acceptance of GM crops and the use of biotechnology in agricultural practices and food production (Harvey, 2003). This is the case, because if the public, the consumer, refuses to accept such applications of biotechnology, there will be no interest in purchasing GM products. This is why public trust is such an important contributing factor concerning the commercial success of biotechnology (Harvey, 2003).

As compared to the EU, the US, which is largely similar to Canada in terms of the GM food debate, appears to have more confidence in those involved in the production, retailing, and regulation of biotechnology (Decima Research Inc., 2004; Ten Eyck et al., 2004). Although the numerous reports issued by the Government of Canada and Pollara and Earnscliffe on public opinion research into biotechnology issues do not suggest that

the government has taken an active interest in increasing public understanding, they do suggest a clear interest in public concern in Canada.

However, the recent announcement by The Agricultural Biotechnology Council "that they intended to 'go out of [their] way to understand and address [public] concerns'" made it clear that public concerns seem to be among the *core* interests of British officials (Gregory, 2003, pp. 137). Furthermore, the public debate GM Nation? was supported by the British Government. This resulted due to the examination of the decision-making process by the Agriculture and Environment Biotechnology Commission (AEBC), which concluded that there was a need for public debate on GM issues that would employ innovative, participatory engagement (Devereux, 2003). It was also recognized that public involvement was required concerning decisions on the commercialization of GM crops in Britain. However, although there has been clear investment by the government to increase public understanding, British companies still highlight what they view as public failings, rather than valuing public points of view regardless of how they were formed (Gregory, 2003).

Some respect for the public could indeed be rather beneficial, since as consumers and citizens it decides whether a new product succeeds or fails. Therefore, rather than characterizing the public by what it lacks, British industry might gain more by placing some value on the numerous qualities the public could add to discussions concerning science, especially given its ability to see broadly, perhaps recognizing some important, potential consequences associated with new technology as a result (Gregory, 2003).

Although Canadian attitudes towards GM food seem to be increasingly positive, as discussed in Chapters 5 and 6, Canadians have expressed a desire for "informed

choice," which raises questions concerning adjustments to the current regulatory system, potentially including the future labeling of GM food (Einsiedel et al., 2000; Pollara & Earnscliffe, 2000-2004; The Government of Canada, 2003). There are also concerns associated with labeling, since advocates of GM crops in particular often believe that labeling deters consumers for the wrong reasons – namely because of fear, which lacks scientific evidence to back it up, derived instead from unfounded attitudes with little or no scientific foundation (The Government of Canada, 2003).

However, both these perspectives are valid regardless of a given individual's opinion or preference. It is true that without labels Canadians are unable to know with confidence what they are purchasing, but it is also true that there is no scientific evidence currently available which demonstrates that GM food is harmful to human health. Nevertheless, being a very new science, the potential implications of biotechnology remain largely uncertain, as is typically the case concerning most novel endeavors. Furthermore, as discussed in Chapter 6, human-beings have reason to approach new developments in science and technology with caution. As is also discussed in the previous Chapter, it is essential that the real motives behind biotechnology be considered upon drawing conclusions concerning decisions to support or to reject it and that public opinion must be acknowledged. The importance of the discourse between scientists, the government, and the public is well portrayed in the following commentary by Irwin and Wynne:

"thus the practical target of advancing the public understanding of science depends upon a willingness to facilitate a broader discussion of the contemporary – and changing – character of science and the relationship between this and wider relations of knowledge and citizenship. This will raise difficult questions about the limitations of scientific understanding, the direction of scientific research, the relationship between public needs

and private profit, and, ultimately, about who should control science" (Irwin & Wynne, 1996, pp. 221).

A discussion of the very nature of our environment, the GM debate is of great importance to Environmental Science. Encompassing issues ranging from the general, ethical, and moral questions concerning biotechnology, to the more tangible impacts and ramifications of this technology, its adoption may well be one of the most sudden and historic steps in the history of our environment. Never before have human-beings had the knowledge and the ability to shape the natural world, and as a result, society has never really had to deal with a decision of such monumental importance. Thus, Environmental Science is the science that can best address and provide insight into how our society might best deal with this question. The knowledge that the study of Environmental Science has already accumulated is the best source of information to use to make educated decisions concerning this subject. Adopting GM crop technology will have real impacts, likely including positive and negative ones, but most importantly probably a combination of both. Whatever the ultimate outcome, trying to best direct and shape GM crop technology and the policies that surround it into the most sustainable thoroughly thought out form, is a proactive and responsible measure we can adopt in order to make GM a technology of long-term benefit.

The results of this research are particularly important in the realm of post-normal science. The complex problems represented by post-normal science necessitate risk assessment and management skills of those who attempt to solve them and science communication plays a crucial role in this.

7.2-Recommendations

To provide recommendations pertaining to this research, it is important to understand the cultural and historical contexts in which science, and specifically the GM food debate, is currently evolving. Due to an immense increase in new scientific and technological advancements over the last decade, the public is regularly exposed to new and controversial ideas. However, this exposure is not necessarily indicative of understanding or trust. To frame the recommendations, I feel it necessary to first outline these contexts.

The last decade of the 20th century witnessed unprecedented advances in science and technology, the passing of the human population milestone of six billion members, and a continued drive toward the globalization of the marketplace, including creation of trade agreements, expansion of international trade conventions, and the growth in the power and influence of multinational conglomerates. With these advances came continued pressures to feed the growing population, distribute the wealth and powers of the world's peoples, and preserve the natural biodiversity of the planet. Long established systems of governance thus came under new demands to protect health and environment, equitably distribute resources and wealth, and facilitate trade between new partners and in commodities with new features and perhaps unknown attributes.

Modern biotechnology, thought by many to be one of the most important achievements of the 20th century, offers the hope to some that we will be able to meet the nutritional needs of the world's peoples as we face increasing population pressures via advancements such as GM food. For others however, biotechnology and GM food raise fears of varying magnitudes.

To governments worldwide, modern biotechnology presents an urgent agenda of development, access and regulatory issues. Royal Commissions, special committees and international task groups have been established to explore, debate, and recommend strategies to deal with these myriad issues. Volumes of documents have been submitted for public consultation and government debate, and preliminary attempts at governance have been tabled. Academics, regulators, parliamentarians, scientists, industrialists, and members of the public have contributed to the debates and calls have been made to improve the science, regulation, consultation, communication, identification, and distribution of benefits and risks.

While public concerns about the safety, equity, and environmental sustainability of genetically modified food crops are many; few experts question their ability to contribute to increased food security in a period of growing need. In the marketplace and countryside it is becoming increasing clear that public confidence in the application of biotechnology to food production is not at all secure. Recent reaction has forced governments and international institutions in turn to reconsider their initial support for agricultural applications of biotechnology and to re-evaluate their approach to both the science itself and to public information. Indeed, a failure to respond adequately to initial concerns has perhaps resulted in this now very public issue becoming more complex than originally envisioned.

Calls for bans, actions of environmental and agricultural violence, and mass-media descriptions of "Frankenfoods" have contributed to the general sense of unease. However, what is of particular note here is that although all of the submissions and comments have made important contributions to specific knowledge of the issues, all

reach essentially similar conclusions in terms of the gaps that remain. Without question the largest gap, and the one with the most potential to pull any scientific or regulatory progress into a void, is the lack of appreciation for public concerns regarding biotechnology. Societal response to scientific issues is becoming an increasingly important area of study and is perhaps brought to its pinnacle when considering an issue of such intimate acquaintance as food for human consumption.

In summary, the literature is clear that the issues surrounding the introduction of agricultural biotechnology are heavily burdened with scientific questions, a regulatory mismatch of instruments originally designed for quite different constructs and public lack of information or miss-understanding of concepts. Yet, the expansion of agricultural investment in GM crops in the major producing countries of Canada, the United States, Argentina, and to some extent parts of Europe and Africa are testament to an optimistic future for agricultural biotechnology. It is imperative that the regulatory questions such as those described above be addressed to keep pace with (or catch up to) this growth area in the new economy. It must not be forgotten that the application of modern biotechnology to agriculture is also an issue that brings with it distinctive national perspectives and priorities. Economic incentives for research and development are bound up with varying degrees of concern for environmental conservation, issues of food security and support for developing countries. National approaches to regulation quite naturally consider local environmental and health concerns, but trade in agricultural commodities in the international market brings new complexities.

Therefore, it becomes clear that the many questions raised can be grouped as those relating to the management of agricultural biotechnology, the safety of food, the

protection of the environment, and the ownership of the products and processes. As a tradable commodity, crops produced through the application of modern biotechnology raise important questions of international trade and national versus international sovereignty for protection of the environment. A prerequisite for any appropriate response to these groups of questions must surely be an understanding of the interplay between the sciences, regulatory bodies, international trade organizations, and society.

It also becomes obvious that the mechanisms for facilitating this discussion have not previously been available, nor have appropriate procedures for developing or implementing any new regulatory initiatives. As discussed above, modern biotechnology presents governments, policy makers, and regulatory agencies with questions of which the drafters of earlier policies had no comprehension. Still, in the absence of new initiatives, existing national and international regulatory instruments are being called into play to respond to the diverse and immediate issues raised.

Repeated calls for policy guidance and new regulatory methodologies were tabled during the latter part of the 1990s and early 2000s. The failure to adequately respond to these calls leaves the public with concerns about the abilities of governments to monitor the advances of science, protect their interests, and control the commercial activities of biotechnology companies. The literature is clear that the complexities of agricultural biotechnology are many and that the somewhat traditional instruments of the regulatory system are inadequate. Studies to date have clearly established that the management issues surrounding risk identification, analysis, management, and communication are fundamental to any regulatory initiative for agricultural biotechnology. When dealing with a living, science based system any discussion of risk raises the related issues of

uncertainty and precaution. Finally, the aforementioned issue of risk management in the context of uncertainty immediately raises a concern regarding liability.

As discussed in the previous chapter and taking into account the above outlined context, Canadians expressed a high level of confidence in their government (specifically in Health Canada) to adequately regulate and investigate biotechnology applications, including those concerning GM food (Pollara & Earnscliffe, 2000-2004; Pollara, 2004). Therefore, in order to maintain this level of trust, it is essential that the Government of Canada and Health Canada do what Canadians have faith they will do.

Therefore, concerning the GM food debate specifically, one recommendation might be that the Government of Canada rebuild any recently lost trust, since new science like GM technology, requires consumer acceptance to be successful. To date Canadians are very trusting of their government pertaining to biotechnology and GM food, however, recent government decisions and associated news studies demonstrate that Canadians could become somewhat skeptical. The most recent example in Canada is Vioxx, a popular pain relief medication, which was taken off the market after news surfaced of adverse drug reactions (CBC, 2005). Given that the drug had previously received market approval, this recent move has the potential to cause Canadians' trust to dwindle. The recent ruling in Montana (the US border will remain closed to Canadian cattle of thirty months or less to prevent the transmission of BSE) is another example that has instilled further feelings of unease in the Canadian public (CBC, 2005). Therefore, the Government of Canada must do everything in its power to maintain the trust it has built among its public and to re-build any trust it has recently lost.

With science communication and a public understanding of science in place, the public would be able to adequately deal with the future labeling of GM food. This would give Canadians the "informed choice" they seem to desire. Therefore, another recommendation proposed by this study is that science communication and a public understanding of science be fostered, since the public cannot be expected to make accurate decisions concerning labeled GM products without an understanding of what these labels mean.

Adequate science communication and public understanding also appear necessary in considering the GM debate in its complete context. With sufficient understanding the public will be able to recognize applications of GM technology that are orientated towards goals that *need* to be addressed and are not simply monetary ambitions (i.e. not fostering reliance on pesticides and unnecessarily expensive machinery so that smaller farmers are able to survive and land does not become monopolized by large corporations). Therefore, a third recommendation would be that science communication and a public understanding of science be developed so as to give the public the tools it needs to make informed decisions and thereby support applications of GM that consider this technology in its complete context.

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Appendix A: The Advisory Council on Science and Technology in Canada

The Advisory Council on Science and Technology was created on July 5th, 1996 (The Government of Canada, 2004). The Council's responsibility is to review Canada's performance concerning research and innovation, identify emerging issues of national concern, and design an innovative program, placing Canada in an international context (The Government of Canada, 2004). Thus, their role includes:

- providing advice on Canada's transition to a knowledge-based economy;
- contributing to the process of identifying the necessary adjustments on how to increase the number of Canadians with the skills necessary for a knowledge based economy;
- providing advice on how government, industry, and academia can work in partnership to transform research and new technologies into new products, processes, and services;
- providing advice on scientific and technological issues to the Cabinet Committee for the Economic Union; and
- responding to specific questions and requests from the Prime Minister (The Government of Canada, 2004).

The Council is comprised of reputable Canadians who characterize different sectors of business, academia, and research institutions, represent all regions of the country, and provide expert, unbiased advice to the Prime Minister (National Science Advisor, 2004; The Government of Canada, 2004).